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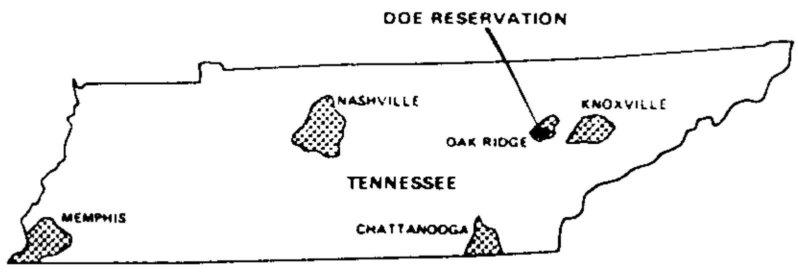
MARTIN MARIETTA

ENVIRONMENTAL SURVEILLANCE OF THE U.S. DEPARTMENT OF ENERGY OAK RIDGE RESERVATION AND SURROUNDING ENVIRONS DURING 1986

Volume 2: DATA PRESENTATION



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MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

ES/ESH-1/V2

ENVIRONMENTAL SURVEILLANCE OF THE U.S. DEPARTMENT OF ENERGY OAK RIDGE RESERVATION AND SURROUNDING ENVIRONS DURING 1986

Volume 2: DATA PRESENTATION

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ACRONYMS

ACN	Acetonitrile
ANSI	American National Standards Institute
APG	Analytical Products Group
BCVWDA	Bear Creek Valley Waste Disposal Area
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Lab Program
CPCF	Central Pollution Control Facility
CPCF-II	Central Pollution Control Facility-Phase II
CRK	Clinch River kilometer
CWA	Clean Water Act
DL	Detection level
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
EML	Environmental Measurements Laboratory
EMSL-LV	Environmental Monitoring Systems Laboratory-Las Vegas
EP	Extraction procedure
EPA	Environmental Protection Agency
ERA	Environmental Resource Associates
FRC	Federal Radiation Council
ICRP	International Commission on Radiological Protection
LLW	Low-level radioactive waste
LLWDDD	Low-Level Waste Disposal, Development, and Demonstration
NBS	National Bureau of Standards
NPDES	National Pollutant Discharge Elimination System
NRWTP	Nonradiological Waste Treatment Plant
ORAU	Oak Ridge Associated Universities
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	Polychlorinated biphenyls
PET	Proficiency Environmental Testing
PW	Process waste
QA	Quality assurance
QC	Quality control
RCRA	Resource Conservation and Recovery Act
SLB	Shallow land burial
SWSA	Solid Waste Storage Area
TDHE	Tennessee Department of Health and Environment

TLD	Thermoluminescent dosimeters
TRK	Tennessee River kilometer
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSWMA	Tennessee Solid Waste Management Act
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
WETF	West End Treatment Facility
WIPP	Waste Isolation Pilot Plant
WS	Water supply
non-TRU	Non-transuranic

1. INTRODUCTION AND GENERAL INFORMATION

1.1 OPERATIONS ON THE OAK RIDGE RESERVATION

The Oak Ridge Reservation (ORR) contains three major operating installations: Oak Ridge National Laboratory (ORNL), the Oak Ridge Y-12 Plant, and Oak Ridge Gaseous Diffusion Plant (ORGDP). These three installations are indicated on the map of the ORR shown in Fig. 1.1.1. The administrative units on the ORR are shown in Table 1.1.1. In addition, two smaller U.S. Department of Energy (DOE) facilities are in the Oak Ridge area: the Scarboro Facility (formerly the Comparative Animal Research Laboratory) and Oak Ridge Associated Universities (ORAU), both of which are operated by ORAU.

ORNL, located toward the west end of Bethel Valley, is a large, multipurpose research laboratory whose basic mission is to expand knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, ORNL conducts research in all fields of modern science and technology. ORNL's facilities include nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

The Oak Ridge Y-12 Plant was originally constructed for the U.S. Army Corps of Engineers in 1943 as a part of the highly classified Manhattan Project. The original mission of the Oak Ridge Y-12 Plant was to separate fissionable isotopes of uranium (U-235) by the electromagnetic process. Today the plant

ORNL-DWG 87-7053

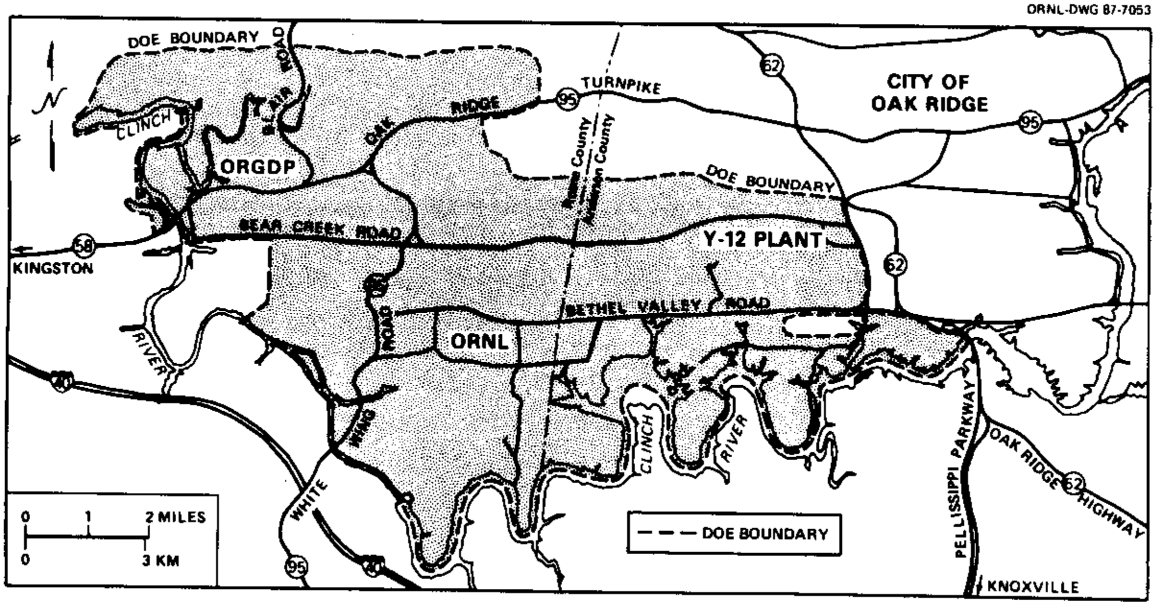

Fig. 1.1.1. DOE Oak Ridge Reservation.

Table 1.1.1. Administrative[a] units on the ORR in 1986

Description	Forested area (ha)[b]	Total area (ha)
Resource management[c]	12,221 (30,185)[d]	14,050 (34,705)
Y-12 Plant primary plant complex[e]		352 (870)
ORNL primary plant complex[e]	4 (10)	147 (364)
ORGDP primary plant complex[e]		405 (1,000)
Scarboro Facility (ORAU-DOE)	81 (200)	432 (1,067)
Total	12,306 (30,395)	15,386 (38,006)

[a]Administrative units are those units that are managed by a major installation or by central Energy Systems.
[b]Hectare (ha) = 2.47 acres.
[c]Resource Management is the unit managed by central Energy Systems.
[d]Numbers in parentheses denote acres.
[e]Primary plant complexes within fenced areas and facilities outside but adjoining the fenced areas.

has progressed from its single mission of 1943 to become a highly sophisticated weapon component manufacturing and development engineering organization. The primary activities of the Oak Ridge Y-12 Plant are production of nuclear weapon components, manufacturing support for DOE weapon design laboratories, processing of source and special nuclear materials, support for ORNL facilities and the Energy Systems General Staff located at the Oak Ridge Y-12 Plant site, and support for other government agencies.

ORGDP began operations in 1945 as the world's first facility for separating uranium by the gaseous diffusion process. Its original mission was the production of enriched uranium for use in the nation's nuclear weapons program. ORGDP's production emphasis has gradually changed from defense program use to peaceful applications—primarily by the nuclear power industry. In addition to further improving the gaseous diffusion process, employees at ORGDP have been involved in developing and in demonstrating more energy-efficient and cost-effective methods for uranium enrichment.

1.2 REGIONAL DEMOGRAPHY

Except for the City of Oak Ridge, the land within 8 km of the ORR is predominantly rural, used largely for residences, small farms, and pasture for cattle. Fishing, boating, water skiing, and swimming are favorite recreational activities in the area. The approximate location and population (1980 census data) of the towns nearest the ORR are Oliver Springs (pop. 3600), 11 km to the northwest; Clinton (pop. 5300), 16 km to the northeast; Lenoir City (pop. 5400), 11 km to the southeast; Kingston (pop. 4400), 11 km to the southwest; and Harriman (pop. 8300), 13 km to the west. Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km to the east and has a population of about 183,000. Table 1.2.1 lists cities and population centers within 80 km of the ORR.

1.3 GEOLOGIC AND TOPOGRAPHIC SETTING

The ORR is located in East Tennesseee in valleys that lie between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast, in the Valley and Ridge Physiographic Province of the Appalachian Mountains (Fig. 1.3.1).

1.3.1 Geology

The province, which is 13 to 20 km wide in this area, extends approximately 2000 km from the Canadian St. Lawrence lowland into Alabama. Bounded by the Appalachian Plateau Province to the west and the Blue Ridge Province

Table 1.2.1. Populations of central East Tennessee towns[a]

Town/city	Population
Anderson County	
Clinton	5,245
Lake City	2,335
Norris	1,374
Oak Ridge	27,662
Oliver Springs	3,600
Blount County	
Friendsville	694
Alcoa	6,870
Maryville	17,478
Knox County	
Knoxville	183,139
Loudon County	
Greenback	546
Lenoir City	5,446
Loudon	3,940
Morgan County	
Wartburg	761
Roane County	
Harriman	8,303
Kingston	4,441
Rockwood	5,767
Sevier County	
Sevierville	4,566
Union County	
Luttrell	962
Maynardville	924
Campbell County	
Caryville	2,039
Jellico	2,769
Jacksboro	1,620
LaFollette	8,176

[a]*Source: Environmental Surveillance of the Oak Ridge Reservation and Surrounding Environs During 1986*, ORNL-6271, Oak Ridge, Tenn., 1986.

to the east, the Valley and Ridge Province is a complex zone characterized by a succession of southwest-trending ridges and valleys. A geologic map of the ORR is shown in Fig. 1.3.2. The characteristic topography of the Oak Ridge area is influenced by the underlying geologic structures and differential erosion. Compressive forces that produced folding and thrusting created a southeast dip to nearly all the units on the ORR (Buchananne and Richardson, 1956). The ridges remain because they consist of relatively resistant material such as dolomite, cherty limestone, and shaly sandstone. Valleys develop in areas of more soluble limestone and easily eroded shale.

The ORR is underlain by many geologic formations or groups ranging in age from early Cambrian to early Mississippian. All of the formations are of sedimentary origin, and most Tennessee limestone is also of clastic origin. From oldest to youngest, they include the Rome Formation, the Conasauga Group, the Knox Group, the Chickamauga Limestone, the Sequatchie Formation, the Rockwood Formation, the Chattanooga Shale, the Maury Formation, and the Fort Payne Chert. A stratigraphic column of the units present on the ORR is given in Table 1.3.1.

Table 1.3.2 shows a generalized geologic section of the bedrock formations in the Oak Ridge area.

Elevations range from 226 to 415 m above mean sea level (MSL)—a maximum relief of 189 m. The area includes gently sloping valleys and rolling-to-steep ridges. The Tennessee Valley Authority's (TVA) Melton Hill and Watts Bar reservoirs on the Clinch River form the southern, eastern, and western boundaries of the ORR, and the residential sector of the City of Oak Ridge forms the northern boundary. The ORR is within the Oak Ridge city limits.

Each geologic unit within the ORR (Fig. 1.3.2) presents a unique set of characteristics dictated by composition, structural configuration, and modifications brought about by chemical and mechanical weathering through geologic time. Understanding the geology of the site and the

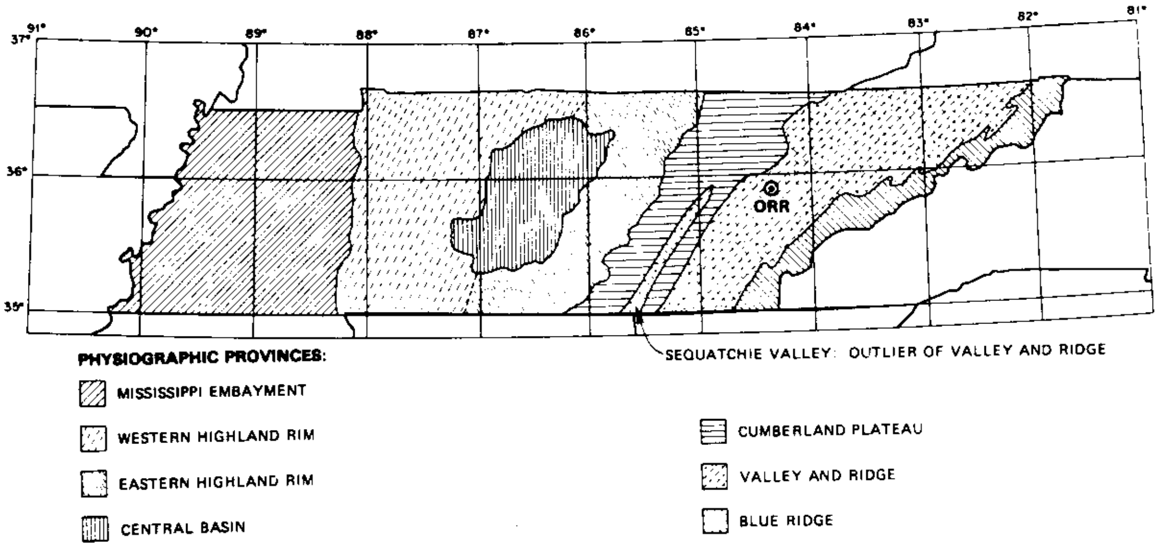

Fig. 1.3.1. Physiographic map of Tennessee.

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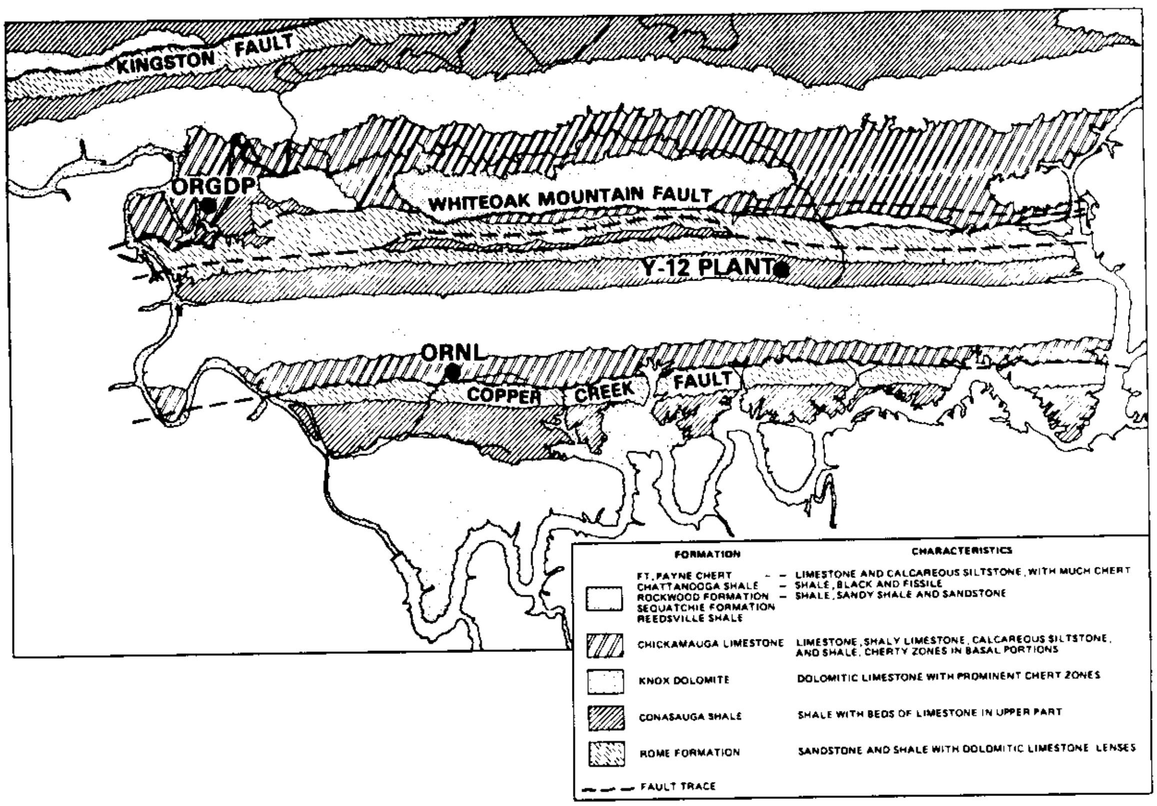

Fig. 1.3.2. Geologic map of the Department of Energy's Oak Ridge Reservation.

Table 1.3.1. Stratigraphic column for the ORR[a]

Unit	Thickness (m)	Age
Fort Payne Chert	20[b]	Lower Mississippian
Maury Shale	1	Upper Devonian
Chattanooga Shale	5	Upper Devonian
Rockwood Formation	210	Lower Silurian
Sequatchie Formation	110	Upper Ordovician
Chickamauga Group	670	Middle Ordovician
Knox Group	920	Upper Cambrian-Lower Ordovician
Conasauga Group	460	Middle Cambrian
Rome Formation	100–188[b]	Lower Cambrian

[a]*Source*: T. R. Butz, 1984. *Geology*, ORNL-6026/V8, Oak Ridge, Tenn.
[b]*Source*: C. S. Haase, E. C. Walls, and C. D. Farmer, 1985. *Stratigraphic and Structural Data for the Conasauga Group and the Rome Formation on the Copper Creek Fault Block near Oak Ridge, Tennessee: Preliminary Results from Test Borehole ORNL-JOY No. 2*, ORNL/TM-9159, Oak Ridge, Tenn.

unique expression of the subsurface units that result in characteristic topography, soils, and groundwater geology will aid in waste management and monitoring.

The principal rock groups within the Reservation (Rome, Conasauga, Knox, and Chickamauga) represent the oldest formations and as such have experienced the most folding, thrusting, and faulting. All the ridges and valleys tend southwest to northeast; underlying rock units dip to the southeast.

The Rome Formation is a heterogeneous and variegated mixture of sandstone, siltstone, shale, dolomite, and limestone. The proportions vary greatly. The stratigraphy of the Rome is one of the major problems; its study is difficult because the Rome mainly occurs just above major thrust faults (and hence is commonly folded and imbricated and shows no base) and because fossils are comparatively scarce. The Rome is more than 213 m thick in many places.

Rock types of the Rome Formation weather differently, but ordinarily sandstone and siltstone beds dominate the residuum and soil, which is only a shallow mantle full of rock chips. The carbonate rocks weather more deeply and locally form bodies of yellow, generally silty clay with a red-brown soil layer.

The Rome Formation grades conformably into the overlying Conasauga Group, which consists of six named formations of alternating shale and limestone. The ORR is located near the northwestern phase/central phase boundary. The Conasauga Shale, in the northwestern phase, consists of light green, olive green, and dull purple shale; the light green is the purest clay-shale, the purple the most silty. Layers and lenses of limestone are common but seem irregular in distribution. The Conasauga Shale generally weathers to a thin acid soil full of shale chips, but where limestone is present, the soil is prevailingly deeper and richer. These limestone strata are also indicated by the presence of low hills or knobs and often cedar trees. The shale normally forms valleys. The thickness of the Conasauga is unknown because it is very crumpled, but it may be estimated at 610 m or a little more.

In the Pine Ridge area, the upper limit of the Conasauga is drawn at the base of the first massive, dark, asphaltic dolomite bed belonging to the overlying Knox Group. The Knox Group extends from the top of the Maynardville Limestone to the marked disconformity between Lower and Middle Ordovician rocks. The Copper Ridge Dolomite represents stages of the Upper Cambrian Series, and higher formations are Lower Ordovician. The northwestern phase of the Knox Group is dominated by generally thick-bedded siliceous dolomite, the silica from which accumulates in the residual clay and soil as chert. The chert and other residual materials associated with each formation are commonly even more distinctive of the formation than the bedrock lithology.

Within the ORR Knox Group the general lithology is from massive dark gray, crystalline, very cherty dolomite at the base to generally less massively bedded, lighter gray, densely to finely crystalline, less cherty dolomite at the top. The Knox weathers to form a deep residual mantle held in place by the abundant chert on the surface. The group underlies broad ridges generally having fairly gentle slopes on the

Table 1.3.2. Generalized geologic section of bedrock formations in the Oak Ridge area[a]

System	Group	Formation	"Member" or unit	Thickness (m)	Characteristics of rocks
Mississippian		Ft. Payne "Chert"			Impure limestone and calcareous siltstone, with much chert
Mississippian / Devonian	?	Chattanooga Shale & Maury Formation			Shale; black, fissile
Devonian					
Silurian					
Silurian / Ordovician	Rockwood	Brassfield		310+	Shale, sandy shale, sandstone; calcareous; red, drab, brown
Ordovician	Rockwood	Sequatchie			
Ordovician	Chickamauga		?		
Ordovician	Chickamauga		H	90	Limestone, shaly limestone, calcareous siltstone, and shale; mostly gray, partly maroon; with cherty zones in basal portions
			G	90	
			F	8	
			E	115	
			D	50	
			C	35	
			B	65	
			A	75	
Ordovician / Cambrian	Knox			800	Dolomitic limestone; light to dark gray; with prominent chert zones
Cambrian	Conasauga	Maynardville Limestone		450	Shale; gray, olive, drab, brown with beds of limestone in upper part
Cambrian	Conasauga	Conasauga Shale	Pumpkin Valley		
Cambrian		Rome Formation		310+	Sandstone and shale; variegated with brilliant yellow, brown, red, maroon, olive-green; with dolomitic limestone lenses

[a]*Source*: C. H. Petrich et al., 1984. *Geography, Demography, Topography, and Soils*, ORNL-6026/V7, Oak Ridge, Tenn.

southeastern side and steeper slopes on the northwestern side. Knox dolomite is very soluble and caverns are common; some of them are large. Sinkholes are a persistent topographic feature of the group.

The Knox Group is the only formation other than Conasauga Shale that has an adequate residuum thickness and sufficient uniformity for land burial of waste material. The Knox overburden (fine-grained cherty clays) has the greatest thickness (normally 3 to 8 m) and extends to a depth of up to 30 m in places on the Reservation.

Groundwater is usually quite deep in the Knox soils, which ensures separation between wastes and groundwater. Siting waste disposal areas at higher elevations generally affords this benefit but is not without potential problems. Because of the dolomite formations, the Knox Group is subject to high water solution and productivity and is the most hydrogeologically unpredictable formation in the Reservation. Therefore, any consideration of its use for waste burial should be carefully evaluated.

The Chickamauga Group includes strata between the top of the Knox Group and the base of the Sequatchie Formation. The group contains many varied lithologies arranged in complex relationships and carbonate facies complicated by an influx of terrigenous clastics from southeastern sources. Lithologically, the Chickamauga is extremely variable, although the entire sequence is calcareous.

The surfaces of valleys underlain by the formation are irregular, with the more silty and cherty layers underlying low ridges and hills. Sinkholes exist but are not as numerous or as large as those in the Knox Group.

The remaining geologic units on the ORR are present in the synclinal structure topographically expressed as East Fork Ridge, located along the northwestern boundary of the Reservation. The units in the syncline include (from oldest to youngest): Sequatchie Formation, Rockwood Formation, Chattanooga Shale, Maury Shale, and Fort Payne Formation. These units comprise approximately 424 m of stratigraphic section and underlie less than 2.5 km^2 (1544 acres or 4%) of DOE lands in the Oak Ridge area.

The underlying structure of the ORR is complex because of the extensive faulting and deformation in the region. Three regional thrust faults in the area of the Reservation—Kingston, Whiteoak Mountain, and Copper Creek— strike to the northeast and dip to the southeast. The latest movement on the faults was late Pennsylvanian/early Permian (280 to 290 million years ago). Although minor seismic activity has been recorded in the region, no surface rupturing associated with any of the faults within the ORR has been recorded. The possibility of fault movement is considered extremely unlikely; therefore, the presence of the faults constitutes only a moderate-to-minor constraint on activities on the ORR.

1.3.2 Topography

The ORR lies in a region characterized by elongated ridges and valleys that tend in a northeast-to-southwest direction. The ORR is geographically bounded on the west by the Cumberland Plateau, on the distant east by the Great Smoky Mountains, and at its immediate eastern and southern boundaries by the Clinch River. Historically, the ridges and valleys provided safety, isolation, and separation for the Manhattan Project. Each of the three major plant facilities is in a separate valley. Southernmost is ORNL, in Bethel Valley between Haw Ridge and Chestnut Ridge (with ancillary facilities in Melton Valley to the south). To the north is the Oak Ridge Y-12 Plant, in Bear Creek Valley between Chestnut Ridge and Pine Ridge. Northernmost is ORGDP, located in the same valley (Big Valley) as the urban portion of the City of Oak Ridge.

The lowest elevations of the ORR are near the Clinch River at approximately 230 m above MSL; the highest are along Pine Ridge and are approximately 385 m above MSL. The ridges and river are natural physical barriers.

The entire Reservation is characterized by a rolling topography of subtle to exaggerated slopes with little or no expanse of flat land. The slopes are categorized into three ranges of relative constraint. The gentlest slopes, 0% to 15%, offer the easiest and most flexible opportunities for development. Slopes of 15% to 25% require great care and sensitivity in siting utilities and structures and pose moderate constraints to development. Although erosion potential exists, these sites offer the opportunity for architectural innovation. Steep slopes of more than 25% are the most difficult to develop: erosion potential is greatest, disturbance is most visible, revegetation is most difficult, and construction costs are highest. A vast amount of the ORR appears to fall within the mild slope classification [62%, or more than 8,900 ha (22,000 acres)].

1.3.3 Reservation Soils

The ORR is overlain primarily by residual soils and, to a much lesser extent, by alluvial soils. The alluvium (water-deposited soil) occurs on low terraces and floodplains along streambeds. Residual soils are formed in place by the weathering of their underlying rock, which occurs as a result of physical weathering and chemical action. The nature of a residual soil depends on the type of source rock, solubility of the source rock components, degree of weathering, climate, vegetation, and drainage. Soils also exhibit different characteristics after being disturbed by excavation and recompaction.

The bedrock that underlies the ORR is part of the Valley and Ridge Province of the eastern overthrust belt. The ridges are made up of dolomite and limestone that have weathered over time to form fine-grained reddish soils with depths of up to 27.5 m and well-developed internal drainage. The valley soils are generally much shallower and are a mix of clays, silts, and weathered shale fragments.

Though some generalizations may be made about the nature of ORR soils, the characteristics of soils are highly localized, and soil properties vary widely even within a soil series. The ORR's residual soils are generally cohesive, fine-grained or silty clays of medium to high plasticity. The in situ material has a moisture content near or higher than optimum for compaction. It has generally adequate strength, but it is highly compressible and settlement under load is often the limiting soil characteristic. The ORR contains no naturally occurring concentrations of sand or gravel.

1.4 SURFACE WATER

Surface water in the Tennessee Valley region supplies water to most nonrural areas. This section includes discussions of stream classification, surface water hydrology, and watershed characteristics.

1.4.1 Stream Classification

The Clinch River is the major surface water area that receives discharges from Oak Ridge installations. Four TVA reservoirs influence the flow and/or water levels of the lower Clinch: Norris and Melton Hill on the Clinch River and Watts Bar and Fort Loudon on the Tennessee River.

The area on and around the ORR has no streams classified as scenic rivers. The water bodies are classified by use. Table 1.4.1 gives the use classifications for the Clinch River and its tributaries on or near the ORR. Classifications are based on water quality.

1.4.2 Surface Water Hydrology

The ORR is bounded on the south and west by a 63-km stretch of the Clinch River. Melton Hill Dam is located on the Clinch River at Clinch River kilometer (CRK) 37.2, forming the Melton Hill Reservoir. Several major embayments bound the ORR; the largest is the Bearden Creek Embayment with an approximate surface area of 48 ha (120 acres). Other embayments include Walker Branch, McCoy Branch, and Scarboro Creek.

At Kingston, Tennessee, the Clinch River drains into the Tennessee, the seventh largest river in the United States. Water levels on the Clinch are regulated by the Tennessee Valley Authority (TVA), and fluctuations on the river have an impact on the tributary streams and creeks draining the ORR.

The three DOE installations, ORGDP, Oak Ridge Y-12 Plant, and ORNL, affect different subbasins of the Clinch River. Drainage from the

Table 1.4.1. Use classification for the Clinch River and its tributaries on the ORR[a]

Stream	Description	DOM[b]	IND[c]	FISH[d]	REC[e]	IRR[f]	LW&W[g]	NAV[h]
Clinch River	km 7.0–19.2 (Poplar Creek)	✓	✓	✓	✓	✓	✓	✓
Poplar Creek	km 0.0–0.8		✓	✓	✓	✓	✓	
Poplar Creek	km 0.8–2.1			✓		✓	✓	
Poplar Creek	km 2.1–8.8			✓	✓	✓	✓	
East Fork Poplar Creek	km 0.0–7.7			✓	✓	✓	✓	
Bear Creek	km 0.0–origin			✓	✓	✓	✓	
East Fork Poplar Creek	km 7.7–13.3			✓		✓	✓	
East Fork Poplar Creek	km 13.3–dam at Y-12 Plant			✓	✓	✓	✓	
Poplar Creek	km 8.8–19.8			✓	✓	✓	✓	
Poplar Creek	km 19.8–23.0			✓		✓	✓	
Indian Creek	At Poplar Creek (km 22.9); km 0.0–origin			✓	✓	✓	✓	
Poplar Creek	km 23.0–origin			✓	✓	✓	✓	
Clinch River	km 19.2–32.0	✓	✓	✓	✓	✓	✓	
White Oak Creek	km 0.0–origin			✓			✓	
Melton Branch	km 0.0–origin			✓			✓	
Clinch River	km 32.0–63.4	✓	✓	✓	✓	✓	✓	✓
Clinch River	km 63.4–65.8	✓	✓	✓	✓	✓	✓	✓
Scarboro Creek	km 0.0–1.6			✓	✓	✓	✓	
Scarboro Creek	km 1.6–2.1			✓		✓	✓	
Scarboro Creek	km 2.1–origin			✓	✓	✓	✓	
Clinch River	km 65.8–74.7	✓	✓	✓	✓	✓	✓	✓
All other tributaries in the Clinch River Basin, named and unnamed, that have not been specifically treated shall be classified				✓	✓	✓	✓	

[a]*Source*: Tennessee Department of Public Health, 1978. *Water Management Plan-Clinch River Basin.*
[b]DOM = Domestic water supply.
[c]IND = Industrial water supply.
[d]FISH = Fish and aquatic life.
[e]REC = Recreation.
[f]IRR = Irrigation.
[g]LW&W = Livestock watering and wildlife.
[h]NAV = Navigation.

Oak Ridge Y-12 Plant enters both Bear Creek and East Fork Poplar Creek. ORGDP drains predominantly into Poplar Creek, and ORNL has its greatest impact on White Oak Creek and Melton Branch. Hydrologic data are extensive for the above-mentioned streams because of their size and relationship to DOE installations. Walker Branch has also been intensely studied as an undisturbed watershed. The location and drainage areas of Clinch River tributaries are listed in Table 1.4.2. Table 1.4.3 lists watershed areas of these streams, and Table 1.4.4 lists their flow characteristics.

Both groundwater and surface water are drained from the ORR by a network of small tributaries of the Clinch River, as shown in Fig. 1.4.1. At Kingston, Tennessee, the Clinch drains into the Tennessee, the seventh largest river in the United States. Water levels in the Clinch are regulated by TVA, and fluctuations on the river have an impact on the tributary streams and creeks draining the ORR.

Each of the three DOE facilities affects a different subbasin of the Clinch River. Drainage from the Oak Ridge Y-12 Plant enters both Bear Creek and East Fork Poplar Creek; ORGDP drains predominantly into Poplar Creek and Mitchell Branch, a small tributary; and ORNL drains into White Oak Creek and several tributaries. Hydrologic data are extensive for these streams because of their size and relationship to DOE facilities. Walker Branch has also been intensely studied as an undisturbed watershed.

Table 1.4.2. Location and drainage areas of Clinch River tributaries

Stream	Mouth location	Drainage area (km^2)
Powell River	CRK[a] 142.9	2430[b]
Big Creek	CRK 133.5	174[b]
Coal Creek	CRK 120.7	95[b]
Hinds Creek	CRK 105.9	165[b]
Bull Run Creek	CRK 75.1	270[b]
Beaver Creek	CRK 63.7	234[b]
Conner Creek	CRK 57.1	16.6[b]
Walker Branch	CRK 53.1	3.89[b]
Hickory Branch	CRK 45.7	17.9[b]
Melton Branch	WOCK[c] 2.49	3.83[b]
White Oak Creek	CRK 33.5	15.5–16.5[b,d,e]
Raccoon Creek	CRK 31.24	1.2[d,f]
Ish Creek	CRK 30.6	0.9[e,g]
Caney Creek	CRK 27.2	21.4[e]
Poplar Springs Creek	CRK 25.9	7.8[d]
Grassy Creek	CRK 23.2	5.0[d]
Bear Creek	EFPCK[h] 2.36	19.2[a]
East Fork Poplar Creek	PCK[i] 8.8	77[a]
Poplar Creek	CRK 19.3	252[d,e,f]
Emory River	CRK 7.1	2240[b]

[a]CRK = Clinch River kilometer.
[b]*Source*: F. C. Fitzpatrick, 1982. *Oak Ridge National Laboratory Site Data for Safety Analysis Reports*, ORNL-ENG/TM-19, Oak Ridge, Tenn.
[c]WOCK = White Oak Creek kilometer.
[d]*Source*: J. M. Loar, 1981. *Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge, Tenn.
[e]*Source*: D. E. Edgar, 1978. *An Analysis of Infrequent Hydrologic Events with Regard to Existing Streamflow Monitoring Capabilities in White Oak Creek Watershed*, ORNL/TM-6542, Oak Ridge, Tenn.
[f]*Source*: Oak Ridge Operations Land-Use Committee, 1975. *Oak Ridge Reservation Land-Use Plan*, ORO-748, Oak Ridge, Tenn.
[g]*Source*: W. M. McMaster, 1967. "Hydrologic Data for the Oak Ridge Area, Tennessee," USGS Water Supply Paper 1839-N.
[h]EFPCK = East Fork Poplar Creek kilometer.
[i]PCK = Poplar Creek kilometer.

1.4.3 Watershed Characteristics

The Clinch River has its headwaters near Tazewell, Virginia, and empties into the Tennessee River at Kingston, Tennessee. The Clinch watershed comprises about 11% of the Tennessee River Watershed. Three dams operated by TVA control the flow of the Clinch River. Norris Dam, built in 1936, is approximately 50 km (31 miles) upstream from the ORR. Melton Hill Dam, completed in 1963, controls the flow of the river near the ORR. Its primary function is not flood control but power generation. Watts Bar Dam is located on the Tennessee River, but it affects the flow of the lower reaches of the Clinch.

The average discharge at Melton Hill Dam between 1963 and 1979 was 150 m^3/s. The average summer (June to September) discharge was 134 m^3/s (Boyle et al., 1982). The maximum reported discharge for the dam is 1215 m^3/s (USGS, 1978). Power is not constantly generated at Melton Hill Dam, so water flow in the Clinch is pulsed. Periods of zero flow are followed by hours of flow up to about 560 m^3/s. Pulsation of flow in the Clinch affects the tributaries on the ORR. During periods of power generation, backflow may occur into White Oak Creek (Boyle et al., 1982). Periods of no flow over the dam have lasted as long as 29 days, and the average number of days of no flow per year is 13. During flood conditions, water velocities may be hazardous and may reach 2.1 m/s (TRW, 1978).

White Oak Creek (WOC) drains an area of 17 km^2 in Bethel and Melton valleys. Runoff from most of ORNL, including all burial grounds, reaches WOC, either directly or via tributaries. The potential for contamination in WOC is great, so it has been the most studied and monitored stream on the ORR.

The headwaters of WOC are on the crest of Chestnut Ridge and its mouth is at CRK 33.5. The total elevation drop from headwaters to mouth is about 146 m. After leaving Chestnut Ridge, WOC flows parallel to bedrock strike down Bethel Valley, then cuts perpendicular to strike through a gap in Haw Ridge and enters Melton Valley, where it is joined by Melton Branch, the largest tributary, at WOCK 2.49. A dam 1 km above the mouth of WOC controls the stream's flow and allows monitoring of contaminants. The dam, which forms White Oak Lake, was originally built in 1943 and constructed of earth. A new structure was completed in 1984 with increased reinforcement and a new sluiceway. The new facility allows more accurate flow measurements to be taken and will be able to withstand and monitor

Table 1.4.3. Oak Ridge watershed areas

Tributary	Confluence location (CRK)[a]	Total basin area (km^2)	Average annual discharge (m^3/s)[b]
Poplar Creek	19.3	352	4.7 (165),[c] 5.0 (176),[d] 6.5 (228)[e]
East Fork Poplar Creek	NA[f]	77	1.4 (49),[c] 1.5 (52),[d] 1.5 (52)[e]
Bear Creek	NA	19	
White Oak Creek	33.5	17[g]	0.38 (13.5)[g,h]
Melton Branch	NA	3.8	0.07 (2.5)[i]
Walker Branch	NA	3.9	
Raccoon Creek	31.4	1.2[j]	NA
Ish Creek	30.6	0.9[k]	0.05 (2)[k]
Caney Creek	27.2	21.4	0.40 (14)
Poplar Springs Creek	25.9	7.8	0.41 (5)
Grassy Creek	23.2	5.0	0.08 (3)

[a]CRK 0.0 is at the confluence with the Tennessee River.

[b]Discharge in cfs in parentheses.

[c]At mouth of Poplar Creek and Clinch River. *Source*: F. C. Fitzpatrick, 1982. *Oak Ridge National Laboratory Site Data for Safety Analysis Reports*, ORNL-ENG/TM-19, Oak Ridge, Tenn.

[d]*Source*: J. F. Lowery et al., 1985. *Water Resources Data Tennessee: Water Year 1984*, USGS Rep. TN 84-1.

[e]Period of record: 1960–1977. Value represents the sum of the average annual discharge of West Fork Poplar Creek (4.98 m^3/s) and East Fork Poplar Creek (1.47 m^3/s). *Source*: J. M. Loar, 1981. *Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge, Tenn.

[f]Not applicable.

[g]At White Oak Dam. *Source*: D. E. Edgar, 1978. *An Analysis of Infrequent Hydrologic Events with Regard to Existing Streamflow Monitoring Capabilities in White Oak Creek Watershed*, ORNL/TM-6542, Oak Ridge, Tenn.

[h]Estimated for the period 1953–55 and 1960–63 (five water years).

[i]*Source*: F. C. Fitzpatrick, 1982.

[j]*Source*: Oak Ridge Operations Land-Use Committee, 1975. *Oak Ridge Reservation Land-Use Plan*, ORO-748, Oak Ridge, Tenn.

[k]At 0.56 km above the mouth. *Source*: W. M. McMaster, 1967. "Hydrologic Data for the Oak Ridge Area, Tennessee," USGS Water Supply Paper 1839-N.

Table 1.4.4. Flow characteristics of some major tributaries on the ORR[a]

Stream	Gauge location	Discharge: Max (m^3/s)	Discharge: Max Date	Discharge: Min (m^3/s)	Discharge: Min Date	Discharge: Average (m^3/s)	Period of record
Melton Branch	MBK[b] 0.15	6.85	03/11/62	0	09/02/62	0.07	1955–1963
White Oak Creek	WOCK[c] 2.65	18.2	08/30/50	0	09/16/61	0.27	1950–1953 1955–1963
White Oak Creek	WOCK[c] 0.96	18.9	12/29/54	0	(During power releases from Melton Hill Dam)	0.38	1950–1953 1955–1963
East Fork Poplar Creek	EFPCK[d] 5.31	73.9	07/06/67	0.37	08/16/69	1.37	1960–1970
Bear Creek	BCK[e] 1.29	16.8	03/12/63	0.01	08/12–14/62		
Poplar Creek	Mouth	180	03/12/63	0.14	10/27/63	4.67	1961–1965

[a]*Source*: J. M. Loar, 1981. *Ecological Studies of the Biotic Communities in the Vicinity of the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge, Tenn.

[b]MCK = Melton Branch kilometer.

[c]WOCK = White Oak Creek kilometer.

[d]EFPCK = East Fork Poplar Creek kilometer.

[e]BCK = Bear Creek kilometer.

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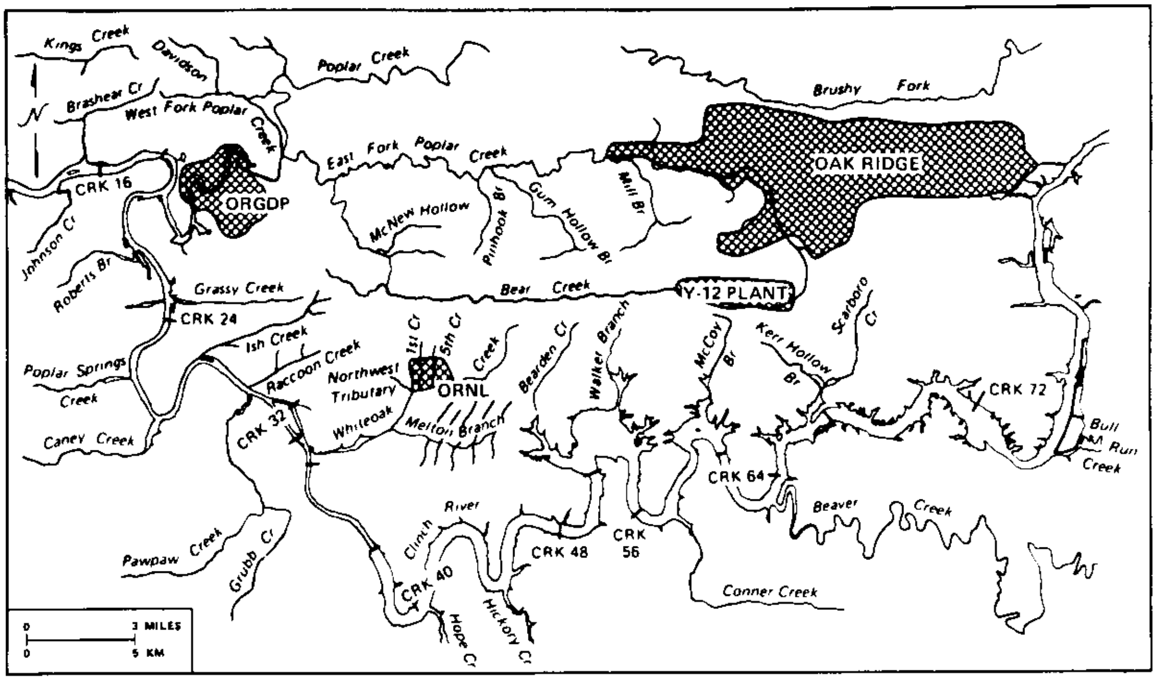

Fig. 1.4.1. Location map of Oak Ridge Reservation tributaries.

flooding conditions with a 50-year return period. Below the dam, WOC is affected by water levels in the Clinch River.

Groundwater discharged from the Knox Dolomite (which underlies Chestnut Ridge) and the Chickamauga Limestone (which underlies Bethel Valley) contributes to stream flow in WOC, supplying most of WOC's base flow. Little groundwater inflow occurs in the rest of the stream course, which is underlain by the Rome Formation (Haw Ridge) and the Conasauga Group (Melton Valley). WOC is sometimes dry, but flow is augmented by discharges from the ORNL wastewater treatment plant. Ninety percent of the time, flow in WOC is greater than 0.01 m^3/s; 50% of the time it is greater than 0.03 m^3/s; 10% of the time it is greater than 0.14 m^3/s (Rothschild, 1984). Flows and water quality are routinely monitored in WOC.

Bear Creek drains an area of approximately 19.2 km^2. At the gauging station the drainage area is 11.0 km^2 (McMaster, 1967). The headwaters of Bear Creek are on the Oak Ridge Y-12 Plant site. Bear Creek does not drain the main site, but does drain the Bear Creek Valley Waste Disposal Area (BCVWDA) sites. The creek flows west down Bear Creek Valley (primarily underlain by Conasauga Group) and then flows north, where it empties into East Fork Poplar Creek (EFPC) at EFPCK 2.36. The drainage pattern is a good example of trellis drainage patterns typical of the Valley and Ridge Province (McMaster, 1967).

EFPC drains an area of about 77.7 km^2, including most of the Oak Ridge Y-12 Plant site and a portion of the City of Oak Ridge. The headwaters of the creek are at the Oak Ridge Y-12 Plant, where flow is controlled by New Hope Pond, a small [~2 ha (5 acres)] settling basin on the east side of the plant. The average gradient along EFPC is about 4 m/km. Channel width varies along the creek's course from 3 to 4.6 m near the Oak Ridge Y-12 Plant to 7.6 m farther downstream (DOE, 1982).

EFPC empties into Poplar Creek (PC) at PCK 8.8 after traversing East Fork Valley. The valley is underlain by Chickamauga Limestone, with 25% of the basin underlain by the Knox Dolomite (McMaster, 1967). Flow in EFPC is augmented by about 0.38 m^3/s (monthly average, 1980–1984) of wastewater from the Oak Ridge Y-12 Plant and 0.23 m^3/s (monthly average, January 1983–May 1985) of water from the sewage treatment plant of the City of Oak Ridge (ORTF, 1985).

Poplar Creek has the largest drainage basin of any stream on the ORR (352 km^2). The western half of the basin lies in the Cumberland Mountains of the Appalachian Plateau, and the eastern half is in the Valley and Ridge Province. Of all the basins in the ORR area, the Poplar Creek basin has the greatest topographic relief. The elevation at the western drainage divide is 975 m above MSL; where Poplar Creek enters the Clinch at CRK 19.3, the elevation is 224 m above MSL. Most of the Poplar Creek basin is underlain by shales and sandstones, both of which are poor water-bearing formations.

Although the entire Poplar Creek drainage basin does not lie within the ORR, it does receive drainage directly from ORGDP and indirectly from the Oak Ridge Y-12 Plant via EFPC. The gauging station for Poplar Creek is at its mouth; thus, water from all parts of the drainage basin is monitored. Coal mining on the Cumberland Plateau affects water quality at the monitoring station (Rothschild, 1984).

The Walker Branch watershed is a small catchment that has been, and continues to be, intensely studied as an undisturbed watershed. Much of the work involves nutrient cycling, which includes detailed hydrologic studies. The watershed is underlain by the Knox Group and drains a portion of Chestnut Ridge. Walker Branch empties into the Clinch at CRK 53.1. The basin is small, about 0.98 km^2 (Henderson, Huff, and Grizzard, 1977).

Some of the hydrologic data collected at Walker Branch suggest that the average loss of precipitation to stream flow was ~56.5% during the period July–June, 1969–1971; 57.1 cm/year of water is lost as evapotranspiration and net change in groundwater storage; and evapotranspiration is estimated to be about 45% of total precipitation. The watershed is small but may be representative of the many small catchments on the Knox Dolomite that are found within the ORR (Henderson, Huff, and Grizzard, 1977).

1.4.4 Water Use

There are nine public water supply systems serving about 91,500 people that withdraw surface water within a 32-km (20-mile) radius of the ORR, as listed in Table 1.4.5. Of these nine supply systems, only one is downstream of ORR outfalls. The intake for Kingston is located at Tennessee River kilometer 914.2 (TRM 568.2), about 0.6 km (0.4 mile) above the confluence of the Clinch and Tennessee rivers and 34.1 km (21.2 miles) below the ORR outfall. As indicated in Table 1.4.5, Kingston withdraws approximately 9% of its average daily supply from the Tennessee River. The city of Rockwood withdraws about 1% of its average daily supply from Watts Bar Reservoir. Its intake is located 2 km from the mouth of King Creek embayment near TRK 890.

Surface water is used by facilities on the ORR as a source of water and for wastewater discharges. There are a number of industrial water withdrawals from the Clinch-Tennessee River system surrounding the ORR (Table 1.4.6).

Point discharges from the Oak Ridge Y-12 Plant include (1) overflow from Kerr Hollow Quarry, which is used for disposal of reactive metals, to Scarboro Creek at km 1.1; (2) overflow from Rogers Quarry, which is used for fly ash disposal and disposal of nonreactive metal parts, to km 3.4 of McCoy Branch; (3) approximately 0.24 m^3/s of wastewater from the Oak Ridge Y-12 Plant, primarily cooling water, to EFPC at or above km 23.5; and (4) surface runoff from the southwestern portion of the Oak Ridge Y-12 Plant site and seepage from lagoons previously used for acid waste, to Bear Creek at or above km 4.8.

Discharges from ORGDP in approximate amounts are (1) 0.028 m^3/s of treated sanitary waste, plus classified waste, to Poplar Creek at km 3.6; (2) surface runoff and some cooling water amounting to 0.1 m^3/s discharging to

Table 1.4.5. Public supply surface water withdrawals within ~32 km of the ORR[a]

Public supply system	Population served (thousand)	Average withdrawal rate (m^3/s)	Withdrawal source and location	Distance from ORR (km)
Clinton	6.2	0.03	CRK[b] 106.7	25.1
Harriman	10.0	0.10	ERK[c] 20.8	21.7
Kingston	5.0	0.014[d]	TRK[e] 914.2	20.9
Lenoir City	6.6	0.04	TRK 967.5	16.6
Loudon	5.2	0.03[f]	TRK 953.0	21.7
Anderson County Utility Board	8	0.03	CRK 89.3	14.5
Cumberland Utility District of Roane and Morgan counties	4.3	0.008[g]	LEREK[h] 3.5	14.0
First Utility District of Knox County	10.5	0.05	SCEK[i] 2.7	18.7
Hallsdale-Powell Utility District	28.7	0.07[j]	BRCEK[k] 2.1	18.2
West Knox County Utility District	15.0	0.06[l]	CRK 74.2	16.3

[a]*Source*: E. R. Rothschild, 1984. *Hydrology*, ORNL-6026/V10, Oak Ridge, Tenn., and F. C. Fitzpatrick, 1982. *Oak Ridge National Laboratory Site Data for Safety Analysis Reports*, ORNL-ENG/TM-19, Oak Ridge, Tenn.

[b]CRK = Clinch River kilometer.

[c]ERK = Emory River kilometer.

[d]Secondary source (9%); spring (91%).

[e]TRK = Tennessee River kilometer.

[f]Half source (50%); spring (50%).

[g]Secondary source (5%); spring (95%).

[h]LEREK = Little Emory River Embayment kilometer.

[i]SCEK = Sinking Creek Embayment kilometer (Tennessee River).

[j]Primary source (70%); spring (30%) (outside 25-km radius).

[k]BRCEK = Bull Run Creek Embayment kilometer (Clinch River).

[l]Primary source (90%); well (10%).

Poplar Creek at km 2.4; (3) 0.0004 m^3/s of water from sludge and backwash systems associated with the potable water system, to the Clinch River at km 23.2; (4) pond effluent from various sources, to Poplar Creek near km 7.2; and (5) treated cooling water to the Clinch River at km 18.2.

All discharges from ORNL are received by the WOC drainage. One waste stream discharged to Melton Branch is a blowdown from the recirculating cooling water system at the High Flux Isotope Reactor (HFIR). All discharge from Melton Branch to WOC is monitored at a sampling station located at km 0.16 of Melton Branch. Discharges directly to WOC include (1) about 0.005 to 0.01 m^3/s of treated domestic (sanitary) waste at WOCK 3.7; (2) cooling water; (3) cooling tower blowdown; (4) demineralizer regeneration wastes; (5) discharges from the low-level radioactive waste collection and ion exchange treatment system; (6) surface drainage from the main ORNL area; and (7) discharge from process building areas. Water flow and quality are monitored at WOCK 2.6.

Essentially all water used on the ORR is imported from the Clinch River. Any water not consumed or evaporated is discharged to streams on the ORR. Most major streams on the ORR receive waste in some form, either as direct discharge, surface runoff, or groundwater discharge.

Table 1.4.6. Industrial water withdrawals from the Clinch-Tennessee River system[a]

Industrial water user	Average withdrawal rate (m^3/s)	Withdrawal source and location	River distance from mouth of White Oak Creek (km)
Withdrawals above White Oak Creek (mouth of CRK[b] *33.5)*			
Modine Manufacturing Co.	0.05	CRK 103.7	71.2
Tennessee Valley Authority Bull Run Steam Plant	25	CRK 77.2	43.7
U.S. Department of Energy ORNL, Y-12 Plant, Scarboro Facility, and City of Oak Ridge	0.96[c]	CRK 66.8	33.3
Withdrawals below White Oak Creek			
ORGDP	0.13[c]	CRK 23.3	10.2
ORGDP	0.54[d]	CRK 18.5	15.0
Tennessee Valley Authority Kingston steam plant	61.3	ERK[e] 2.9	29.6
Watts Bar hydro plant, lock, and steam plant	0.02	TRK[f] 851.5	94.5

[a]*Source*: E. R. Rothschild, 1984. *Hydrology*, ORNL-6026/V10, Oak Ridge, Tenn., and F. C. Fitzpatrick, 1982. *Oak Ridge National Laboratory Site Data for Safety Analysis Reports*, ORNL-ENG/TM-19, Oak Ridge, Tenn.,
[b]CRK = Clinch River kilometer.
[c]Process and potable water.
[d]Cooling water makeup only.
[e]Emory River kilometer.
[f]Tennessee River kilometer.

1.5 GROUNDWATER

1.5.1 Geohydrology and Groundwater Occurrence

Information on groundwater capacity in the sandstone and shale of the Rome Formation is sparse because very few wells have been drilled in it. Because of the shallow depth to bedrock and the steep terrain underlain by the Rome Formation, both surface and shallow subsurface flows predominate, and deep groundwater flow is probably slower than that found in other units.

The hydrologic properties of the Conasauga Group are somewhat variable because of its heterogeneous composition. The Maynardville Limestone in Bear Creek Valley often contains cavities that are several meters wide and extend laterally for at least 30 to 40 m (Butz, 1984). The capacity to transmit water is facilitated by large solution openings.

In the Conasauga Group formations, weathering processes have removed much of the limestone, leaving soils composed of thin residual layers of siltstone that often exhibit extreme folding and faulting. These soils have a low primary (intergranular) porosity and, thus, low storage capacity. Most water that infiltrates through the surface moves laterally in the upper weathered zone to collecting streams; thus, the rate of recharge to the water table aquifer is low. Springs are particularly common at the Knox and Conasauga interface (McMaster, 1963).

The Knox Group extends from the top of the Maynardville Limestone to the marked disconformity between Lower and Middle Ordovician rocks. The Knox Group is the principal aquifer of the Oak Ridge area and of East Tennessee. The relatively large water storage capacity of this geologic unit is the result of fractures of bedrock enlarged by dissolution of the dolomites (Butz, 1984). Some of these openings attain cavernous proportions. Sinkholes occur frequently in the Knox Group outcrop belts, and many sizeable springs arise from the base of the ridges underlain by the Knox. Depths to the water table reach 40 m at the ridge tops (McMaster, 1963). The position of the water table commonly coincides with the interface between bedrock and the residual clay overburden. The residual material, which is the thickest soil mantle in the area and varies in depth from 10 to 40 m, actually provides the major area for this unit's groundwater recharge. This thickness of overburden has a high infiltration capacity, which also tends to minimize overland runoff and maximize recharge (Sheppard, 1974). In most instances, ridges underlain by the Knox Group also define the watershed divides of the area, which is true of most ridges. The mean yield of springs and wells in the Knox Group used for public and industrial water supplies is 0.017 m^3/s, making it a good water supply (Boyle, 1982). Springs arising from the Knox are common, especially at the Knox-Conasauga contact. No estimate is available for mean yield of domestic water wells in the Knox Group.

The Chickamauga Group is between 450 and 600 m thick in the Oak Ridge vicinity and consists of alternating limestone and siltstone/mudstone lithologies (Haase, Walls, and Farmer, 1985). The Chickamauga Limestone underlies Bethel and East Fork valleys. Sinkholes are present on the Chickamauga but are not numerous or large. Large solution cavities do not generally occur; most openings are only a few centimeters wide. The clay-rich residuum restricts most infiltration, and water storage is predominantly in near-surface (<30-m-deep) openings in the bedrock. Total water flow and flow rates are relatively small (Webster, 1976). Solution features decrease with depth, which suggests that deep flow is very limited in the Chickamauga (Rothschild, 1984).

Generally, groundwater flow on the ORR follows water table conditions. Hence, shallow groundwater levels parallel topographic contours with joints and fractures controlling flow direction for deep groundwater. Recharge is derived almost entirely from precipitation, and groundwater discharge is through evapotranspiration, springs, and streams.

The major soils on the ORR are silty (grain size 0.06 to 0.002 mm) rather than sandy or clayey. They are generally permeable and well drained. However, in areas where clay dominates the content of the subsoils, this outweighs the permeability, and the drainage of this region is characterized by fast runoff. The extensive clay subsoils channel much of the hydrological input into surface flow (Fitzpatrick, 1982).

As in most areas, groundwater discharge contributes to the base flow of surface streams that ultimately augment the Clinch River water supply. The Clinch is a major drainage feature of the area, and its base flow is determined by groundwater discharges to the surface water system. The low water table elevation in areas near the river is expected to be controlled by the river level elevation, which is true in most surface stream areas. It is unlikely that groundwater flow could pass beneath the Clinch.

Depth to the water table varies both spatially and temporally. At a given location, depth to water is generally greatest during the October–December quarter and least during the January–March quarter (Fitzpatrick, 1982).

In Bethel Valley, depth to the water table ranges from 0.3 to 11 m, whereas in Melton Valley the range is from 0.3 to 20 m. Seasonal fluctuations tend to be greatest beneath hilltops and other groundwater divides. As much as 4.5-m seasonal variation has been reported for Melton Valley, which is in the Conasauga Group.

Water table maps may be indicative of the direction of groundwater movement, at least in the near-surface, weathered zone of rock units. Deeper in the groundwater flow system, in relatively unweathered rock, water movement is controlled by the orientation of secondary openings (Webster, 1976). There is insufficient information about the distribution of secondary openings, especially in carbonate rocks, to accurately predict groundwater movement (Rothschild, 1984).

Groundwater flow in the residual soil is generally toward the closest stream of the surface drainage network. In Bethel Valley, groundwater in the Chickamauga Limestone moves through small solution channels. Although the rate of groundwater flow in the area is not known, the direction and pattern of this flow in Bethel Valley are essentially subdued replicas of the topography. Thus, water flows from areas of high elevation to those of low elevation, and the principal movement is in directions normal to the contour lines. The lay of the land is such that drainage at and below the surface of Bethel Valley apparently converges to feed White Oak Creek. An exception occurs in the western end of Bethel Valley, where the groundwater west of a groundwater divide flows into the Raccoon Creek drainage basin rather than into White Oak Creek.

The groundwater system in Melton Valley basically has a very shallow active zone (McMaster, 1967). This system is not unusual and is characterized by highest permeability for groundwater flow near the surface and declining permeability with depth. Although quantitative studies of near-surface groundwater flow during storm events are still in progress, it appears that most subsurface flow occurs in a near-surface region that extends to a depth of less than about 5 m. The general hydrologic picture is that of rather closely coupled surface water and groundwater systems in which circulation is rather shallow and much of the movement occurs in the near-surface zone during the wetter part of the year (late November through April).

Contaminated plume movement has been a major topic of studies in Melton Valley. The traditional concept of a subsurface contamination plume as a primary pathway for contaminant migration depends on hydraulic conductivity and discharge points. The hydraulic conductivity of the less-weathered material is about 6 cm/d, whereas the near-surface zone is characterized by 20- to 1500-cm/d hydraulic conductivities. Thus, the nature of the groundwater system suggests that subsurface flow over long distances may be limited by the low permeability of formations. Furthermore, the distribution coefficients (Kd) for most radionuclides in the Conasauga Group (shales) are rather high, which suggests that any deep migration would be attenuated. A commonly observed pathway for contaminant migration, where it occurs, is thought to be via the bathtub effect (i.e., a trench collects enough water to cause an overflow at the downstream end). Thus, subsequent movement is emergence at the surface followed by runoff downhill. A variation of that process is movement of shallow subsurface flow in fill material along and just above the interface with natural materials underlying the fill.

1.5.2 Groundwater Use

Wells shown are those for which the Tennessee Department of Water Resources keeps logs that include well location, elevation, and depth to water. Additional wells exist within the regions shown, but they either have not been reported to the state or were incompletely reported.

Over 100 water supply wells and springs are located within 16 km of the ORR. Several industrial groundwater supplies exist within about 32 km of the ORR. The nearest is at the Charles H. Bacon company in Lenoir City, Tennessee. An estimated average of 320 m^3 is obtained daily from this supply (Exxon, 1976), which is located about 15 km south-southeast of the ORR. A daily average of about 38 m^3 is obtained from the well supplying the Lenoir City Car Works, which is about 15 km south of the ORR, as well as the one supplying the Ralph Rogers Company, which is approximately 15 km northeast of the ORR. Other industrial groundwater supplies are farther from the ORR.

There are 17 public groundwater supplies located within a 35-km radius of the ORR. Of these sources, the closest to the ORR is the Allen Fine Spring, which supplies the Dixie-Lee Utility District in Loudon County. This groundwater source is about 11 km southeast of the ORR, and it serves approximately 6700 people with an average of about 1500 m^3 of water per day. The well that serves the Edgewood Center in Roane

County is about 12 km southwest of the ORR, and the spring that supplies the Cumberland Utility District of Roane and Morgan counties is approximately 13 km west of the ORR.

Connections between off-site and on-site groundwater sources are being investigated by the U.S. Geological Survey (USGS). Because of the stratigraphic and structural control of groundwater flow in the region, groundwater beneath the ORR is expected to migrate along strike and discharge to surface water bodies, rather than migrating to off-site wells.

The importance of the Knox Group as a regional aquifer is apparent from its wide use by the public and industry. The mean Knox spring and well yields estimated from water use figures are about 0.017 m^3/s. Reliable estimates of the mean yield to domestic wells in the Knox Group are not available. Yields are expected to vary widely depending on the size and extent of cavity systems encountered by individual wells. Water from the Chickamauga Group is also used on the ORR.

1.6 CLIMATE

The mountains to the east and the Cumberland Plateau to the west have a protecting and moderating influence on the region's climate. As a result, it is milder than the more continental climate found just to the west on the Plateau or on the eastern side of the Smoky Mountains. Prevailing winds follow the general topographic trend of the ridges: daytime, up-valley winds come from the southwest; nighttime, down-valley winds come from the northeast. The Smoky Mountains to the southeast provide general shelter; severe storms such as tornadoes or high-velocity windstorms are rare. Similarly, the mountains divert hot, southerly winds that develop along the southern Atlantic coast.

In the fall, slow-moving high-pressure cells suppress rain and, while remaining nearly stationary for many days, provide mild weather. The year-round mean temperature is about 15°C, with a January mean of about 3.5°C and a July mean of about 25°C. Temperatures of 38°C or higher and -18°C or below are unusual. Low-level temperature inversions occur during about 56% of the hourly observations (NOAA, 1955–1986). Table 1.6.1 summarizes the climatic conditions of the Oak Ridge area.

Chemically, the atmosphere is a mixture of gases, concentrations of which vary from trace levels to the 78% of the atmosphere that consists of nitrogen (N_2). Physically, the most significant feature of the atmosphere is its constant motion as a result of thermal energy produced by the unequal heating of the earth by the sun. This solar energy is the driving force for many complex physical, chemical, and biological processes that occur on or near the earth's surface (Godish, 1985).

In the initial dispersion process from point or area sources, pollutants are released into the ambient air, where their transport and subsequent dilution depend on local meteorological phenomena and the influence of topography. In the Oak Ridge area, dispersion processes are influenced by meteorological phenomena such as wind (speed and direction), turbulence, and atmospheric stability.

The temporal changes of wind direction and speed resulting from the weather systems can be combined to determine the wind climatology of the Oak Ridge area. Of all the climatology data, those on wind are of the most significance for atmospheric transport and diffusion. One of the most useful climatological presentations of wind data is the wind rose (Slade, 1968).

A wind rose is a circle from whose center emanate lines representing the direction from which the wind blows. The length of each line is proportional to the frequency of the wind from that particular direction; the frequency of calm conditions may be entered in the center. Data are given for eight primary and eight secondary directions of the compass. Wind speed is divided into ranges.

1.7 PRECIPITATION, EVAPOTRANSPIRATION, AND RUNOFF

The source of both surface water and groundwater is precipitation (Zurawski, 1978). In

Table 1.6.1. Monthly climatic summary for the Oak Ridge area based on a 20-year period[a]

Month	Temperature			Precipitation	
	Max	Min	Mean	Rain	Snow
	°C[b]	°C	°C	cm	cm
January	9.3	−1.8	3.3	13.5	8.6
February	10.7	−0.8	4.9	13.5	6.6
March	14.8	2.4	8.6	14.2	3.3
April	21.7	8.3	15.0	11.2	0.03
May	26.2	12.5	19.3	9.1	0.0
June	29.6	17.1	23.3	10.2	0.0
July	30.7	19.1	24.9	14.2	0.0
August	30.4	18.4	24.4	9.7	0.0
September	27.5	14.8	21.2	8.4	0.0
October	21.8	8.4	15.2	6.8	1.5
November	14.3	2.2	8.3	10.7	1.3
December	9.3	−0.8	4.3	14.5	6.4
Annual		14.4		135.9	26.2

[a]*Source*: National Oceanic and Atmospheric Administration (NOAA), "Local climatological data for Oak Ridge, Tennessee," U.S. Department of Commerce, monthly publications, 1965–1986.

[b]$°C = (°F - 32) \times 5/9$.

an average year, precipitation in the Tennessee region ranges from 102 cm in the northern Valley and Ridge Province to 206 cm in the mountainous eastern part (Zurawski, 1978). The average for the region is 132 cm (TVA, 1975). In a normal year, most precipitation occurs in the winter and spring months, least in the summer and fall months. About 60% of the yearly precipitation returns to the atmosphere by evaporation and the transpiration of plants (Zurawski, 1978). Of the remaining 40%, a part flows overland into streams and a part percolates into the ground to replenish, or recharge, the groundwater reservoirs (Fig. 1.7.1). A typical water budget is: average rainfall over drainage area (128 cm), stream discharge (55 cm) with low flow of 29 cm and overland flow of 26 cm, and evaporation and transpiration of 73 cm.

Precipitation is plentiful on the ORR. The mean annual rainfall is about 138.2 cm, based on 1948–1986 precipitation data (NOAA, 1965–1986). Mean annual precipitation ranges from more than 147 cm in the northwest section of central East Tennessee to about 117 cm in the northeast section (Rothschild, 1984). Rainfall is at a maximum near the Cumberlands and decreases from northeast to southeast, reaching a minimum at the foot of the Smoky Mountains.

Loss of water to the atmosphere by evapotranspiration is about 76 cm annually, or about 55% of the total annual precipitation. Evapotranspiration is at a maximum from July to September, during the vegetation growing season. Seasonal relationships between evapotranspiration and precipitation are reflected in seasonal patterns of runoff to streams, which is greatest in the winter, when evapotranspiration is low and precipitation is high. Precipitation not lost as evapotranspiration or quick runoff to streams percolates through the soil and eventually recharges the groundwater system.

Topography of the area is such that all drainage from the ORR flows into the Clinch River, whose flow is regulated by several dams that provide reservoirs for flood control, electric power generation, and recreation. The principal tributaries through which liquid effluents from the plant areas reach the Clinch River are White Oak Creek, Bear Creek, East Fork Poplar Creek, and Poplar Creek.

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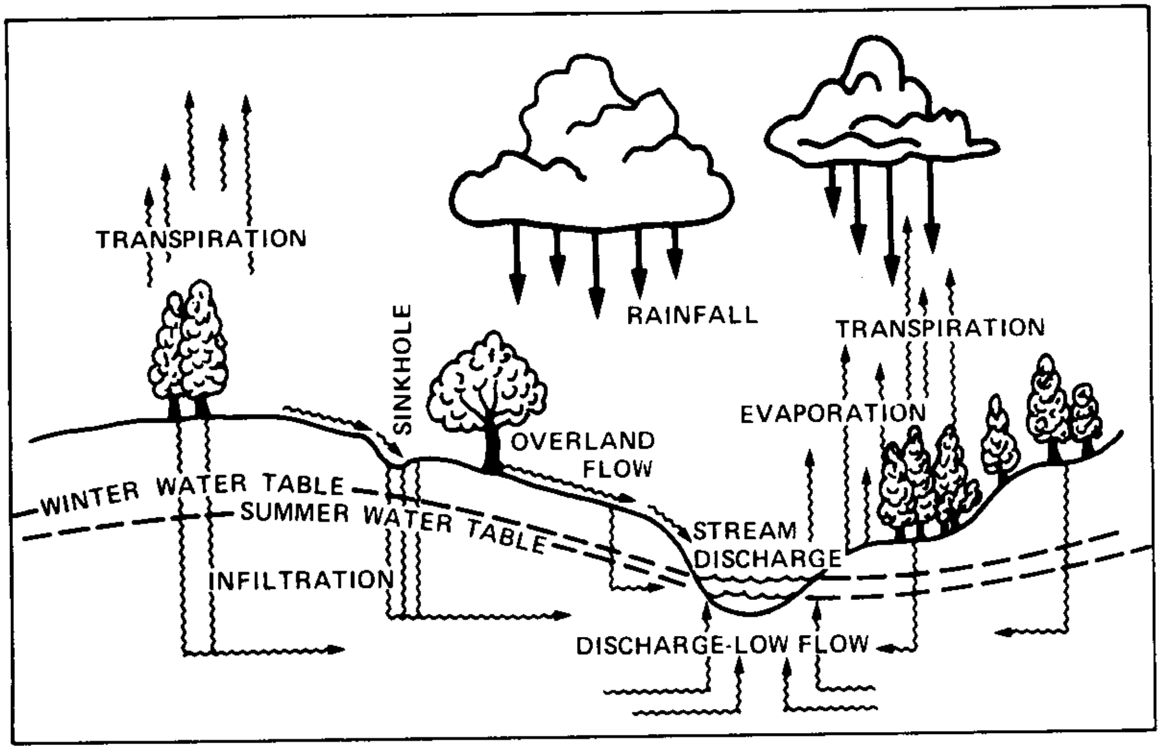

Fig. 1.7.1. Typical water budget (Source: Burchett, 1977).

2. ENVIRONMENTAL MONITORING AND SAMPLING SUMMARY

Routine monitoring and sampling for radiation, radioactive materials, and chemical substances on and off the ORR are used to document compliance with appropriate standards, identify trends, provide information for the public, and contribute to general environmental knowledge. The surveillance program assists in fulfilling the DOE policy of protecting the public, employees, and the environment from harm that could be caused by its activities and reducing negative environmental impact to the greatest degree practicable. This document provides information on the environment and presents calculations of doses to the public. Environmental monitoring information complements data on specific releases, trends, and summaries. A summary of routine environmental monitoring on the ORR is given in Table 2.1 for a wide range of environmental media.

Table 2.1. Summary environmental monitoring and sampling on the Oak Ridge Reservation

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
			Air	
20	Continuous	Weekly	Weekly	Gross alpha, gross beta, ^{131}I
2	Continuous	3/week	3/week	Gross alpha, gross beta, ^{131}I
8	Continuous	Weekly	Quarterly	^{90}Sr, gamma scan, ^{238}Pu, ^{239}Pu, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{236}U, ^{238}U
16	Continuous	Weekly	Weekly	^{131}I
11	Composite	Continuous	Weekly	Fluoride
3	Continuous	Monthly	Monthly	^{3}H
2	Composite	24-h/3-d	Monthly	Total suspended particulates (TSP)
2	Continuous	Continuous	Continuous	SO_2
2	Continuous	Bimonthly	Bimonthly	^{3}H
4	Composite	24-h/6-d	Weekly	Suspended particulates, metals (quarterly)
8	Continuous	Semiweekly	Semiweekly	Suspended particulates, Pb, Ni, metals (quarterly)
5	Continuous	Weekly	Weekly	Fluoride, total U, chromium
11	Composite	Continuous	Quarterly	Uranium isotopic, gross alpha, gross beta
2	Composite	24-h/6-d	Weekly	Total suspended particulates (TSP)
			Stacks	
28	Continuous	5/week	5/week	Uranium
16	Continuous	3/week	3/week	Uranium
7	Continuous	Weekly	Weekly	Uranium
			Fish	
3	Semiannually	Semiannually	Semiannually	^{90}Sr, gamma scan, Hg, PCBs
			Soil	
17	Annually	Annually	Annually	^{90}Sr, gamma scan, ^{238}Pu, ^{239}Pu, ^{238}U, ^{234}U, ^{235}U
13	Semiannually	Semiannually	Semiannually	F, total U
			Grass	
17	Annually	Annually	Annually	^{90}Sr, gamma scan, ^{238}Pu, ^{239}Pu, ^{238}U, ^{234}U, ^{235}U
13	Semiannually	Semiannually	Semiannually	F, total U
			Pine needles	
6	Semiannually	Semiannually	Semiannually	F, total U
			Stream sediment	
14	Semiannually	Semiannually	Semiannually	U, Hg, Pb, Ni, Cu, Zn, Cr, Mn, Al
8	Semiannually	Semiannually	Semiannually	Hg, Pb, Ni, Cu, Zn, Cr, Mn, Al, Th, Cd, U
15	Grab	Quarterly	Quarterly	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo,

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
				Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U, loss on ignition (% moisture), (% ash), (% organic matter), sieve analyses (% sand, silt, and clay), total organic carbon, moisture content in soil
14	Grab	Quarterly	Quarterly	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U, As, Sb, Se, Pb, gross alpha, gross beta, mercury (total & dissolved), PCBs, loss on ignition (% moisture), (% ash), (% organic matter), sieve analyses (% sand, silt, and clay), total organic carbon, moisture content in soil
15	Grab	Quarterly	Quarterly	Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U, As, Sb, Se, Pb, gross alpha, gross beta, mercury (total & dissolved), PCBs, loss on ignition (% moisture), (% ash), (% organic matter), sieve analyses (% sand, silt, and clay), total organic carbon, moisture content in soil
15	Grab	Quarterly	Quarterly	Hg, PCB
15	Grab	Quarterly	Quarterly	PCB, Hg, gross alpha, gross beta, field parameters
15	Grab	Quarterly	Quarterly	As, Sb, Se, Pb, Hg, PCB, gross alpha, gross beta, field parameters, TOC
15	Grab	Quarterly	Quarterly	Hg, PCB, gross alpha, gross beta, field parameters
			Milk	
4	Semiannually	Semiannually	Semiannually	^{90}Sr, ^{131}I
5	Bimonthly	Bimonthly	Bimonthly	^{90}Sr, ^{131}I
			TLDs	
6	Continuous	Semiannually	Semiannually	External gammas
11	Continuous	Quarterly	Quarterly	External gammas
7	Continuous	Monthly	Monthly	External gammas
11	Continuous	Continuous	Continuous	External gammas
11	Continuous	Semiannually	Semiannually	External gammas

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
			Water	
10	Continuous	Continuous	Continuous	Flow
2	Continuous	Continuous	Continuous	pH, DO
1	24-h	3/week	3/week	BOD, TSS, NH_3 (as N)
1	Grab	3/week	3/week	Oil & grease, fecal coliform
6	Grab	Weekly	Weekly	pH
1	Grab	Weekly	Weekly	TOC, nitrate(N), sulfate
1	24-h	Weekly	Weekly	Metals, TSS
4	Grab	Weekly	Weekly	Oil & grease
3	Grab	Per discharge	Per discharge	TSS, nitrate(N), sulfate, TOC, oil and grease, metals
5	24-h	Bimonthly	Bimonthly	TSS, metals
1	24-h	Bimonthly	Bimonthly	TTO
1	24-h	Bimonthly	Bimonthly	Nitrate(N)
2	24-h	Bimonthly	Bimonthly	Sulfate
6	Grab	Monthly	Monthly	Volatiles
7	Grab	Monthly	Monthly	TDS, BOD
5	Grab	Monthly	Monthly	TOC
4	Grab	Monthly	Monthly	Oil & grease
1	Grab	Monthly	Monthly	Fecal coliform
2	Grab	Monthly	Monthly	pH
1	Grab	Quarterly	Quarterly	Phenols
32	Grab	Quarterly	Quarterly	Flow, pH
66	Grab	Quarterly	Quarterly	Flow, temp., pH
66	Grab	Quarterly	Quarterly	Oil & grease, TSS
56	Grab	Yearly	Yearly	Oil & grease, TSS
56	Grab	Yearly	Yearly	Flow, temp., pH
1	Composite	Daily	Daily	Gross alpha, gross beta, gamma scan, ^{90}Sr
2	24-h	Bimonthly	Bimonthly	P
5	Grab	Bimonthly	Bimonthly	Oil & grease
4	Grab	Bimonthly	Bimonthly	TOC
1	Grab	Bimonthly	Bimonthly	P
6	24-h	Monthly	Monthly	Metals
1	24-h	Monthly	Monthly	Hg
5	24-h	Monthly	Monthly	TSS, fluoride, nitrate(N), sulfate, NH_3 (as N), total phosphorus, PCB
5	Grab	Monthly	Monthly	Temp., conductivity, DO, turbidity

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
2	Grab	Monthly	Monthly	Chlorine
1	Grab	Monthly	Monthly	Cyanide
1	Grab	Monthly	Monthly	Sulfate
6	Grab	Monthly	Monthly	Phenols
3	Continuous	Daily	Daily	Gross alpha, gross beta, gamma scan
4	Composite	Daily	Quarterly	Gross alpha, gross beta, ^{90}Sr, ^{60}Co, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{228}Th, ^{230}Th, ^{232}Th
5	Composite	Weekly	Monthly	^{90}Sr, gamma scan
4	Grab	Weekly	Monthly	^{90}Sr, gamma scan
2	Composite	Weekly	Monthly	^{90}Sr, gamma scan, ^{228}Th, ^{3}H
1	Grab	Monthly	Monthly	Gross alpha, gross beta
1	Grab	5/quarterly	5/quarterly	^{131}I
2	Composite	Weekly	Quarterly	^{3}H
1	Continuous	2/week	Weekly	Cr, Cu, Ni, Ba, B, Co, Mg, Mo, Mn, Ti, Sb
1	Grab	5/week	5/week	Temperature
1	Grab	1/week	1/week	PCB
1	Grab	1/week	1/week	Total toxic organics (TTO)
1	Grab	1/week	1/week	Cyanide
1	Continuous	4/week	Weekly	Total dissolved solids (TDS)
1	Continuous	1/week	1/week	Ammonia(N), bromide, Cl resin, chloride, total organic nitrogen, phosphorus, SO_4, SO_3, S, surfactants, Sn, As, Tl
1	Grab	1/week	Weekly	Phenols
1	Continuous	2/week	Weekly	TOC, nitrate-nitrite(N)
1	Continuous	4/week	Weekly	Fl
4	Grab	1/week	Weekly	Oil & grease
4	Continuous	2/week	2/week	Suspended solids
6	Continuous	2/week	2/week	Al
6	Continuous	4/week	4/week	COD
1	Continuous	2/week	Weekly	Cr
1	Continuous	2/week	Weekly	Dissolved solids
1	Continuous	2/week	Weekly	Fl
1	Continuous	2/week	Weekly	Nitrate(N)
6	Continuous	2/week	2/week	Oil & grease
6	Continuous	4/week	4/week	Suspended solids
1	Grab	4/week	4/week	Temperature

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
1	Grab	4/week	Weekly	Turbidity
6	Continuous	2/week	2/week	Be, Cd, Hg, Se, Ag, Pb, Zn Perchloroethylene, methylene chloride, trichloroethane, trichloroethylene
1	Grab	2/week	2/week	Turbidity
1	Grab	1/week	Weekly	Suspended solids
1	Grab	1/week	Weekly	Al
1	Grab	1/week	Weekly	Sulphate
1	Grab	1/week	Weekly	COD
1	Grab	1/week	Quarterly	Cd, Cr, Pb, Hg, Zn, As, Cu, Ni, P
5	Grab	5/week	5/week	Flow
1	Continuous	3/week	3/week	Ammonia(N)
1	Continuous	3/week	3/week	BOD_5
1	Grab	3/week	3/week	Fecal coliform
1	Continuous	3/week	3/week	Suspended solids
1	Continuous	1/week	Weekly	Be
1	Continuous	1/week	Weekly	Cd
1	Continuous	1/week	Weekly	Hg
1	Continuous	1/week	Weekly	Se
1	Continuous	1/week	Weekly	Ag
1	Continuous	1/week	Weekly	Pb
1	Continuous	1/week	Weekly	Zn
1	Grab	1/week		Perchloroethylene, methylene chloride, trichloroethylene, trichloroethane, total halomethanes
2	Grab	1/quarter	Quarterly	DO
1	Grab	5/week	5/week	Soluble solids
1	Grab	5/week	5/week	Cl residual
6	Continuous	1/week	1/week	Uranium
4	Continuous	2/week	2/week	COD
4	Continuous	1/week	1/week	Cr
4	Continuous	1/week	1/week	Ti
1	Flow proportional	Daily	Daily	Gross alpha, gross beta, gamma scan, ^{90}Sr
1	Flow proportional	Weekly	Monthly	Gamma scan, ^{90}Sr, ^{3}H
1	Grab	Weekly	Monthly	Gamma scan, ^{90}Sr
1	Grab	Weekly	Monthly	^{3}H
1	Grab	Monthly	Quarterly	Gamma scan, ^{90}Sr, Pu, transPu, U

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
1	Grab	Weekly	Monthly	Gamma scan, ^{90}Sr, ^{3}H
1	Flow proportional	Weekly	Monthly	Gamma scan, ^{90}Sr, ^{3}H, transPu, ^{3}H, Th, U
1	Time proportional	Weekly	Monthly	^{3}H
1	Time proportional	Monthly	Quarterly	Gamma scan, ^{90}Sr, Pu
1	Grab	Daily	Quarterly	Gamma scan, ^{90}Sr, Pu, transPu, U
1	Flow proportional	Weekly	Monthly	Gamma scan, ^{90}Sr
1	Flow proportional	Weekly	Monthly	Gamma scan, ^{90}Sr, ^{3}H
1	Grab	Weekly	Monthly	Gamma scan, ^{90}Sr, Pu, transPu, ^{3}H
1	Flow proportional	Weekly	Weekly	Gross alpha, gross beta, gamma scan, ^{90}Sr, Pu, transPu, ^{3}H
1	Weekly	Weekly	Weekly	Flow, Li, SS, Zr, K, Na, temperature, pH (min-max), As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg; ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
1	Weekly	Weekly	Weekly	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
1	Weekly	Weekly	Weekly	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); ammonia(N), fluoride, surfactants (as MBAS), dissolved solids, total nitrogen, BOD, DO, Be, residual chlorine, perchloroethylene (VOA scan); ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
1	Daily	Daily	Daily	pH, DO, flow
1	Monthly	Monthly	Monthly	Suspended solids
5	Weekly	Weekly	Weekly	pH, DO, flow
2	Monthly	Monthly	Monthly	Flow, Li, SS, temperature, pH, As, Ni, Pb, Hg; ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
2	Daily	Daily	Daily	Flow
77	Yearly	Yearly	Yearly	pH, flow
97	Quarterly	Quarterly	Quarterly	pH, temperature, flow
22	Weekly	Weekly	Weekly	pH
20	Yearly	Yearly	Yearly	Flow
2	Weekly	Weekly	Weekly	pH, flow
1	Daily	Daily	Daily	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
2	Daily	Daily	Daily	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
1	Daily	Daily	Daily	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); Ag, cyanide, total toxic organics (VOC + BNA + PCB), color, aluminum
19	Quarterly	Quarterly	Quarterly	Free chlorine, flow, pH, Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
2	Monthly	Monthly	Monthly	pH, flow
1	Weekly	Weekly	Weekly	Flow, Li, SS, Zr, K, Na, temperature, pH, As, Cd, Cr, Cu, Fe, Ni, Se, Zn, Pb, Hg, COD, sulfate (as SO_4), turbidity, oil and grease, settleable solids (mL/L); Ag, cyanide TTO (VOC + BNA + PCB), color, Al, P, chloride, phenols, Ba, Ca, Co, Mg, Mn, Mo, sulfide, titanium, total halomethanes, chloroform, bromodichloromethane, dibromochloromethane, bromoform, B, Sb, chlorinated organics, (VOA + base neutral); ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
2	Monthly	Monthly	Monthly	ICP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, V, Zn, U
			Groundwater	
27	Grab	Yearly	Yearly	pH, DO, conductivity, turbidity
27	Grab	Yearly	Yearly	Gross alpha, gross beta, gamma scan, ^{90}Sr, ^{3}H
22	Grab	Quarterly	Quarterly	Cl, F, phenols, SO_4, NO_3, TOC, TOX, pH, conductivity, gross alpha, gross beta, gamma scan, total radium, pesticides, metals, fecal coliform
11	Quarterly	Quarterly	Quarterly	alpha activity, Al, Sb, As, Ba, Be, beta activity, B, Cd, Ca, chloride, Cr, Co, conductivity, Cu, Endrin, extractable organics, fluoride, groundwater elevation, Fe, Pb, Lindane, Li, Mg, Mn, Hg, methoxychlor, Mo, Ni, Nb, nitrate (as N), pH, phenols, P, K, Se, Si, Ag, Silvex, Na, Sr, sulfate, temperature, Tl, Th, Ti, total coliform bacteria, total organic chloride, total radium, toxaphene, total U, ^{235}U, V, volatile organics, Zn, Zr, 2,4-D
1	Weekly	Weekly	Weekly	37 parameters

Table 2.1 (continued)

Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
1	Weekly	Weekly	Weekly	5 parameters
2	2/week	2/week	2/week	161 parameters
5	Monthly	Monthly	Monthly	10 parameters
18	Quarterly	Quarterly	Quarterly	36 parameters
6	Yearly	Yearly	Yearly	97 parameters
16	Quarterly	Quarterly	Quarterly	98 parameters
3	Quarterly	Quarterly	Quarterly	100 parameters
36	Quarterly	Quarterly	Quarterly	35 parameters
44	Quarterly	Quarterly	Quarterly	33 parameters
44	Quarterly	Quarterly	Quarterly	33 parameters
44	Quarterly	Quarterly	Quarterly	3 parameters
44	Quarterly	Quarterly	Quarterly	6 parameters
44	Quarterly	Quarterly	Quarterly	7 parameters
52	Quarterly	Quarterly	Quarterly	6 parameters
6	Quarterly	Quarterly	Quarterly	68 parameters
54	Quarterly	Quarterly	Quarterly	16 parameters
13	Quarterly	Quarterly	Quarterly	9 parameters
45	Quarterly	Quarterly	Quarterly	31 parameters
60	Quarterly	Quarterly	Quarterly	39 parameters
36	Quarterly	Quarterly	Quarterly	39 parameters
36	Quarterly	Quarterly	Quarterly	39 parameters
53	Quarterly	Quarterly	Quarterly	2 parameters
54	Quarterly	Quarterly	Quarterly	14 parameters
45	Quarterly	Quarterly	Quarterly	10 parameters
2	4/hour	4/hour	4/hour	1 parameter
2	4/hour	4/hour	4/hour	1 parameter
2	Continuous	Continuous	Continuous	1 parameter

3. ON-SITE DISPOSAL AND OFF-SITE SHIPMENT OF WASTE

3.1 REGULATORY REVIEW

3.1.1 Orders and Regulations Governing Radioactive Wastes

Management of radioactive wastes, waste by-products, and radioactively contaminated facilities is governed by DOE Order 5820.2, which applies to all DOE elements, contractors, and subcontractors that manage radioactive waste as defined in the Atomic Energy Act of 1954 (as amended). Guidelines are provided for characterization, storage, and disposal of high-level radioactive wastes, low-level radioactive wastes, transuranic wastes, and wastes contaminated with naturally occurring radionuclides. The Oak Ridge installations produce contaminated, low-level radioactive wastes as a result of operations. Additionally, the Tennessee Department of Health and Environment (TDHE) reviews low-level waste disposal operations because such programs potentially impact the groundwaters of the state of Tennessee.

3.1.2 Orders Governing Classified Wastes

Because of the nature of business conducted at the Oak Ridge installations, several operational aspects are required to be secure. Materials used, fabricated parts, and containers have been classified to prevent dissemination of potentially valuable information. DOE Order 5632.1 prescribes DOE requirements for the physical protection of classified matter.

Hazardous waste management at the Oak Ridge installations is conducted under DOE Orders 5480.1A and 5480.2, as well as the Atomic Energy Act, the Resource Conservation and Recovery Act (RCRA) of 1976, and its Tennessee equivalent, the Tennessee Hazardous Waste Management Regulations. DOE Order 5480.1A ensures that hazardous waste generated by DOE-funded activities will be managed in an environmentally acceptable manner. DOE Order 5480.2 provides the requirements for hazardous waste management programs implemented at DOE-funded installations. The Atomic Energy Act of 1954, as amended, dictates provisions for establishing regulations governing processing and use of source, by-product, and special nuclear materials.

The Resource Conservation and Recovery Act (RCRA), an amendment to the Solid Waste Disposal Act, regulates the generation, transportation, treatment, and disposal of hazardous wastes and regulates all facilities disposing of solid wastes. Source material, special nuclear material, and by-product material are generally excluded from RCRA regulations. DOE proposes to issue regulations regarding by-products to clarify DOE's responsibility under RCRA for these wastes. Radioactive material mixed with hazardous wastes will be regulated by RCRA. Hazardous wastes are defined under RCRA by specific source lists, nonspecific source lists, and characteristic hazards. Other portions of RCRA pertinent to the Oak Ridge installations include standards for transporters of hazardous waste and owners and operators of hazardous waste treatment, storage, and disposal facilities; permit requirements for treatment, storage, or disposal of hazardous wastes; inspections; federal enforcement; hazardous waste site inventory; and monitoring analysis and testing criteria for landfills.

The 1976 RCRA was amended in November 1984 by the Hazardous and Solid Waste Amendments, which have two principal purposes: (1) to regulate previously exempt generators and sources, and (2) to regulate land disposal more stringently, eliminating it where possible. Requirements imposed by new RCRA amendments detail the standards. The amendments reauthorize and extend RCRA regulations through 1988 and require the Environmental Protection Agency (EPA) to promulgate new regulations governing several aspects of waste management.

3.1.3 RCRA Compliance and Permitting

To obtain compliance with RCRA, the Oak Ridge installations submit permit applications to environmental regulators for each hazardous waste treatment, storage, or disposal facility. Each permit application has two parts: Part A permit applications, submitted in 1984, and Part B permit applications, submitted in 1985. Facilities with interim status could have filed for closure and ceased operations instead of filing for Part B permit applications.

Information required for Part B includes general facility description, waste characterization, and analysis plan; information on processes generating the waste; procedures to prevent hazards; contingency plans; and closure and postclosure plans. After negotiation and acceptance of Part B, Oak Ridge installations will be fully permitted under RCRA and subject to stringent guidelines specified in 40 CFR Pt. 264. The installations are then to be inspected annually by EPA, TDHE, DOE, and/or internal auditors to ensure RCRA compliance.

Tennessee regulations equivalent to RCRA are the Tennessee Hazardous Waste Management Regulations found in Tennessee Rules, Chapter 1200-1-11. These are virtually identical to RCRA. Minor differences exist with respect to wastewater treatment and exempting recycle facilities from hazardous waste regulation. Though previously granted the authority to regulate RCRA activities, the State of Tennessee will need to apply for authorization to administer the Solid and Hazardous Waste Amendments of 1984.

3.1.4 Regulations Governing Toxic Substances Control Act Wastes

Specific toxic substances are regulated by the Toxic Substances Control Act (TSCA) of 1976. These substances differ from RCRA hazardous materials and include polychlorinated biphenyls (PCBs). Source material, special nuclear material, and by-product material are excluded from TSCA. The only regulatory element pertinent to Oak Ridge installations' environmental management is the Polychlorinated Biphenyls Rule. These regulations are specified in 40 CFR Pt. 761. To achieve compliance, Oak Ridge installations are looking toward eliminating bulk quantities of PCBs.

3.1.5 Regulations Governing Conventional Waste

The Tennessee Solid Waste Disposal Act and regulations promulgated under this act govern the planning, design, construction, operation, and maintenance of solid waste processing and disposal facilities. Excluded are solid or dissolved material in domestic sewage that are subject to permit under the Federal Water Pollution Control Act in the NPDES and special nuclear material as defined under the Atomic Energy Act (as amended). Special wastes such as low-level radioactive wastes, asbestos, and beryllium oxide, however, cannot be disposed of in a conventional facility unless specifically permitted under this act.

3.2 1986 GENERATION AND DISPOSAL SUMMARY

Radioactive wastes generated by the three Oak Ridge installations during 1986 are given in Table 3.2.1. Nonradioactive waste disposal activities are given in Table 3.2.2. Table 3.2.3 gives the hazardous or special waste activities during 1986.

3.3 OAK RIDGE Y-12 PLANT SOLID WASTE MANAGEMENT PROGRAM

The Oak Ridge Y-12 Plant has developed an extensive Solid Waste Management Program. In accordance with the RCRA and the Tennessee Solid Waste Act, a solid waste is defined as any solid, liquid, semisolid, or contained gas that is being discarded. Therefore, the Solid Waste Management Program at the Oak Ridge Y-12 Plant addresses liquid wastes and contained

Table 3.2.1. 1986 solid radioactive waste generation summary

Parameter	Ci	Disposed of (Ci)	Stored (Ci)
^{241}Am	508		508
^{243}Am			1.1×10^{-5}
^{249}Bk			2.0×10^{-5}
^{14}C	2.01		2.01
^{252}Cf	6.72		6.72
^{242}Cm	0.80		0.8
^{244}Cm	6.02		6.02
^{60}Co	1,764	1,622	142
^{134}Cs	13.9	13.9	
^{137}Cs	4,993	4,967	26.1
^{152}Eu	1,257	1,257	
^{154}Eu	1,268	1,268	
^{153}Gd	271	271	
^{3}H	7.92	0.36	7.57
^{125}I	0.058	0.058	
^{131}I	0.002	0.002	
^{192}Ir	3,942	3,942	
^{85}Kr	1.0	1.0	
Mixed fission products	1,145	5.0	1,140
^{32}P	0.001	0.001	0.00001
^{147}Pm	85.2	85.2	
^{238}Pu	100		100
^{239}Pu	530		530
^{240}Pu	3.82		3.82
^{90}Sr	137.7	90.33	47.38
^{232}Th	1.02	1.02	0.0001
^{232}U	0.162	0.166	
^{233}U	5.74	4.26	1.48
^{235}U	0.101	0.1	0.001
^{238}U	0.50	0.14	0.42
Total	16,050.67	13,528.54	2,522.32

gaseous wastes if determined to present a problem, as well as solid wastes. The Solid Waste Management Program has been divided into five subprograms, each reflecting differing regulatory authority.

Of concern to all Oak Ridge Y-12 Plant solid waste management programs, in addition to research and development goals, is prudent waste management. The Oak Ridge Y-12 Plant Hazardous Waste Management Policy declares that its aim is to protect employees, the public, and the environment from hazardous wastes and material. Equipment and procedures for waste management will be continually improved. In accordance with this policy and prudent waste management in general, Oak Ridge Y-12 Plant has developed strategies for streamlining management of solid wastes. The chief goal is to minimize generation of solid wastes while achieving compliance with applicable environmental regulations.

Solid wastes are often categorized at the Oak Ridge Y-12 Plant as follows: industrial and sanitary wastes, security classified wastes, low-level radioactive wastes, RCRA hazardous wastes, and mixed wastes (hereafter included in the solid hazardous waste category). RCRA hazardous waste is a candidate for commercial recovery or disposal programs; mixed wastes, which contain both RCRA hazardous and radioactive components, are not candidates for commercial recycle or disposal.

Ideally, after strategy implementation, most of the solid wastes generated will be conventional wastes. When this is not possible, prudent management will minimize the amount of other wastes (classified, hazardous, radioactive) present. Six major waste-minimization options are available at Oak Ridge Y-12 Plant: segregation, material substitution, process innovation, mechanical volume reduction, recycle and/or reuse, and treatment. These options are not mutually exclusive and may be combined to suit individual needs.

Current strategy for solid waste management consists of waste avoidance/reduction, storage, treatment, delisting (where appropriate), and disposal. Each concept is an integral portion of the overall waste management strategy. Waste storage is necessary to ensure compliance with environmental regulations while treatment and disposal techniques are identified and implemented and during the delisting process.

A Low-Level Waste Disposal, Development and Demonstration (LLWDDD) program has been established to provide for interim waste storage, improved operation in existing burial grounds, demonstration of candidate disposal technologies, and a waste minimization program.

Six Oak Ridge Y-12 Plant sponsored technology demonstrations have been scheduled under the LLWDDD program to address Environmental Impact Statement strategy for uranium disposal in Bear Creek Valley.

Table 3.2.2. Nonradioactive waste disposal activities 1986

Waste category	Quantity (kg)	Treatment, storage, or disposal
	ORGDP	
Furniture, batteries, and tires	33,000	Public sale
Scrap metal	310,000	Public sale
Sanitary	1,411,000	Centralized Sanitary Landfill II
Demolition	211,000	Centralized Sanitary Landfill II
Fly ash	403,000	Centralized Sanitary Landfill II
Total ORGDP	2,368,000	
	ORNL	
Tires	5,200	Public sale
Batteries	1,300	Public sale
Scrap metal	280,000	Public sale
Paper products	120,000	Public sale
Construction materials	3,600,000	ORNL contractor's landfill
Fly ash	11,000,000	ORNL contractor's landfill
Coal-pile runoff sludge	50,000	ORNL contractor's landfill
Sanitary	1,100,000	Centralized Sanitary Landfill II
Total ORNL	16,200,000	
	Y-12 Plant	
Sanitary and industrial	6,700,000	Centralized Sanitary Landfill II
Fly ash	15,000,000	Rogers Quarry
Clean scrap metal	1,760,000	Public sale
Batteries and tires	95,900	Public sale
Construction spoil	22,300,000	Centralized Sanitary Landfill II
Total Y-12 Plant	45,847,900	
Grand total	64,415,900	

Production activities at Oak Ridge Y-12 Plant generate tons of nonhazardous solid waste contaminated by low levels of radioactivity. Since 1955, low-level radioactive solid waste has been disposed of by shallow land burial (SLB) at the Bear Creek Valley Waste Disposal Area (BCVWDA) located in the Bear Creek drainage basin approximately 3 km downstream, or west of the S-3 Ponds. Ground disposal of uranium, uranium-contaminated wastes, thorium-contaminated wastes, oils, solvents, mop waters, and other liquids has been practiced in the BCVWDA. Some of the waste liquids and solids have been contaminated with PCBs, organic solvents, and other materials. Disposal practices were improved during the 1970s, and major improvements were made in 1983 with regard to waste characterization and disposal facility design. The current BCVWDA operation is described in the report Y/IA-169, *Design and Operating Plan for the Y-12 Plant Burial Ground A for Disposal of Low Level Radioactive Solid Wasge*, which was reviewed by DOE, TDHE, and EPA in 1984. Only uranium and uranium-contaminated solid wastes are now being buried there. Operating plans for the continued use of BCVWDA have been submitted by the Oak Ridge Y-12 Plant to DOE and TDHE. TDHE has concurred on extended operations in BCVWDA provided that the Oak Ridge Y-12 Plant continue to improve burial operations and participate in storage and demonstration programs.

Low-level radioactive wastes (LLW), including some quantities from ORGDP and ORNL, are now segregated and transported to BCVWDA

Table 3.2.3. Hazardous and/or special waste disposal activities 1986

Waste category	Quantity (kg)	Treatment, storage, or disposal
	Y-12 Plant liquids[a]	
Waste oil	161,000	On-site storage
Waste solvents	61,500	On-site storage
Waste oil	99,100	Commercial off-site disposal
PCB liquid waste	116,000	Commercial off-site disposal
PCB liquid waste	12,500	On-site storage
RCRA waste chemicals	226,000	Commercial off-site disposal
RCRA waste chemicals	146,000	On-site storage
Inorganic liquid waste (CPCF)	3,400,000	On-site treatment/discharge
Inorganic liquid waste (CPCF-II/OTF)	5,400,000	On-site treatment/discharge
Inorganic liquid waste (S-3 Pond)	6,300,000	On-site treatment/discharge
Inorganic liquid waste (WTF)	6,700,000	On-site treatment/storage
Total Y-12 Plant liquids	22,622,100	
	Y-12 Plant solids[a]	
DOT ORMB wastes	61,000	On-site storage
PCB solid waste	77,800	Commercial off-site disposal
PCB solid waste	51,200	On-site storage
Classified waste	100,000	Security pit
Asbestos waste (clean)	139,000	Centralized Sanitary Landfill II
Asbestos waste (rad)	172,000	Bear Creek Burial Grounds
Uranium-contaminated waste	1,950,000	Bear Creek Burial Grounds
WTF sludge (solids)	986,000	
CPCF sludge	73,000	
Uranium solids	5,000 m^3	
Total Y-12 Plant solids	3,610,000 kg + 5,000 m^3	
Total Y-12 Plant	26,232,100 kg + 5,000 m^3	
	ORNL	
Scrap metal	666,900	ORGDP salvage
Metal shavings	120 cu yd.	ORGDP salvage
Chemical waste collected	132,055	Storage
Mixed waste collected	26,277	Storage
Chemical waste	27,137	Baton Rouge, LA
	19,849	Chicago, IL
	6,112	Deer Park, TX
	1,976	El Dorado, AR
	23,184	Emelle, AL
	11.7	Quarry
	2,045	Y-12 Plant landfill
	18,270	Demco
	21,565	Quadrex, FL
	17,280	Chicago, IL
Other waste	9,889	Centralized Sanitary Landfill II
Animal bedding		
Asphalt		
Roofing materials		
Block		
Brush		
Brick		
Concrete		
Empty containers		
Organic garbage		
Paper		
Cardboard		
Glass		
Fly ash ash		

Table 3.2.3 (continued)

Waste category	Quantity (kg)	Treatment, storage, or disposal
Empty paint cans		
Empty aerosol cans		
Empty hazardous materials containers		
Empty pressurized gas cylinders		
Coal pile runoff sludge		
Empty pesticide containers		
Plastic		
Rubber		
Rock		
Rubble		
Textile products		
Tile		
Wood		
Construction and demolition debris		
Total ORNL	804,332	
	ORGDP	
Nitric acid	1,400	Y-12 Plant
Electroless nickel solution	16,000	Y-12 Plant
Y-12 Plant returned waste	2,400,000	Y-12 Plant
Waste chemicals	16,000	Commercial off-site disposal
Laboratory chemicals (includes H_2O for disposal process)	26,000	Storage
Laboratory chemicals	800,000	Storage
Solvents and oils (radiation-contaminated)	31,000	Storage for TSCA incinerator
Total ORGDP	3,290,400	
Grand total (Y-12 Plant, ORNL, ORGDP)	30,326,832 kg + 12,414 m^3	

[a]Fiscal year 1986.

with various means of disposal being employed.

Radioactively contaminated trash (nonhazardous) is disposed by the trench-and-fill method with daily soil cover in the trenches. Certain special wastes which are identified by the Tennessee Solid Waste Disposal Act and contaminated with low-level radioactivity are disposed in area A in a manner similar to that prescribed in the state-permitted landfill.

Depleted uranium chips or uranium turnings are transported with water in dumpsters and are disposed of in earthen pits. Uranium fines and sawdust are disposed of in "walk-in pits" with a suitable layer of soil used as cover.

The previously used asbestos pits have been closed. Uranium-contaminated asbestos wastes are being disposed in special cells in the BCVWDA area. Asbestos wastes not contaminated with uranium have been disposed of in Centralized Sanitary Landfill II as special waste. The previously used BeO waste pits have also undergone closure. Both the asbestos materials and BeO wastes are permitted for disposal in Centralized Sanitary Landfill II.

Waste volumes currently disposed in BCVWDA have been examined, and alternative options for interim storage and/or final disposal have been considered carefully.

Storage of LLW is necessary to extend the operating life of current disposal facilities and to bridge the gap between closure of existing facilities and availability of new ones. During 1985, the Oak Ridge Y-12 Plant developed storage options for LLW, including below-grade as well as above-grade storage in metal buildings, above-grade container storage on asphalt pads, storage in concrete vaults, and waste storage in existing buildings.

Uranium turnings: treatment and disposal. Depleted uranium machine turnings (chips) and depleted uranium metal have been disposed in SLB operations in the BCVWDA. The uranium chips will be sent to the Uranium Chip Oxidizer Facility, where the volume of uranium chips is reduced and converted to its most stable oxide form.

Construction of two storage vaults for uranium oxide and bulk metal storage on Chestnut Ridge has been completed. The facilities, with a combined capacity of 1812 m^3, are completely enclosed, waterproof concrete vaults.

A large portion of the depleted uranium scrap metal is collected and recycled through the High Energy Physics Program, which provides shielding material for various projects.

To help mitigate the potential for ground and surface runoff pollution from the BCVWDA chip disposal pits, the Oak Ridge Y-12 Plant has implemented a program to improve chip collection and disposal.

A study is being conducted to develop a process for safely treating depleted uranium fines and "sawdust."

The Oak Ridge Y-12 Plant generates large quantities of bulk depleted uranium scrap each year. Studies are under way to develop methods to reduce the amount of depleted uranium and uranium alloy scrap generated and alternatives to its storage.

Scrap metal management. A variety of scrap metal (uranium-contaminated and noncontaminated), drummed oils and solvents, empty drums, and equipment is stored at the existing salvage yard located east of Building 9420 and north of the railroad tracks. Noncontaminated scrap is sold to the public.

Scrap metal contaminated with depleted or enriched uranium presents a major storage space problem. Alternatives to on-site storage are being developed, and much of the contaminated scrap is being consolidated at ORGDP for shearing and storage until plans for future processing are developed.

Hazardous waste management programs. RCRA defines hazardous wastes as originating in any one or any combination of four ways.

The Waste Oil/Solvent Storage Facility will provide storage for PCB-contaminated oils that also contain uranium and/or organic solvents. Organic solvents will be relocated to the new Liquid Organic Waste Storage Facility. A new covered concrete pad in the western exclusion area has been placed in operation for sampling and storage of drummed oils. Waste oils are subsequently pumped into bulk storage tanks and are sorted by contaminant levels prior to disposal.

Miscellaneous waste chemicals are packaged in small quantities by the generators for transport to the RCRA Staging and Storage Facility where collecting, labeling, packaging, and manifesting chemicals will take place before commercial disposal.

Liquid process wastes generated throughout the Oak Ridge Y-12 Plant are collected at designated locations and then treated at the Central Pollution Control Facility (CPCF), the Central Pollution Control Facility-Phase II (CPCF-II), the West End Treatment Facility (WETF), and the K-1232 Facility at ORGDP. Sludges are generated from the treatment of process wastes or exist in holding ponds formerly used for waste treatment. The vast majority of these sludges are listed as hazardous wastes contaminated with depleted uranium. Additionally, some of these sludges are characteristically hazardous (EP toxic). Management of these sludges includes storage, treatment, delisting, and disposal. Wastes from ORGDP, ORNL, and the Oak Ridge Y-12 Pland will be managed by this facility. Another processing option is sludge stabilization in grout matrix or glass matrix. The Central Sludge Fixation Facility at ORGDP accommodates grout stabilization of wastewater treatment sludges.

A second component of sludge management is storage. Interim sludge storage is necessary until disposal facilities are in place. Existing buildings are being used for sludge storage at ORGDP. Bulk storage of large volume sludge streams in 1.895-million-liter tanks will be provided by sludge generators, under an FY 1989 line item project, the Production Waste Storage Facility. In addition to tank storage for sludge, vault storage will also be provided for ash from the

TSCA incinerator, and warehouse storage for classified waste. An FY 1992 line item project, the Production Waste Treatment Facility, will provide facilities for treatment and disposal of low-level radioactive hazardous and mixed wastes.

Acid and caustic wastes generated from plating and cleaning operations may either be treated on site or be disposed of commercially without treatment. The CPCF and the WETF will treat acid and caustic wastes. Certain corrosive wastes will be handled in the RCRA Staging and Storage Facility before shipment off site.

Ignitable wastes generated at the Oak Ridge Y-12 Plant include nonchlorinated solvents, now stored in drums in an earthen diked area at the storage yard. This storage has been partially closed, with final closure scheduled for 1988. The Liquid Organic Waste Storage Facility will provide both tank and drum storage for waste solvents generated at the Oak Ridge Y-12 Plant. Oils and solvents that meet acceptability criteria for the TSCA incinerator at ORGDP may be sent there for use as fuel. As an alternative, they may be recyled commercially.

Acetonitrile (ACN) will be stored in a separate facility. The RCRA Staging and Storage Facility will also manage ignitable wastes. Ultimately, these wastes will be incinerated or disposed of commercially.

Reactive waste and some contained gases have the potential either to react violently when combined with water or to release toxic, flammable, or corrosive fumes or gases. Reactive laboratory chemicals; metal hydrides; lithium, sodium, or potassium metal; and "NaK" are some of the reactive wastes produced at the Oak Ridge Y-12 Plant. The Oak Ridge Y-12 Plant and ORNL currently dispose of most water-reactive metals and shock-senstive materials in Kerr Hollow Quarry. Contained gases in defective gas cylinders are also vented at the quarry. Both the Oak Ridge Y-12 Plant and ORNL are reviewing commercial disposal options for these kinds of waste to reduce the use of Kerr Hollow Quarry for emergency disposals. An FY 1987 research and development study to determine acceptable alternatives for disposaing of reactive materials is scheduled.

The Oak Ridge Y-12 Plant disposes of small quantities of water-reactive metals (such as sodium) in Kerr Hollow Quarry. An FY 1986 research and development study was to determine acceptable alternatives for disposing of reactive materials.

Plating waste solutions and waste chemicals are characteristically hazardous because metals are present. These wastes may either be shipped off-site for commercial disposal without treatment or be treated on-site. Where possible, extraction procedure (EP) toxicity tests are conducted on mercury contaminated waste to determine if RCRA regulations for hazardous wastes apply. Commercial disposal off-site is an option for wastes meeting uranium contamination guidelines for such disposal. Mercury bearing wastes that exceed uranium contamination guidelines are stored on-site.

Specific guidelines for managing mercury contaminated waste are as follows: wastes containing less than 12 ppm of mercury are sent to Centralized Sanitary Landfill II. Scrap with less than 50 ppm of mercury (average value) and less than 60 ppm of mercury (maximum value) can be sold. Bulk wastes with more than 500 ppm of mercury are stored on-site. All materials shipped to either Centralized Sanitary Landfill II or off-site for commercial disposal must be below the Oak Ridge Y-12 Plant radioactivity guidelines of 30 pCi/g for bulk waste, less than 1000 dpm/100 cm^2 measurable alpha activity, and no enriched uranium.

A 1985 assessment was conducted to verify sources of PCBs at Oak Ridge Y-12 Plant (including ORNL facilities at the Oak Ridge Y-12 Plant), and to ensure that full TSCA compliance is being achieved. Sources of PCBs at the Oak Ridge Y-12 Plant include transformers, capacitors, heat transfer systems, hydraulic systems, and waste oils and solvents. As a result of PCB assessment, Oak Ridge Y-12 Plant will undertake activities to develop a more efficient and comprehensive TSCA compliance program. The Oak Ridge Y-12 Plant stores PCB materials contaminated with uranium, which is above limits set by company policy acceptable for off-site handling and disposal. A TSCA-approved incinerator is under construction and will be completed in 1987 at ORGDP to facilitate ultimate disposal of radioactively contaminated PCB materials from the Oak Ridge Y-12 Plant and other DOE facilities.

A current line item project involves replacement of large PCB-filled transformers at the Oak Ridge Y-12 Plant. The transformers will be shipped to an EPA-approved PCB incinerator in Kansas, where they will be drained and flushed. The liquid will be incinerated, and the remaining material will be stored in an EPA-approved landfill in Nevada. Completion of this line item project will substantially reduce the inventory of PCBs at the Oak Ridge Y-12 Plant.

The Oak Ridge Y-12 Plant operates Centralized Sanitary Landfill II for the disposal of conventional (nonradioactive, nonhazardous) solid wastes on Chestnut Ridge near the eastern end of the installation. The landfill serves ORNL, ORGDP, and other DOE prime contractors in Oak Ridge in addition to the Oak Ridge Y-12 Plant. Operation is by SLB using the trench-and-fill method and is permitted by TDHE. The permit has been modified recently to allow disposal of asbestos materials, aerosol cans, materials contaminated with beryllium oxide, glass, and fly ash. Requests have been filed with the state to allow the disposal of additional materials at this site. The State of Tennessee has approved a request to modify the operating plan to permit disposal in larger trenches.

Construction spoils generated at the Oak Ridge Y-12 Plant by an on-site construction contractor have been disposed in a borrow area, Construction Spoils Area No. 1. An operating permit from TDHE has been received for this site. As of January 1, 1985, construction spoils are no longer disposed at this site. Disposal has been limited to uncontaminated spoil dirt, trees, brush, and stumps and other debris, which are now disposed of in Centralized Sanitary Landfill II.

The Oak Ridge Y-12 Plant pumps fly ash and bottom ash generated at the steam plant in a slurry form up Chestnut Ridge and then into Rogers Quarry for sedimentation and clarification. TDHE considers this disposal method an inappropriate use of the state's waters and has requested that a study be done to assess the impact of the ash on Rogers Quarry and the underlying groundwater quality. The results of this study will determine if an alternative disposal method is needed.

Tons of uncontaminated scrap metal are stored in a designated section of the salvage yard. The scrap, which is primarily ferrous, is regularly sold to outside commercial scrap dealers. Storage of the uranium-contaminated piles in adjacent areas offers little in the way of environmental control. Possible pollution of groundwater or of East Fork Poplar Creek from salvage yard runoff is being assessed.

New Hope Pond has been used for many years as a sedimentation and equalization basin. The pond acts as a safety valve in the event of an actual spill upstream. However, through the years a buildup of sediment has resulted in a decline in retention time. The lower retention time lowers the efficiency of sedimentation, equalization, and neutralization. The pond was dredged to reestablish retention time, but again the pond is in need of dredging. A New Hope Pond Sediment Removal Project will transport and dispose of pond bottom sludge. Disposal would be in the sediment disposal basin on Chestnut Ridge as planned.

Before the pond can be dredged, issues of the hazardous characteristics of the sludge must be resolved. The Chestnut Ridge Sludge Disposal Basin, located south of New Hope Pond has been used for the dewatering and disposal of sludges dredged from New Hope Pond.

The Chestnut Ridge Borrow Area Waste Pile is a shallow land burial facility used for the disposal of mercury contaminated soils from the City of Oak Ridge. The material is contained by a synthetic liner.

Other mercury contaminated wastes on the ORR cannot be disposed of commercially. The Industrial Waste Landfill III, a shallow land burial site, is proposed for the disposal of this material.

The United Nuclear Waste Disposal Site, located south of the Oak Ridge Y-12 Plant on the crest of Chestnut Ridge, is an unlined pit containing approximately 29,000 drums of waste generated during the decommissioning of the United Nuclear Corporation Plant in Rhode Island. The waste includes sludges, soil, construction rubble, and other debris, some of which contain high levels of nitrates. Because of the high nitrate content, the TDHE has expressed concern about potential degradation of the groundwater. Sampling, analysis, pathways analyses, and other evaluations have been completed to identify the most appropriate closure option. Closure is expected during FY 1987.

3.4 ORNL SOLID WASTE MANAGEMENT

The objectives of solid waste management at ORNL are to provide long-term isolation of waste contaminated with radioactivity and/or hazardous materials generated as a result of ORNL operations and research and to protect ORNL personnel, the public, and the general environment from these wastes.

The solid waste management program at ORNL is divided into: radioactive waste with two categories of low-level waste and transuranic waste; hazardous waste with two categories of hazardous waste and mixed waste; and conventional waste with two categories of sanitary and industrial waste. Two broad categories of radioactive solid waste materials are distinguished by characteristics of radionuclides present in the waste.

The first category is commonly referred to as non-transuranic (non-TRU) and is characterized as material containing <100 nCi/g of TRU nuclides, where TRU activity is defined as being generated by ^{233}U and higher-atomic-weight nuclides. This category is also referred to as low-level waste (LLW). The second category is referred to as transuranic and by definition contains >100 nCi/g of the TRU nuclides, which typically have long half-lives (>20 years). This currently accepted distinction between the two categories is specified in DOE Order 5820.2, which was placed in effect at DOE-ORO installations in 1984.

SLB disposal of the non-TRU wastes is limited by available space at Solid Waste Storage Area (SWSA) 6 and by the low probability of developing a new SLB site within the near term. As an interim measure, waste volume reduction and minimization techniques will be utilized to conserve the available SLB space while longer-term disposal options are evaluated and/or demonstrated a central repository called the Waste Isolation Pilot Plant (WIPP) located in New Mexico is planned for all TRU wastes that can meet the WIPP acceptance criteria.

The categorization and characterization of solid waste materials at ORNL are further complicated by the presence of nonradioactive components in the wastes that are classified as hazardous or toxic by regulations promulgated since 1976. Radioactive material combined with substances classified as RCRA-hazardous produces a distinct classification generally referred to as "mixed" waste.

Pure RCRA-hazardous materials are collected, packaged, and shipped off site to approved commercial disposal sites. Similarly, nonradioactively contaminated, PCB-contaminated materials are handled according to provisions stipulated in TSCA regulations. Although there is no commercial means for disposal of radioactively contaminated PCB wastes, the use of the ORGDP TSCA incinerator (scheduled for operation in CY 1987) for destruction of these wastes is planned, provided the wastes meet the relatively stringent restrictions for feed materials to this unit.

Sanitary solid wastes (nonhazardous, nonradioactive) generated at ORNL are placed in the Chestnut Ridge sanitary landfill, a practice which is expected to be acceptable for the near term. Construction spoils and debris are deposited in the Contractors' Landfill, a permitted facility east of Highway 95, adjacent to Bethel Valley Road. Space in this facility is expected to be available for about two more years.

Non-TRU solid waste at ORNL originates from nearly every operating facility; however, the bulk of the LLW is generated by radiochemical processing and isotope production; reactors; physical, chemical, and biological research; analytical laboratories; and remedial actions.

Practically all SLB of solid waste at ORNL has been by one of two disposal methods: trenches or unlined auger holes. Trench burial is used for low-level and nonfissile wastes, and auger holes are used for waste containing fissile isotopes or non-TRU waste containing high beta-gamma activity.

Waste disposal trenches are nominally 15.24 m long and 3.05 m wide, depending on specific site topography. Depth is nominally 3.1 to 5.2 m, determined by the level of the water table below. The depth of all trenches must be at least 0.61 m above the known high-water-table level, as defined by the best currently available hydrologic profiles. Lateral spacing between adjacent trenches is ≥1.52 m. Trenches are excavated with a slight slope toward one end, and surface water drainage is controlled by appropriate ditching around trenches to meet prevailing surface drainage requirements.

Auger holes are a specialized form of trench burial that allows greater control of radiation exposure during disposal operations and prevents excessive quantities of fissionable material from accumulating in a given area. Auger hole disposal is used for either high-activity waste or fissionable (primarily ^{235}U) waste.

Of the six different SWSAs that have been designated and used during the existence of ORNL four have been filled and are no longer being used. The fifth is composed of two distinct geographical areas providing different solid waste storage functions. These areas are SWSA 5 north and SWSA 5 south. SWSA 5 south was used for disposal of routine buried LLW solid waste but is now closed. SWSA 5 north is used for retrievable storage of TRU-contaminated waste. SWSA 6 is the site currently used for most SLB of solid wastes. The goal is to provide approximately 10 more years of waste storage capacity through waste minimization, by aggressive pursuit of volume reduction, and by utilizing interim storage at ORGDP.

Two systems used to monitor the movement of radionuclides from some of the SWSAs are (1) a series of monitoring wells located upgradient and downgradient within the SWSAs to provide samples of the groundwater and (2) a series of flow measurement and sampling stations on White Oak Creek and its tributaries known as the Streamflow Monitoring System. Data from these systems provide both information on the retention capabilities of storage areas and an estimate of the total release of radionuclides to the Clinch River to ensure conformance with effluent-release requirements.

In addition to reducing waste volume by compaction, steps have been taken to improve waste packaging. Use of a glass melter or incineration facility is also planned. Development of new and/or modified waste facilities is also being considered. Since June 1985, generators have been required to package as much waste as possible in 208-L (55-gal) drums (i.e., a standard container). This practice allows waste containers to be placed in the trenches in an orderly array, which reduces void space and minimizes later subsidence. In addition, there is a potential for using a drum crusher and supercompaction techniques.

One of the most undesirable conditions encountered in SLB of radioactive waste is the migration of radionuclides from burial sites as a result of geological features or site hydrology. Evidence of this condition at ORNL is found in small but uncontrolled releases of radioisotopes to White Oak Lake. Approaches that can reduce the effects of these undesirable geological and hydrological conditions include (1) packaging and storage of wastes in containers/facilities with long-term integrity, (2) reduction of ^{90}Sr and ^{3}H in the waste at the point of generation, and (3) use of improved waste forms or improved burial methods to reduce leaching.

Leachate studies of a pilot concrete box disposal facility are under way at SWSA 6 to demonstrate the effectiveness of this system for hydrologically isolating the high-activity LLW. This technology might be extended to aboveground use; concrete boxes/modules offer promise of isolation of the wastes from water intrusion and, therefore, a more permanent disposal technique requiring less maintenance. The aboveground modules also offer ease of construction, flexibility of design to meet various conditions, ease of monitoring, and capability for applying the experience to underground modules if this becomes a more desirable alternative.

As part of a combined effort with the Remedial Action Program, work has begun to develop information necessary for a radiological assessment (pathways analysis) for SWSA 6. Work is under way to determine what is currently known about SWSA 6 (existing geologic, hydrologic, soil, and waste inventory).

Proposed disposal techniques for non-TRU materials and alternatives to these practices will change in various ways: (1) use of modified/different storage techniques (aboveground storage, concrete boxes, etc.); (2) immobilization of waste by fixing it in concrete or glass; and (3) compaction of waste (using a supercompactor and drum compactor) that was previously considered noncompactible. A hazardous waste disposal facility is also being constructed to manage both hazardous and mixed wastes in compliance with DOE Order 5480.2.

Before 1970, 6200 m^3 of TRU-contaminated wastes was disposed of at ORNL by SLB. These wastes may contain as much as 100 nCi/g in TRU content; their retrieval is not included in the plans developed at this time. To date, monitoring of all streams in or near the ORNL burial grounds has shown that essentially no TRU radionuclides are being released to the environment. Monitoring will continue, and the safety of continued storage will be reviewed periodically.

RCRA was promulgated in 1976, and EPA was designed as the government agency empowered to implement the act. A 1984 court decision granted EPA authority to regulate all hazardous waste and granted DOE authority to regulate all radioactive waste generated at DOE facilities. ORNL applied for and received an "interim status" classification from EPA per 40 CFR 122.23. The EPA/RCRA identification code for ORNL is TN1890090003. Hazardous/mixed waste is being handled at ORNL on an interim basis until permanent disposal facilities are available.

A hazardous waste is a waste which, because of its quantity, concentration, or characteristics (physical, chemical, infectious, etc.), can present a substantial hazard (actual or potential) to personnel or to the environment if improperly managed, stored, transported, treated, or disposed. Hazardous waste includes a broad array of significantly different material that can be generated by nearly every manufacturing process or end-usage activity. A waste is classified as hazardous by EPA if it is corrosive, reactive, toxic, or ignitable as defined in 40 CFR 261, Part C. A waste can also be classified as hazardous if any of its constitutents is included in the over 400 hazardous materials listed by the EPA in one of the tables in 40 CFR 261, Part D. (A hazardous material becomes a hazardous waste when it is discarded or is intended to be discarded.) Any waste that is classified as hazardous by EPA is subject to the so-called "cradle to grave" manifest system (i.e., detailed records must be kept to track the waste from its origin to its ultimate disposal).

The many independent research projects at ORNL are supported by an equally large number of small scientific laboratories that store and use hazardous materials. Most of these laboratories are potential generators of such hazardous waste as spent experimental samples, by-products, and hazardous materials (usually chemicals) that have exceeded their shelf life or usefulness. Studies conducted by the Biology Division and involving laboratory animals result in animal waste and carcasses that constitute hazardous waste. When ORNL was constructed, asbestos was used extensively as an insulation material; since then it has been shown to be a hazardous material. Now, as old buildings are torn down and/or remodeled, the asbestos must be removed and properly disposed of. Waste oils from sources such as motor vehicles, machines, vacuum pumps, etc., are generated by every division at ORNL. Hazardous waste is also generated by the groups that support the research projects, such as photographic labs and reproduction facilities.

Mixed waste is a waste that can be classified as being both hazardous and radioactive. The most common examples of this type of waste are cleaning fluids and oils removed from systems that have operated in contaminated environments and scintillation fluids containing radioactive tracer elements that are used for chemical and biological analyses. Much of the research at ORNL is performed with radioactive materials; therefore, the generation of mixed waste is inevitable. The radiation in radioactive oils and scintillation fluids is typically very low level, but because the waste is mixed and no specific regulations apply, it is being stored on-site for an indefinite time. Scintillation fluids and vials are packed and stored in sealed 208-L drums, and contaminated oils are stored in designated storage tanks. A TSCA incinerator is being constructed at ORGDP and may offer a future solution to the storage problem. The possibility of disposing of scintillation fluids and vials at an off-site disposal facility is also being investigated.

Hazardous waste at ORNL is routinely collected, identified, and packed in appropriate containers to be shipped to EPA-approved disposal sites or to be stored on-site to await further dispostion. Presently, all hazardous waste is stored and packaged at Building 7507, and mixed waste is stored on a concrete pad located outside and near Building 7507. The various categories of waste are generated in experimental laboratories or by specific operations at ORNL.

According to the Annual Hazardous Waste Report, the total mass of hazardous waste generated at ORNL facilities in 1986 was over 293,000 kg. The total amount accumulated in 1985 was slightly less. (Wastewater is handled as a separate entity and was not included in these totals.) Spent photographic solutions constitute the largest volume of hazardous waste accumulated annually at ORNL; this volume includes photographic waste generated by the Oak Ridge Y-12 Plant, which is collected and accumulated. The major types of mixed hazarous waste generated at ORNL were flammable liquids, including radioactive oils and scintillation fluids.

Currently, two conventional waste disposal sites receive waste from ORNL facilities. The ORNL Contractor's Landfill, located at the west end of ORNL, was developed to receive conventional solid wastes from on-site construction and upgrade projects. In addition, it receives significant quantities of conventional process by-products from ORNL operations. This facility is quickly reaching its permitted capacity. When this occurs, all ORNL conventional waste will be directed to the Oak Ridge Y-12 Plant Sanitary Landfill, which currently receives all ORNL general refuse. Located on Chestnut Ridge, south of the Oak Ridge Y-12 Plant site and about six miles east of the ORNL site, the Oak Ridge Y-12 Plant Sanitary Landfill is the primary conventional waste landfill operation for the Oak Ridge Reservation.

About 7.5×10^5 L/d of ORNL sanitary sewage is treated by an aerobic digestion process. The ORNL Sewage Treatment Plant, operated under ORNL's NPDES permit, outfall number X01, produces a sludge from this process that is dewatered on sludge drying beds. The nutrients in the resulting solid that would preclude further volume reduction in a biological system are eliminated. Inleakage of very low levels of radioactive contaminants to the sanitary sewer system results in concentration of these contaminants in the sludge. About twice a year the solids are packaged in 208-L drums for disposal as solid LLW. The total estimated volume of this stream is about 2.7 m^3.

Acidic rainwater runoff from the ORNL Coal Storage Yard is collected in a clay-lined basin. Neutralization of the acid with lime in the Coal Yard Runoff Treatment System (Building 2544) causes precipitation of contaminants that have been leached from the coal pile. The precipitated solids are removed by clarification and are further processed by vacuum filtration with diatomaceous earth. The resulting filter cake, a nonhazardous material generated at an average rate of 2.3 m^3/week, is disposed of at the ORNL Contractor's Landfill. The Coal Yard Runoff Treatment System operates under ORNL's NPDES permit, outfall number X02.

About 2.5×10^7 kg per year of coal containing about 8% ash is burned for steam generation at the ORNL Steam Plant. Bottom ash from the fire side of the boilers is pneumatically conveyed to the storage silo, as is fly ash from the electrostatic precipitators that capture the airborne fraction. The ash is loaded from the silo into dump trucks and is transported to the ORNL Contractor's Landfill at an average rate of about 8.7 m^3/d, 7 d/week. Steam Plant ash is specifically cited in the state permit for the ORNL Contractor's Landfill.

General refuse is collected at each ORNL building from trash cans and placed in dumpsters at each site. These dumpsters are transported to an on-site trash compactor, and the refuse is compacted and reloaded onto trucks for transport to the Oak Ridge Y-12 Plant Sanitary Landfill for disposal. The volume of general refuse is estimated to be 28 m^3 per normal work day.

Bulky material, such as large cardboard boxes that cannot conveniently fit into dumpsters, is temporarily stored at the building loading docks until the boxes are carried, uncompacted, to the Oak Ridge Y-12 Plant Sanitary Landfill. The generation rate of this material is estimated to be 18 m^3 per normal work day.

3.5 ORGDP SOLID WASTE MANAGEMENT PROGRAM

In addition to air and water pollution control programs, ORGDP has developed an extensive waste management program to monitor all waste as defined by the RCRA and Tennessee Solid Waste Management Act (TSWMA) in accordance with the applicable state, federal, and DOE requirements. The waste management system at ORGDP provides management for five categories of materials generated for disposal at ORGDP. The first is radioactive materials managed according to DOE Order 5820.1 and the Atomic Energy Act of 1954: nonhazardous, low-level, radioactively contaminated wastes.

The second category is classified waste generated at ORGDP. DOE Order 5632.1 mandates the physical protection of classified material.

The third category is hazardous waste as defined by RCRA. DOE Orders 5480.1A and 5480.2 and state and federal regulations control the way hazardous wastes are managed. The wastes may or may not be radioactively contaminated.

The fourth category includes PCBs that are managed according to TSCA. Contaminated electrical equipment and waste oils, solvents, and solids are the major components of PCB waste generated at ORGDP.

The fifth category includes sanitary waste that is regulated by TSWMA. The types of waste in this category include sanitary water, fly ash, and construction debris.

The primary goal of the solid waste strategy is minimizing generation of solid wastes while achieving compliance with applicable environmental regulations. Solid wastes are most often categorized as (1) industrial/sanitary, (2) security classified, (3) low-level radioactive, (4) RCRA hazardous, and (5) mixed.

Ideally, the majority of solid wastes generated would be conventional wastes. When this goal is unattainable, prudent management will minimize the amount of other wastes (classified, hazardous, radioactive) generated. Five major waste minimization options are available at ORGDP: (1) segregation, (2) material substitution, (3) process innovation, (4) mechanical volume reduction, and (5) recycle/reuse.

To obtain compliance with RCRA, ORGDP has submitted permit applications for all TSD facilities to environmental regulators. Each permit application has two parts. Part A permit applications, submitted in August 1985 for ORGDP, include information such as process throughput, storage capacities, waste characterization by RCRA hazard code, process description, and photographs. Federal revision of RCRA ruled that all Part B permit applications were to be submitted by November 9, 1985. Facilities with interim status could file for closure and cease operations instead of filing for a Part B permit application. Nineteen Part B permit applications were prepared through 1985 for 17 facilities, and one facility closed in 1986.

Information required for the Part B permit application includes a general facility description, a waste characterization and analysis plan, information on processes generating the waste, procedures to prevent hazards, contingency plans, and closure/post-closure plans. After negotiation and acceptance of Part B permit applications, facilities at ORGDP will be fully permitted under RCRA and subject to stringent guidelines specified in 40 CFR Pt. 264. ORGDP will then be inspected annually by the EPA, TDHE, DOE, and/or internal auditors to ensure RCRA compliance.

Enrichment, maintenance, decontamination, development, and testing activities at ORGDP release minimal quantities of low-level radioactive materials to the environment. Because the primary function of the site was the enrichment of uranium in the ^{235}U isotope, uranium is the predominant radionuclide found in waste streams. Small quantities of ^{99}Tc, ^{237}Np, and ^{239}Pu have also been released in the waste streams because these radionuclides were present in UF_6 reactor return feed material that was shipped to ORGDP for enrichment.

ORGDP generates solid radioactive waste by (1) discarding radioactively contaminated scrap paper, wood, trapping media, etc., (2) discarding radioactive process equipment, and (3) removing radionuclides from liquid and airborne discharges. Currently, all scrap metal contaminated with radionuclides is stored above ground in anticipation of future smelting or sale. Sludges generated by settling and scrubbing operations are stored in holding ponds K-1407-B and K-1407-C.

The primary generator of radioactive liquid wastes is the uranium decontamination and recovery facility (K-1420-A). One stream consists of decontamination solutions (mostly water) containing uranium and small quantities of ^{99}Tc. This stream is being discharged into the K-1407-B holding pond for settling. However, new RCRA regulations have forced the closure of unlined surface impoundments such as K-1407-B and K-1407-C ponds, thus eliminating a place to settle the solids. The new Central Neutralization Facility, K-1407-H, which was to go on line in April 1987, will provide the capability to remove these solids before discharge through the K-1700 discharge location.

Plans call for the sludges in K-1407-B and K-1407-C ponds to be chemically fixed in concrete and stored above ground until the material can be delisted as a hazardous waste under RCRA guidelines. Low-level wastes such as cleaning rags, scrap paper, and other burnables are collected and stored in K-310-2 for disposal in the TSCA incinerator. Other solid wastes such as contaminated building rubble, asbestos, and contaminated soils are disposed of at the Oak Ridge Y-12 Plant low-level burial facility.

Radioactive waste streams generated at ORGDP are managed in strict accordance with the applicable state and federal regulations and DOE orders. Several waste management facilities are already in place. Changing laws and regulations have made it necessary to upgrade several facilities and design and construct new facilities that reflect the most recent environmental technology.

The K-700 Scrap Metal Storage Facility consists of a 2.8-ha (7-acre) tract of land used for storing low-level radioactively contaminated scrap metal. Ferrous and nonferrous materials of every description are generated at the ORGDP site and are transported by truck to the storage yard.

The K-1421 waste incinerator consists of a 440-kg/h incinerator used for disposing of low-level, radioactively contaminated type "O" waste. The waste includes such combustibles as clothing, gloves, and paper, contaminated during normal operation or during spill cleanup activities. This facility was shut down in mid-1986 because it could not meet Tennessee Air Regulations particulate emissions limits.

The K-306-1 container storage area consists of a 288-m^3 area used for the storage of PCB materials that are radioactively contaminated. The wastes will be stored at the facility until they are disposed of by burning in the K-1435 TSCA Incinerator. The storage area may be used in the future to store Oak Ridge Y-12 Plant wastewater sludges.

The K-1407-H Central Neutralization Facility will provide pH adjustment and chemical precipitation for several aqueous streams throughout the ORGDP site. The treatment system will consist of two 94,750-L reaction tanks and a 227,400-L sludge thickener tank. Acidic wastes will be neutralized with a hydrated lime slurry, and basic wastes will be neutralized with sulfuric acid. Treated effluents will be discharged through the K-1700 NPDES point before they enter Poplar Creek. Contaminated sludges that precipitate out in the sludge thickener tank will be sent to the K-1419 Sludge Fixation Facility for treatment or be stored in an approved aboveground storage area.

The K-1425 facility consists of a container storage building with approximately 180 m^3 of storage area, a container staging and pour-up area, and four 85,275-L storage tanks. Containerized liquid wastes are transferred to the large storage tanks via a drum unloader system. Typical materials stored at the facility include oils, solvents, water, and organics that are hazardous contaminated with PCBs and/or uranium. These materials are generated in the various operational areas, buildings, and support service areas throughout ORGDP. Wastes stored in the facility will ultimately be disposed of in the K-1435 TSCA Incinerator. Materials brought to the facility have previously been identified and are labeled and inventoried as to when they were brought to the facility.

The K-1420A flammable waste storage tank provides storage of flammable and ignitable liquid waste generated at ORGDP. The facility consists of a 113,700-L tank that has been modified to store low-flashpoint (less than 60°C) and high-vapor-pressure materials. The types of wastes stored in the tank include flammable solvents, gasoline, and paint wastes. Only drums of waste that have been identified will be brought to the facility, where they will be transferred into the storage tank. The materials will be stored at this facility until the wastes can be disposed of at the K-1435 TSCA incinerator.

The K-311-1 container storage area provides storage for radiogenic lead wastes generated during past Oak Ridge Y-12 Plant operations. The wastes are stored in 208-L steel drums and fiber drums. The facility is in an enclosed building and has an area of approximately 225 m^2. Wastes stored at the facility include lead ingots, lead slag, and lead carbonate contaminated with low-level radioactive contaminants. Approximately 51 tons of material is stored at the facility.

The K-1232 facility provides chemical precipitation and pH adjustment for wastewaters primarily generated at Oak Ridge Y-12 Plant. The water is treated in the 12 tanks located in the K-1232 facility. After the various feed chemicals are added and mixed, the waste is discharged to two lagoons, where the precipitates are allowed to settle out. The settled sludges are collected, dewatered, drummed, and transported to K-306-1/Vault 23-A for storage. The liquid effluent is discharged from the facility to an NPDES discharge location at the K-1203 sewage treatment facility.

Waste streams treated at the K-1232 facility include nitric acid and other acid wastes, caustic waste, and mop and rinse water contaminated with organic constituents. The nitrate wastes are taken to K-1232 for neutralization only and returned to the Oak Ridge Y-12 Plant for storage. All other wastes are treated and discharged from the facility through the K-1203 sewage treatment plant NPDES discharge location.

Effluent control procedures at K-1232 begin before the waste is transported to ORGDP. Samples of the wastes are collected at the Oak Ridge Y-12 Plant and analyzed to determine the chemical composition of the material. When chemical characterization is complete, a recipe can be developed for treating the material. Once the material has been treated at the facility, samples are collected to verify that the treatment is complete, and then the material is discharged to the settling ponds for sedimentation. Samples are also collected at the discharge from the settling basins to determine compliance with the discharge guidelines specified in the NPDES permit.

The K-1413 treatment tank consists of a 79,590-L underground tank used primarily as a backup facility for the K-1232 treatment facility. The tank is seldom used for treating Oak Ridge

Y-12 Plant wastewater. The unit provides chemical precipitation and pH adjustment for heavy-metal-laden corrosive solutions.

The K-306-1/Vault 23-A Hazardous Waste Storage Facility will be used primarily for storing sludges generated during the treatment of Oak Ridge Y-12 Plant wastewater at the K-1232 facility.

The storage facility is 88.4 m long by 13.7 m wide and has a maximum storage capacity of approximately 3000 208-L drums. The containers being stored at this facility are sealed, labeled, identified, and inventoried prior to or immediately following transport to the facility. Similar materials generated at Oak Ridge Y-12 Plant are also stored in this facility.

The K-1407-A neutralization facility consists of a 125,070-L reaction pit where sulfuric acid and calcium hydroxide are used to neutralizate corrosive waste water. The K-1407-B holding pond consists of a 0.52-ha (1.3-acre) impoundment with a storage volume of approximately one million gallons. It is used for the settling of metal hydroxide precipitates generated during neutralization and precipitation in the K-1407-A neutralization facility.

Radioactively contaminated wastewater treated at this location is generated at the K-1420 uranium decontamination facility. Equipment used in the gaseous diffusion and development facilities gradually accumulates uranium bearing compounds. When this equipment is removed or disposed of, it may require decontamination to meet radiation standards. The decontamination process is performed in the K-1420 facility. The primary cleaning method includes mechanical removal in combination with cleaning solutions consisting of water, steam, weak nitric acid, and sodium carbonate. The waste reductions contain uranium and other metallic ions. All corrosive solutions from K-1420 requiring treatment are piped to the K-1407-A neutralization pit for treatment.

The K-1407-B holding pond currently contains approximately 7500 m^3 of sludge that will be removed as part of the closure for the facility. The K-1407-B holding pond is considered a surplus facility, and plans are being made to close it out by the end of 1988. The pond is being closed because it does not meet regulatory requirements for surface impoundments as specified under the 1984 reauthorized RCRA requirements. Plans are to remove the sludge from the pond and fix it in concrete for aboveground storage.

Effluents from the K-1407-A and K-1407-B facilities are controlled by instrumentation, and K-1407-B is monitored analytically for uranium discharge concentration. The K-1407-A facility instrumentation includes level indicators and pH monitors. High-level alarms are set for the reaction pit and are transmitted to the Central Control Facility and the K-1420 Control Room. The pH meters are used for operating purposes to determine when the wastewater can be discharged. The K-1407-B effluent is also controlled by instrumentation and by analysis for the discharge of uranium. The weir at K-1407-B can be opened and closed and is controlled by pH. The weir will automatically close when pH falls below 6.0 or rises above 9.0. Twenty-four-hour composite samples are collected from the effluent weekly for uranium and radionuclide analysis.

The new K-1419 sludge fixation facility is used for mixing hazardous and mixed-hazardous inorganic waste with concrete to form a nonhazardous mixture that can be stored above ground until a final disposal method can be identified. The facility consists of a storage tank area for hazardous-mixed wastes and a series of storage tanks for nonhazardous feed materials, feed tanks, and mixers. The hazardous mixed sludges and liquids are mixed with the nonhazardous feed materials such as fly ash, cement, sand, and clay. The concrete-waste mixture is then discharged from the mixers into a concrete truck to be transported to the K-1417 casting yard, where it is stored in 337- and 364-L epoxy-coated steel drums.

The hazardous-mixed waste to be processed at K-1419 will be stored in eight aboveground tanks used to receive, store, and feed the waste materials for the mixers. The wastes are mixed with a fixation recipe to stabilize them in the form of concrete blocks. The fixation recipes are specific for each type of sludge and will contain cement with various mixtures of fly ash, sand, or clay.

The K-1417 facility will be used to cast and store mixed hazardous waste contaminated concrete blocks generated at the K-1419 sludge fixation facility. The area is used for the pouring, setting, and storage of stabilized waste in 337- and 364-L epoxy-coated steel drums. In addition, the facility has a truck and equipment washing system that also collects runoff and spillage from the casting building. All wastes coming into the area will be from the K-1419 facility.

The K-1407-C retention basin is an unlined surface impoundment with a storage volume of approximately 9.48 million liters. This impoundment has been used primarily for storing potassium hydroxide sludge generated from the K-402-9 purge cascade scrubber facility. The surface impoundment also contains metal hydroxide sludges that were removed from the K-1407-B settling pond in 1973. The scrubber sludge and the K-1407-B sludge are radioctively contaminated.

As in the case of the K-1407-B pond, the K-1407-C basin is considered surplus, and plans are being made to close out the facility by the end of 1988. The pond is being closed because it does not meet regulatory requirements for a surface impoundment. Closure plans include removing the sludge from the pond and fixing it in concrete for aboveground storage.

The K-726 PCB storage facility is located at the K-770 scrap metal yard and consists of a diked concrete block building with approximately 225 m^2 of storage space. It is used primarily for the storage of low-level, uranium-contaminated PCB waste that also contains combustible liquids, including kerosene that has been used for cleaning and/or flushing. PCB materials will be stored at this location until they are disposed of at the K-1435 incinerator.

In addition to treatment, storage, and disposal facilities two RCRA facilities store only pure RCRA hazardous materials. These facilities are the K-1025-C storage facility and the K-1035-A satellite drum storage facility. The K-1025-C facility is used for storing miscellaneous waste chemicals until they are transported to an off-site commercial disposal facility. The K-1035-A facility provides storage for hazardous wastes that are generated during the operation of a circuit board manufacturing process. These wastes are stored at the location or the K-1025-C facility until transported to an off-site commercial disposal facility.

There are three sources of sludges that are presently being generated or are planned to be stored at the ORGDP. The wastewater sludges generated from the treatment of Oak Ridge Y-12 Plant wastewater at K-1232 are stored at K-306-1/vault 23-A. This sludge is a listed material that requires storage by RCRA requirements. As more facilities come on line at the Oak Ridge Y-12 Plant for waste treatment, the amount of material from K-1232 will be decreasing. However, the same type and quantity of sludge will be generated at Oak Ridge Y-12 Plant and will be transported to ORGDP for storage. Plans are to have the sludge delisted as a RCRA material and disposed of as a low-level nonhazardous material.

Sludges presently being stored in the K-1407-B and K-1407-C holding ponds are scheduled to be removed and fixed in concrete. Initially, it was planned that the material could be fixed in concrete to render it nonhazardous and then be buried in a landfill. However, uranium compounds present in the material may eliminate the possibility of shallow land burial. If the materials are not buried, a larger facility will be needed to store the concrete blocks. Studies are presently under way to determine the options available for storing and/or burying this material.

Acid and caustic wastes are generated at the ORGDP from plating and metal cleaning facilities and from coal pile runoff during rainy conditions. The K-1501 steam plant also generates acidic and caustic solutions as a result of the water softening equipment used for boiler water treatment. All of the streams mentioned are drained by gravity to the K-1407-A neutralization facility.

PCBs, uranium-contaminated and noncontaminated, are regulated by the TSCA. The materials that contain or are contaminated with PCBs include electrical equipment, waste oils, solvents, hydraulic systems, and heat transfer systems. The disposal of PCB material containing radioactivity presents problems because no *de minimus* levels exist for off-site disposal of uranium. The TSCA incinerator was designed and justified because radioactively contaminated liquid wastes could not be shipped off site for disposal. The incinerator is expected to begin operation in FY 1988.

ORGDP has 80 PCB Askarel transformers in standby for use should the gaseous diffusion process restart. These transformers pose no threat to the environment. They can remain in standby after the October 1, 1985, deadline because they are located in an industrial building. In addition to the transformers, 11,266 capacitors are located in the diffusion cascade process buildings. These capacitors pose no threat to the environment and are in standby for possible restart. Emergency procedures to handle accidental spills are in place, and frequent operator drills ensure that the procedures are reviewed with operating personnel.

Large quantities of liquid and solid PCB wastes are in storage at the ORGDP in 208-L drums stored in curbed buildings K-726 or K-306-1 until their final disposition.

4. AIRBORNE DISCHARGES AND AIR AND METEOROLOGICAL MEASUREMENTS

4.1 AIRBORNE DISCHARGES

Each installation has air pollution control systems in place to reduce discharges to within emission standards mandated by the Clean Air Act (CAA). In addition to ensuring emissions control, each installation maintains accurate, up-to-date air pollution permits for sources that emit air contaminants. Descriptions of operations releasing air pollutants, number of emission points, and the pollutants discharged for Oak Ridge Y-12 Plant, ORNL, and ORGDP are given in Tables 4.1.1 through 4.1.3.

The Oak Ridge Y-12 Plant steam plant has been cited repeatedly by the Tennessee Department of Health and Environment (TDHE) for failure to meet opacity requirements for its emissions. A plan was developed to eliminate all opacity exceedances except those during startup and shutdown of the boilers. A long-range plan calls for the shift from oil to natural gas for startup and shutdown to eliminate exceedances during those periods, also. Those plans notwithstanding, TDHE imposed new requirements on the steam plant in early 1986, and source emission stack testing was conducted throughout the week of April 20. These tests were designed to see if opacity exceedances are accompanied by particulate emission exceedances. In August, installation personnel appeared at a show-cause hearing in Nashville on the opacity problem and to outline plans for improving the steam plant. As a result of their testimony, the Enforcement Program did not recommend a fine or an order. The 1986 Oak Ridge Y-12 Plant steam plant opacity performance is given in Table 4.1.4.

On December 18, 1985, a quality assurance task team was appointed to review opacity noncompliance problems at the ORGDP K-1501 steam plant and make recommendations that would bring the plant into 100% compliance with Tennessee air emission standards. The team was made up of representatives from the utilities, environmental management, engineering, process support, and maintenance organizations. When two electrostatic precipitators were installed in 1978, the plant was in compliance until numerous problems were experienced. Although each of the problems was corrected individually and overcome to some extent, the result was a less-than-consistent compliance record. As a result of the shutdown of the gaseous diffusion process, a 25% reduction in the ORGDP steam demand occurred in early FY 1986. Base-loading natural gas to improve compliance during coal firing resulted in a 70% reduction in noncompliances in FY 1986. The team reviewed six alternatives and recommended the installation of two 18,000-kg/h wood-fired boilers as the most economical compliance option. The 1986 ORGDP steam plant opacity performance is given in Table 4.1.5.

Most gaseous wastes are released to the atmosphere through stacks. Radioactivity may be present in gaseous waste streams as solids (particulates), absorbable gas (iodine), or nonabsorbable species (noble gas). Most gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. Stacks are routinely monitored for radionuclides of concern at each of the three Oak Ridge installations. In addition to stack discharges, there are potential airborne releases from burial grounds (e.g., ^{3}H and ^{14}C) and from uranium chip fires at the Oak Ridge Y-12 Plant. Table 4.1.6 summarizes the combined 1986 point discharges of radionuclides from the three Oak

Table 4.1.1. Air emission sources—Oak Ridge Y-12 Plant

Description of function	No. of emission points	Pollutant[a]
Acid wash station	1	NO_x
Area exhaust	3	Part-Be source
	6	Part
	3	VOC
	3	NO_x
	1	SO_2
Abrasive saw exhaust	1	Part-du
Annealing	2	Part
	2	NE
Acid vats	1	Acid fumes
Anodizing	1	NE
Acid and plating tank	1	Acid fumes
Acid line vent	1	NO_x
Arc melt furnace	1	Part
Boiler	1	Part
	1	SO_2
	1	NO_x
	1	VOC
Briquetting process	1	Part
	1	VOC
Blending box	1	Part
Carbon machine shop	2	Part
	2	VOC
Carbon furnace	2	VOC
Caustic scrubber	4	Cl
	3	HCl
	1	Part
	3	LiCl
	2	NO_x
Cleaning	3	Part
	3	VOC
	2	NE
	1	NO_x
Calciner vent	2	Part
Chemical recovery	3	Part
	3	NO_x
Centrifuge and tank	1	Part
Casting	1	NE
	1	Part
Conversion	1	Part
	1	HF
Chip burner	1	Part
Chilled water system	1	VOC
Degreaser	1	NE
	1	Non-VOC
	1	NO_x
	11	VOC
	1	HCl
Diesel generator	1	Part
Dryer	1	VOC
Dry box	1	NE
Dissolver-UO_3	1	NO_x
Dissolver	1	NO_x
Deburr benches	1	Part
	1	Misc. metal
Drycleaning machine	1	VOC
Electric shop	1	Misc.
Electropolisher	1	KOH
	1	VOC
	2	NE
	1	Phosphoric acid
Extraction column vent	1	NO_x
	1	VOC
Film dryer	2	Part
Foundry	1	Part
Grinders/milling machines	7	Part
	2	Metal fines
Glove boxes	5	Part-Be source
	19	Part
	1	NE
Grit blaster	2	Part
Hoods	1	SO_2
	6	NO_x
	1	HCl
	32	VOC
	20	Part
	3	Acid fumes
	1	H_2SO_4
	1	Other
	1	Fluorides
	1	Part-Be source
HNO_3 dip tank	1	NO_x
Hot press	2	Part-Be source
HF vaporizer	1	HF
HF emergency vent	1	F
Insulator shop	1	Part
Inspection house	1	Part-Be source
KOH stripping	1	Phosphoric acid
	1	KOH
Incinerators	5	Part
	1	NO_x
	1	F
	1	HCl
	1	HCN
Kel-F diptank	1	VOC
Kiln and calciner	1	Part
Lathe and furnace	1	Part
Laundry dryers	1	Part
	1	VOC
Lime storage silo	2	Part
LiOH neutralizing	1	HCl
LiOH tank	2	NE
Machine shop	15	Part
	1	Part-Be source
	4	Misc. metal
	1	^{113}Freon
	8	VOC
Maintenance shop	1	VOC
	4	Part
Material handling	2	Part-Be source
	1	Part
	1	Acetic acid
	1	Ethanol
Metal cleaning	1	VOC

Table 4.1.1. (continued)

Description of function	No. of emission points	Pollutant[a]	Description of function	No. of emission points	Pollutant[a]
Metal storage	1	Part	Reactor unloading station	2	Part
Metal working	8	Part	Reduction	1	VOC
	3	VOC		1	NO_x
Muffle furnace	2	Part		2	Part
Mixing and rolling	1	Part		1	Acetic acid
	1	VOC		7	CO
Nickel plating	1	Part	Reactors	1	NO_x
Nitric acid tank	3	NO_x		1	Acid fumes
Nitric acid recovery	1	NO_x		2	Part
	1	VOC	Rolling mill	4	Part
NO_4 emergency vent	1	NO_x		2	VOC
NiCr plating tanks	1	NE	Sandblaster	6	Part
Neutralization vessel	1	Part	Storage tanks	1	SO_2
	1	NO_x		14	NO_x
	1	Acid fumes		9	LiOH
	3	HCl		4	NaOH
Neut. reactor	1	Acid fumes		2	NaOCl
Non-emitting	1	NE		1	HCl
Ovens	12	NE		2	Mineral oil
	13	VOC		1	Plating solution
	11	Part		5	NE
Nickel, copper strike tank	1	HCl		7	Acid fumes
Open coal storage pile	1	Part		1	H_2SO_4
Ozonation tank	1	NO_x		18	VOC
Ozone generator	1	Ozone	Salt baths	1	VOC
Plasma torch	2	Part		2	Part
Painting	10	VOC	Saw and grinder	2	Part
Pickling tank	1	Part	Saw, lathe, drill	1	Part
	3	NO_x		1	VOC
	2	VOC	Slag crusher and hopper	1	Part
	2	NE	Seal peal	1	VOC
	1	Acid fumes	Steam plant	3	Part
Plating process	4	Fumes		4	SO_2
	5	NE		2	NO_x
	2	SO_2	Sulfuric acid tank	1	Part
	1	NO_x	Swaging	1	Part
	1	HCl	Surface coating	1	NE
	1	HCN	Tank vent	2	Acid fumes
	1	KCN		3	HCl
Plastic molding	1	VOC		1	Non-VOC
Process vats	1	HCl	U-chip oxidizer	1	Part
	1	NE	Underground gas tank	1	VOC
	1	Acid fumes	Vapor blaster	1	Part
Pulverizer	1	Part	Vacuum system	18	Part
Perchlorethylene storage tank	1	VOC		1	VOC
Process vent	1	Part		9	NE
	1	NO_x	Vulcanizer	1	VOC
Pan filters	2	Part	Vice stand hood	1	Part-du
	1	Acid fumes	Welding	14	Part
Paper shredder	1	Part		2	VOC
Print copier	2	Amonia		2	NE
Pump shop	1	VOC	Woodworking	24	Part
Press	4	Part	Wash station	1	VOC
	3	VOC	Waste shredder/compactor	1	Part
Quencher	1	NE	Waste oil solvent tanks	5	VOC
	1	Part	X-ray	1	Part
			Total	619	

[a] NO_x = nitrogen oxides; Part = particulates; Part-Be source = particulate-beryllium source; Part-Du = particulate-depleted uranium source; VOC = volatile organic compound; NE = no emission.

Table 4.1.2. Air emission sources—ORNL

Description of function	No. of emission points	Pollutant[a]
Baghouse	1	Part
Boiler	7	CO
Boiler	7	NO_x
Boiler	7	Part
Boiler	7	SO_x
Boiler	7	VOC
CEUSP	1	NO_x
Cyclone	1	Asbestos part
Degreaser	1	Freon TF
Degreaser	2	Trichloroethylene
Degreaser	2	Varsol
Degreaser	4	Perchloroethylene
Degreaser	8	VOC
Hoods	1	Fluorides
Hoods	1	NO_x
Hoods	1	Ozone
Hoods	1	SO_x
Hoods	1750	Misc.
Lead shop	4	Lead part
Nuclear fuel reprocessing	1	NO_x
Nuclear fuel reprocessing	1	Uranium oxides
Smoke bomb test	1	Part
Spray booth	7	VOC
Storage tanks	5	VOC
Total	1828	

[a]VOC = volatile organic compounds; Part = particulates; NO_x = nitrogen oxides;

Ridge installations to the atmosphere. The total discharge was 92,600 Ci. Table 4.1.7 summarizes the 1986 chemical emissions to the atmosphere from the three Oak Ridge installations.

4.2 AIR MONITORING

Five systems for monitoring air at Oak Ridge DOE installations are: (1) stations around the perimeter of Oak Ridge Y-12 Plant; (2) stations around the perimeter of the ORGDP; (3) stations on and around the ORR; (4) stations around the perimeter of ORNL; and (5) stations outside the ORR at distances of from 19 to 121 km, designated as remote air monitors.

Air stations are numbered as follows: ORNL stations are designated A1–A30; ORR stations are A31–A50; remote stations are A51–A60; Oak Ridge Y-12 Plant stations are A61–A80; and ORGDP stations are A81–A100. There are more numbers assigned than there are stations, which allows additional stations to be added without altering the numbering system.

Air monitoring stations are categorized into five groups according to geographical locations:

(1) Oak Ridge Y-12 Plant perimeter air monitoring stations A61–A72 are located at or near the Oak Ridge Y-12 Plant boundaries.

(2) ORNL perimeter air monitoring stations A3, A7, A9, A21, and A22 are located at or near the ORNL boundary. Stations A21 and A22 are used only for external gamma radiation measurements; there is no sampling equipment. These stations are being upgraded to provide sampling capability.

(3) ORGDP perimeter air monitoring stations A81–A98 are located at or near the ORGDP boundaries.

(4) The DOE ORR network consists of stations A8, A23, A31, A33, A34, A36, and A40–46. During the latter part of 1985 and early 1986, ten ORR stations were upgraded. Each air station has the capability to perform both sampling and continuous monitoring. Station A46 is a new real-time monitoring location installed during the third quarter of 1986 in the Scarboro community in Oak Ridge, and its sampling capability was activated in October 1986.

(5) The remote air monitoring system consists of six stations (A51–A53 and A55–A57) that are outside the ORR at distances of from 19 to 121 km. This system provides background data to aid in evaluating local conditions in East Tennessee and fallout data.

Locations of the Oak Ridge Y-12 Plant, ORNL, ORGDP, ORR, and remote air

Table 4.1.3. Air emission sources—ORGDP

Description of function	No. of emission points	Pollutant[a]	Description of function	No. of emission points	Pollutant[a]
Bake-off oven	1	Organics	Ni Plating	1	HCl vapor
Bake-off oven	1	Part	Ni Plating	1	NO_x
Cleaners	17	Part	Oil storage tanks	7	Mineral oil
Cleaning and drying	1	Part	Oil storage tanks	32	Code BG oil
Coal sizing and conveying system	1	NE	Ovens	3	Part
			Ovens	1	NE
Coal/gas/oil steam plant	1	CO	Ovens	1	Other
Coal/gas/oil steam plant	1	Fluorides	Paint drying oven	1	VOC
Coal/gas/oil steam plant	1	Nitrogen oxides	Parts cleaning	1	NO_x
Coal/gas/oil steam plant	1	Organics	Parts cleaning	1	Trioxide
Coal/gas/oil steam plant	1	SO_2	Pellet conversion oven	1	Technetium
Coal/gas/oil steam plant	1	Sus. part	Pellet conversion oven	1	Uranium
Concrete fixation	1	Part	Pellet conversion oven	2	Fluorides
Curing oven	1	Organics	Plastic shop	1	Organics
Degreaser	1	NE	Plastic shop oven	1	NE
Degreaser	1	Perchloroethylene	Plating system	1	HCl vapor
Degreaser	3	Organics	Product withdraw vent	1	Fluorides
Disassembly stand	1	Fluorides	Relief compressor	1	Fluorides
Disassembly stand	1	Part	Sand blaster	2	Part
Disassembly stand	1	Uranium oxide	Scrubber	1	Fluorides
Drying tracks	5	Hydrocarbons	Spray booth	1	Part
Emission stack	1	Fluorides	Spray booth	3	VOC
Emission stack	1	Part	Steam plant	1	SO_2
Emission stack	1	Uranium	Steam plant	2	Part
Exhaust hood	1	VOC	Storage tank	1	Acetone
Fabrication	1	Part	Storage tank	1	Ethyl alcohol
Filter test facility	2	Part	Storage tank	1	Gasoline
Fire Dept. training facility	1	Part	Storage tank	1	Hexane
Fluorine vents	4	Fluorides	Storage tank	1	Isopropyl alcohol
Fuel oil storage	2	Organics	Storage tank	1	Methylene chloride
Furnace	1	VOC	Storage tank	1	Paints
Furnaces	13	Hydrocarbons	Storage tank	1	Water
Gas storage tank	2	NE	Storage tank	1	Xylene
Grit blaster	1	Part	Storage tank	4	Freon
Heat exchange	1	^{114}Freon	Storage tank	4	Other
Heat exchange	1	FHC	Storage tank	4	Perchloroethane oil
Hood	3	Hydrocarbons	Storage tank	4	Trichlorethane
Incinerator	1	CO	Storage tank	4	Varsol
Incinerator	1	Fluorides	Vacuum system	1	NE
Incinerator	1	HCl	Vacuum system	3	HF
Incinerator	1	Organics	Vacuum system	5	Fluorides
Incinerator	2	NO_x	Vacuum system	16	CO
Incinerator	2	Part	Vacuum system	16	Organic
Incinerator	2	SO_2	Vacuum system	16	Uranium
KOH scrubber	1	Technetium	Vent	2	Fluorides
KOH scrubber	1	Uranium	Vent	1	NE
Laboratory vents	12	Many	Vent	1	VOC
Machine repair	1	Fluorides	Waste oil decontamination	1	Organics
Machine repair	1	Part	Wet air vents	2	Fluorides
Main vent	1	Fluorides	Wreck disassembly	1	Fluorides
Mechanical lab	1	Part	Wreck disassembly	1	Part
			Total	269	

[a]NE = no emission; VOC = volatile organic compounds; Part = particulate; SO_x = sulfur oxides;

Table 4.1.4. 1986 Oak Ridge Y-12 Plant steam plant opacity performance

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Annual
Total minutes	129,600	131,040	132,480	132,480	525,600
Total days	90	91	92	92	365
Total minutes of noncompliances					
East stack	1,650	1,470	2,238	714	6,072
West stack	1,752	1,704	162	0	3,618
Total days of noncompliances					
East stack	51	51	79	24	205
West stack	33	44	4	0	81
Percentage of minutes of noncompliances					
East stack	1.3	1.1	1.7	0.5	1.2
West stack	1.4	1.3	0.1	0.0	0.7
Percentage of days of noncompliances					
East stack	56.7	56.0	85.9	26.1	56.2
West stack	36.7	48.4	4.3	0.0	22.2

Table 4.1.5. 1986 ORGDP[a] steam plant opacity performance

Month	Number of days included	Cumulative days included	Number of days out of compliance	Cumulative days out of compliance	Percentage of noncompliance	Cumulative percent noncompliance
Oct	29	29	11	11	37.9	37.9
Nov	30	59	16	27	53.3	45.8
Dec	31	90	13	40	41.9	44.4
Jan	31	121	9	49	29.0	40.5
Feb	28	149	15	64	53.6	43.0
Mar	31	180	7	71	22.6	39.4
Apr	30	210	2[b]	73	6.7	34.8
May	31	241	1	74	3.2	30.7
June	30	271	1	75	3.3	27.7
July	31	302	0	75	0.0	24.8
Aug	31	333	2	77	6.5	23.1
Sept	30	363	7	84	23.3[c]	23.1

[a]K-1501, FY 1986.
[b]Wood pellet test burn.
[c]Coal-fired test burn.

monitoring stations are shown in Figs. 4.2.1 through 4.2.5.

Environmental air samples were taken for determination of SO_2, fluorides, suspended particulates, and uranium around Oak Ridge Y-12 Plant.

A variety of sulfur compounds are released to the atmosphere from both natural and anthropogenic sources (Godish, 1985). Among the most important are the sulfur oxides (SO_x), which are produced when fossil fuels containing inorganic sulfides and organic sulfur are combusted. Of the four known monomeric sulfur oxides, only SO_2 is found at appreciable levels in the gas phase, in the troposphere. Sulfur trixoide (SO_3) is emitted directly into the atmosphere in fossil fuel combustion and is produced by the oxidation of SO_2 in the atmosphere.

Table 4.1.6. 1986 point discharges of radionuclides to the atmosphere from the three Oak Ridge installations

Radionuclide	Discharge (Ci)
Uranium[a]	0.19 (211 kg)
Iodine-131 (^{131}I)	<0.035
Tritium (^{3}H)	31,000
Xenon-133 (^{133}Xe)[b]	51,000
Krypton-85 (^{85}Kr)[b]	10,600
Technetium-99 (^{99}Tc)	0.0038
UID[c]	0.00000060
Total	92,600

[a]Uranium of varying enrichments/curie quantities calculated using the appropriate specific activity for material released.
[b]Upper-limit values based on direct radiation measurements in the stack gas stream and an assumed mixture of noble gases.
[c]Unidentified alpha.

Table 4.1.7. Estimates of 1986 emissions of gaseous chemicals to the atmosphere

Chemical	Amount (kg)
Acetylene	7,868,800
Alcohol	382,000
Ammonia	70
Argon	4,350,000
Mixed gases[a]	2,100
Carbon monoxide	50
Carbon dioxide (gas)	1,500
Carbon dioxide (solid)[b]	155,000
Chlorine	32,000
Fluorocarbons	6,640
Fluorine, hydrogen fluoride	25,900
Freon	38,800
Gaseous halogens and halogenated particulates	3,400
Gaseous and particulate fluorides	26,400
Gaseous chlorides	30
Steam plant discharges (particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons)	3,691,000
Helium	723,680
Hydrogen	1,172,900
Hydrogen sulfide	10
Methane	10
Nitrogen (gas)	19,277,000
Oxygen (gas)	243,500
Oxygen (liquid)[b]	54,600
Propane	2,500
Sulfur hexafluoride	4,700
Trichloroethane, perchlorethylene, methylene chloride, acetone	279,400
Total	38,342,000

[a]The major constituent is argon.
[b]Volatized from this form.

Sulfur dioxide monitoring is conducted continuously at two stations at the Oak Ridge Y-12 Plant (Fig. 4.2.1). These two stations are identical except for their location. Ambient air is pumped into pulsed, ultraviolet fluorescence analyzers that are connected to recording units housed in temperature-controlled shelters. They are calibrated weekly to ensure that they remain within the ±15% drift allowed by the state. Oak Ridge Y-12 Plant is the only ORR installation

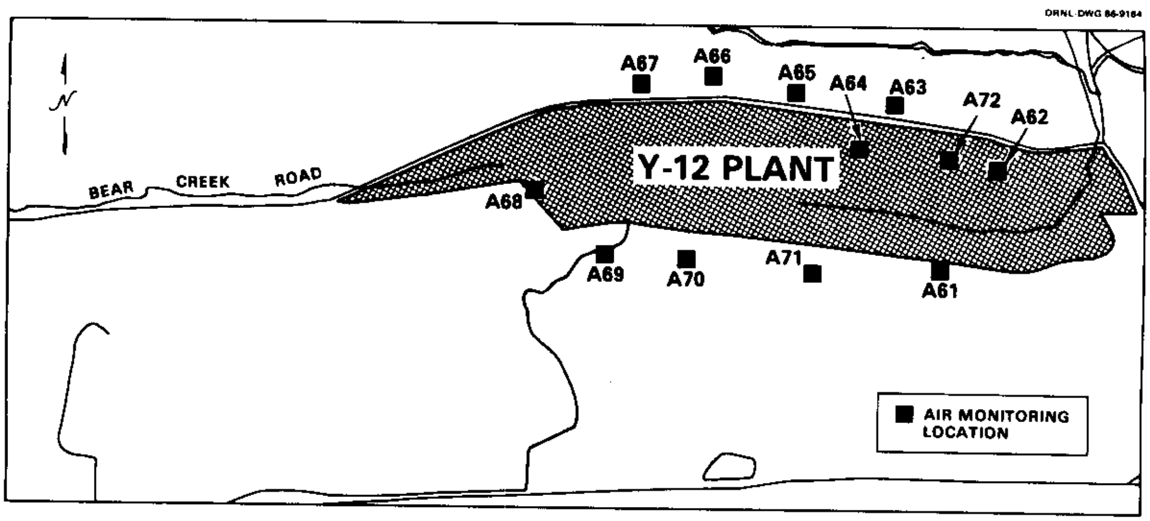

Fig. 4.2.1. Location map of perimeter air monitoring stations around the Oak Ridge Y-12 Plant.

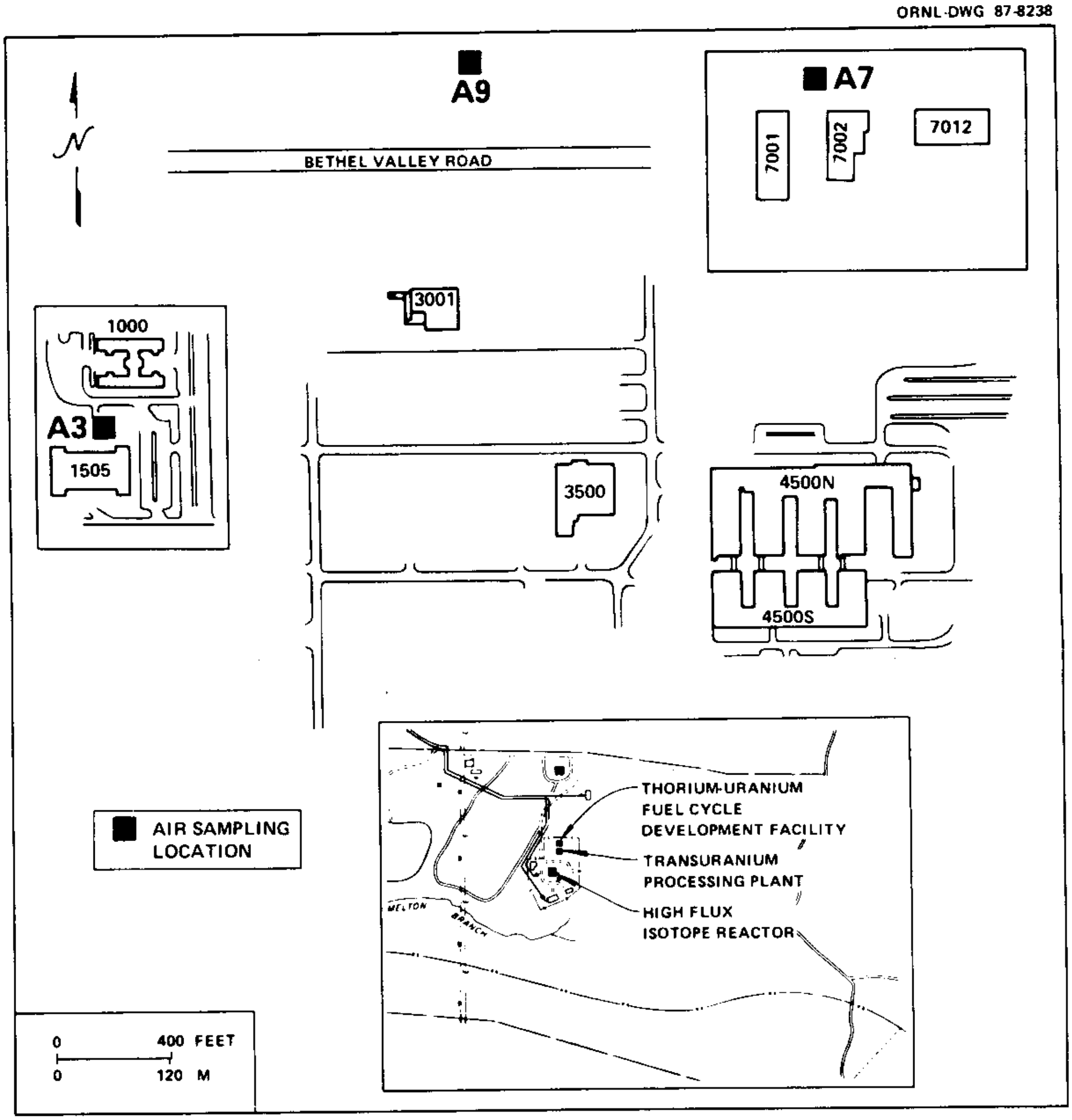

Fig. 4.2.2. Location map of perimeter air monitoring stations around ORNL.

ORNL-DWG 86-9186R2

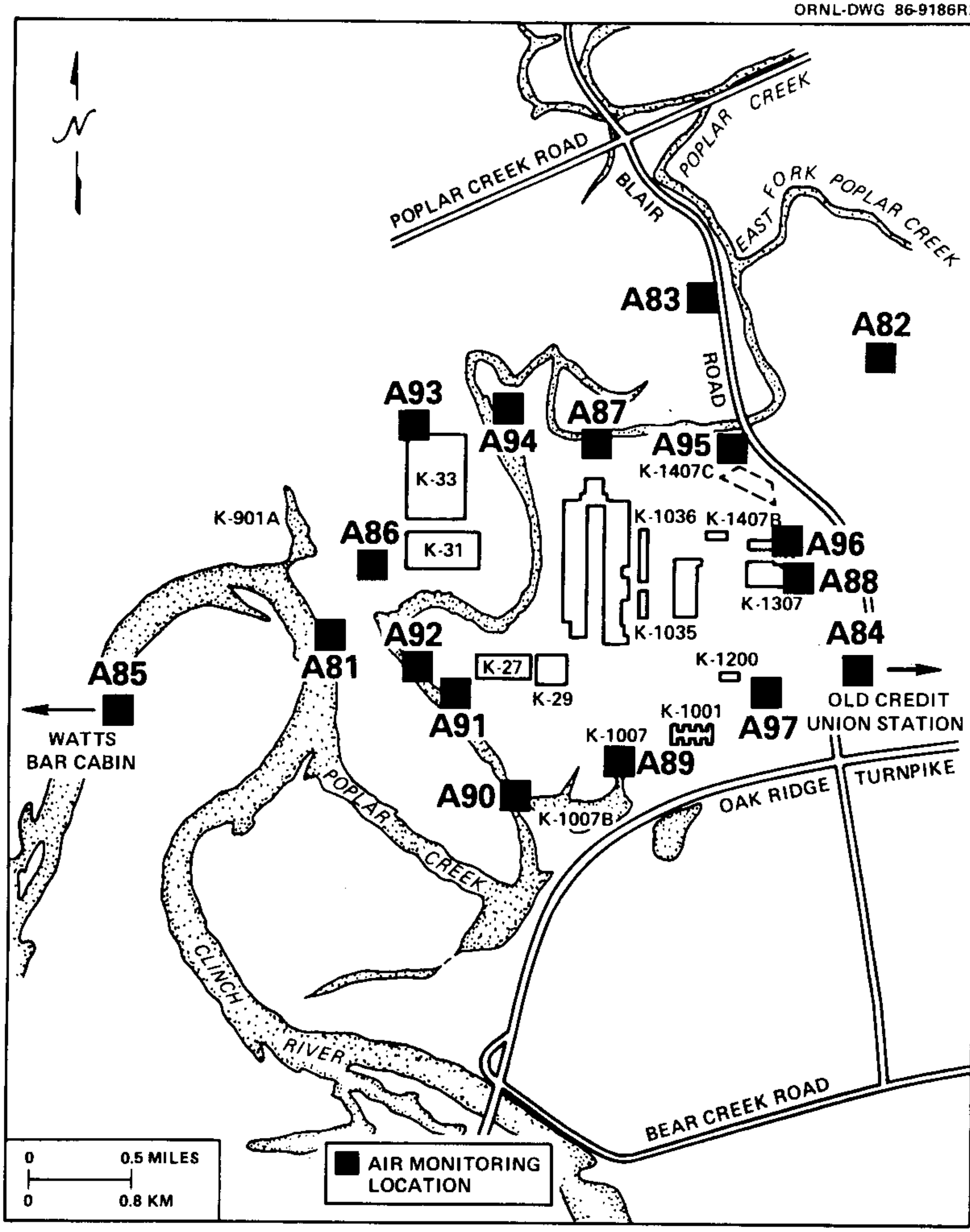

Fig. 4.2.3. Location map of perimeter air monitoring stations around ORGDP.

ORNL–DWG 87-6804

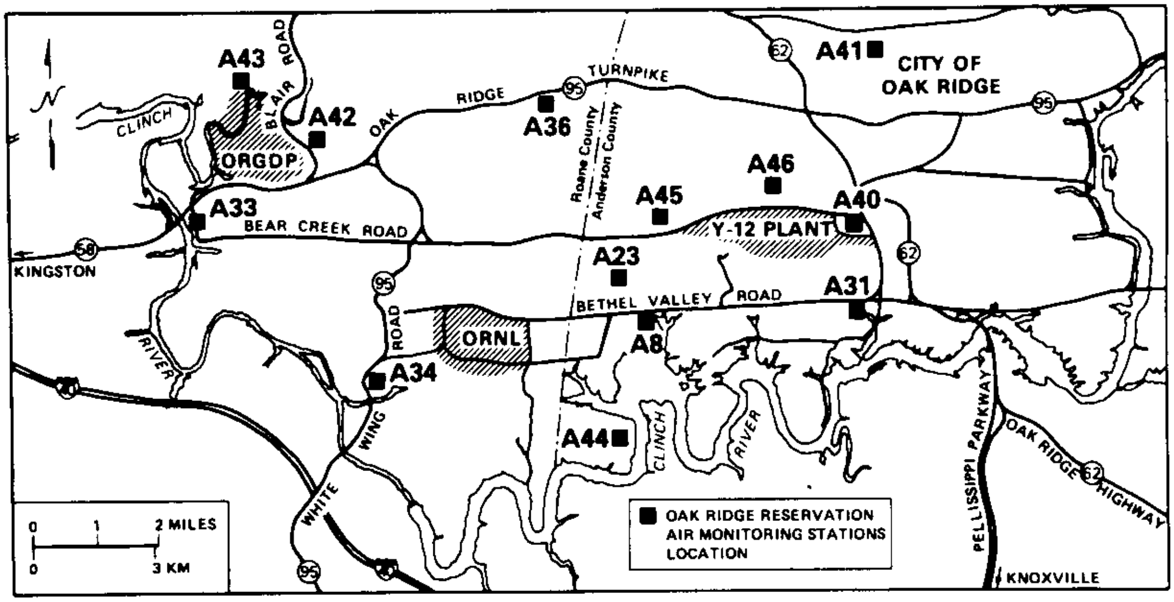

Fig. 4.2.4. Location map of Oak Ridge Reservation air monitoring stations.

ORNL-DWG 87-6805

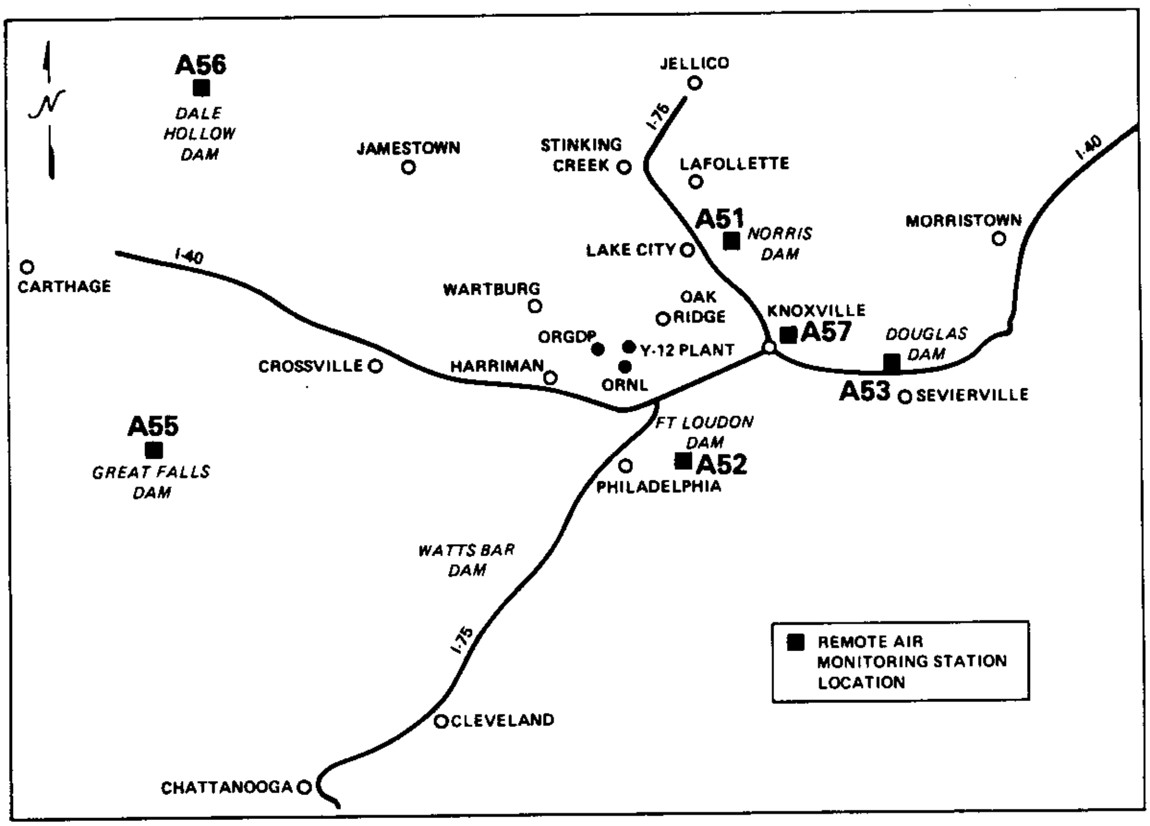

Fig. 4.2.5. Location map of remote air monitoring stations.

that must monitor SO_2. TDHE conducts a quarterly audit of each system.

Concentrations of SO_2 are recorded hourly for each month. Each day's average is compared with the 3- and 24-h ambient air standards. Table 4.2.1 lists the maximum 3-h, maximum 24-h, and monthly and annual averages for both stations at Oak Ridge Y-12 Plant. On the average, the 1986 ambient air SO_2 values were only about 20% of the state standards. No violations of the 3- or 24-h standards occurred in 1986. The highest values at either station for SO_2 were only about 30% of the standards.

Table 4.2.1. 1986 sulfur dioxide in air[a,b]

Month/ station ID	Monthly av SO_2 (mg/L)	Max 24-h av SO_2 (mg/L)	Max 3-h av SO_2 (mg/L)
January			
A62	0.017	0.024	0.045
A68	0.009	0.019	0.050
February			
A62	0.018	0.032	0.044
A68	0.010	0.017	0.018
March			
A62	0.017	0.026	0.064
A68	0.009	0.016	0.031
April			
A62	0.014	0.026	0.063
A68	0.010	0.023	0.048
May			
A62	0.010	0.023	0.055
A68	0.006	0.012	0.033
June			
A62	0.013	0.021	0.057
A68	0.008	0.011	0.020
July			
A62	0.011	0.021	0.040
A68	0.009	0.012	0.025
August			
A62	0.011	0.016	0.038
A68	0.009	0.013	0.025
September			
A62	0.009	0.018	0.046
A68	0.007	0.012	0.021
October			
A62	0.011	0.016	0.024
A68	0.004	0.008	0.022
November			
A62	0.010	0.016	0.031
A68	0.005	0.011	0.025
December			
A62	0.016	0.033	0.079
A68	0.011	0.044	0.102

[a]See Fig. 4.2.1.
[b]The Tennessee 24-h average standard is 0.14 mg/L, and the Tennessee 3-h average standard is 5 mg/L.

At Oak Ridge Y-12 Plant, one of the pollutants discharged to the atmosphere is hydrogen fluoride (HF).

The uranium enriching process employed in the United States is gaseous diffusion, which requires that uranium be in a gaseous compound, uranium hexafluoride (UF_6). Much of this UF_6 inventory is processed in systems that operate below atmospheric pressure and, therefore, presents no significant UF_6 release potential. Uranium hexafluoride reacts rapidly with moisture in the air, forming uranyl fluoride (UO_2F_2) and HF. Uranium compounds such as UO_2F_2 and UF_6 exhibit both chemical toxicity and radiological effects, while HF exhibits only chemical toxicity. Other toxic substances that may be present in the gaseous diffusion plants—in much smaller quantities—include chlorine (Cl_2), chlorine trifluoride (ClF_3), fluorine (F_2), uranium tetrafluoride (UF_4), and technetium (Tc) compounds.

Once released into the atmosphere, these toxic materials remain airborne for various lengths of time depending on atmospheric conditions and the properties of the material. Individuals exposed to these airborne toxicants may suffer varying health effects depending on the concentration of the toxicant, duration of exposure, and the sensitivity of the individual.

Typical chemical reactions of some of these compounds released to the atmosphere are:

$$UF_6 + 2H_2O \rightarrow UO_2F_2 + 4HF + heat$$

$$16ClF_3 + 27H_2O \rightarrow 10ClO_2 + 48HF + HCl + 5HOCl + O_2 + heat$$

$$2F_2 + 2H_2O \rightarrow 4HF + O_2 + heat$$

$$3HF \rightleftarrows (HF)_3 + heat$$

$$6HF \rightleftarrows (HF)_6 + heat$$

Fluoride sampling locations around ORGDP are indicated in Fig. 4.2.3 by A81 through A85 (A85 is located about 8 km from ORGDP, upwind of the predominant wind direction). ORGDP fluoride data for 1986 are reported in Table 4.2.2.

In the past, Oak Ridge Y-12 Plant fluoride sampling was conducted at a limited number of sites. In 1985 the fluoride monitoring program was expanded to include 11 stations (Fig. 4.2.1) that are run continuously. Fluoride sampling is conducted every seven days all year long.

Table 4.2.2. 1986 fluorides in air[a]

New (old) station ID	Number of samples[b]	Concentration for averaging interval, max ($\mu g/m^3$) 7 d	30 d[c]	Number of times standard exceeded 7 d	30 d[c]
		First quarter			
A81 (F1)[d]	12	<0.03	<0.03	0	0
A82 (F2)[d]	10	<0.03	<0.03	0	0
A83 (F4)[d]	9	<0.03	<0.03	0	0
A84 (F5)[d]	12	<0.03	<0.03	0	0
A85 (F6)[e]	11	0.04	<0.03	0	0
		Second quarter			
A81 (F1)	13	<0.03	<0.03	0	0
A82 (F2)	13	0.05	<0.03	0	0
A83 (F4)	13	<0.03	<0.03	0	0
A84 (F5)	13	<0.03	<0.03	0	0
A85 (F6)	13	0.05	<0.03	0	0
		Third quarter			
A81 (F1)	12	<0.03	<0.03	0	0
A82 (F2)	12	0.08	<0.04	0	0
A83 (F4)	13	0.04	<0.03	0	0
A84 (F5)	13	0.06	<0.04	0	0
A85 (F6)	13	0.05	<0.03	0	0
		Fourth quarter			
A81 (F1)	13	<0.03	<0.03	0	0
A82 (F2)	13	<0.03	<0.03	0	0
A83 (F4)	5	<0.03	<0.03	0	0
A84 (F5)	13	<0.03	<0.03	0	0
A85 (F6)	13	<0.03	<0.03	0	0

[a]Data are not amenable to comparison with 12-h or 24-h standard; 6-d or 7-d sample period compared with 7-d averaging interval. See text for method of measurement. These stations are not sited in accordance with 40 CFR Pt. 58 and are not satisfactory for judging compliance with ambient air quality standards.

[b]Samples are continuous; analyses are conducted on 7-d composites.

[c]Tennessee air pollution control (gaseous) for averaging intervals: 1.6 $\mu g/m^3$ for 7 d and 1.2 $\mu g/m^3$ for 30 d. All values are maximum—not to be exceeded more than once per year.

[d]See Fig. 4.2.3 (ORGDP).

[e]Station A85 is approximately 8 km from ORGDP, upwind of the prevailing wind direction; it may be considered representative of general ambient background concentration.

Atmospheric fluoride is collected by absorbing the fluoride on 50-mm-diam filters treated with potassium carbonate. This method is applicable to the measurement of gaseous and water-soluble particulate fluoride in the atmosphere. The lowest amount of fluoride reported is 2 μg per sample, which is well below state criteria, and most of it is brought in with the prevailing winds. Ambient fluoride data in air around Oak Ridge Y-12 Plant are given by week in Table 4.2.3 and by quarter in Table 4.2.4.

The Oak Ridge Y-12 Plant monitors suspended particulates in ambient air at two locations at the east and west ends of the site (Fig. 4.2.1). Sampling for suspended particulates consists of drawing air through a preweighed Whatman 41 filter paper for 24 hours every 6 days. Before it is weighed, each filter paper is allowed to equilibrate in a laboratory atmosphere. At the end of the 24-h sampling period, the filter papers are again allowed to equilibrate before they are weighed. From the weight differential arising from particle accumulation, sampling time, and air flow, the particulate concentration (expressed in $\mu g/m^3$) can be calculated. These values are compared with the Tennessee primary and secondary ambient air standards. Oak Ridge Y-12 Plant data for 1986 are reported in Tables 4.2.5 and 4.2.6. If a sample is found to exceed the state standard, the filter is studied under a high-powered microscope to determine the type of material present. In the past, if the majority of the filter were covered with road dust, insect parts, pollen, or other fugitive particles, the state has not considered it a violation. During 1986, no violations were recorded.

Suspended particulates were measured in the ORGDP area at locations A86 through A97, as shown in Fig. 4.2.3. Locations A86 through A89 are sampled for particulates for 24 hours every sixth day. Locations A90 through A97 are continuous air monitors; the filter paper is analyzed for particulates approximately every 48 to 72 hours. The ORGDP first- and second-quarter data are given in Table 4.2.7; third- and fourth-quarter data are given in Table 4.2.8. There were no violations in 1986.

Data on the gross alpha and beta activity around Oak Ridge Y-12 Plant are given in Table 4.2.9. Data on the ^{238}U and ^{235}U concentrations are given in Table 4.2.10. Data on the ^{234}U and ^{236}U concentrations are given in Table 4.2.11.

Annual concentrations of gross alpha and gross beta in air are summarized in Table 4.2.12. As usual, a majority of the measurements are below the instrument detection limit and less-than-detectable limits are reported. In the past, the flow rate at each station varied, thus biasing the calculated concentrations (total activity divided by total volume of air sampled, where total volume equals the sampling period times the flow rate). In 1986, at ORNL perimeter and Oak Ridge Reservation stations, the flow rate was maintained within a set range (0.045 to 0.09 m^3/min). Flow rates outside of this range were treated as missing values and were not used in the calculation. Because of the instrumental limitations on air samplers at remote stations (A50 to A57), flow rates at these stations stayed higher (0.09 to 0.207 m^3/min). To minimize the effect caused from dividing less-than-detectable values by a flow rate much higher than 0.075 m^3/min, an adjustment was made in the calculations of gross alpha and gross beta concentrations in 1986. That is, all flow rates greater than 0.075 m^3/min were assigned to 0.075 m^3/min if the gross alpha and/or gross beta measurements were at or below detectable levels. Thus, the results are comparable.

The minimum concentrations of gross alpha and gross beta at all stations were calculated based on this minimum detectable level (MDL). The calculated minimum concentration is 9.8×10^{-15} Ci/m^3 under optimal sampling condition (7-d sampling period and flow rate at 0.075 m^3/min). Some of the minimum concentrations shown in Table 4.2.12 are less than 9.8×10^{-15} Ci/m^3 because flow rates at these stations were much higher than 0.075 m^3/min and the measured gross alpha and/or gross beta values were just slightly above the detection level.

The higher maximum values at all stations correspond primarily with the worldwide deposition of a radioactive cloud from the

Table 4.2.3. 1986 weekly ambient fluoride in air concentration ($\mu g/m^3$)[a]

	Station number: new (old)[a]										
	A61(1)	A62(2)	A63(3)	A64(4)	A65(5)	A66(6)	A67(7)	A68(8)	A69(9)	A70(10)	A71(11)
1/16/86	0.02	0.02	0.01	0.04	0.02	0.01	0.01	0.01	0.02	0.02	0.02
1/23/86	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01
1/30/86	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01
2/06/86	0.01	0.01	0.02	0.02	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01
2/13/86	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01
2/20/86	0.01	0.01	0.02	0.03	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01
2/27/86	0.01	0.01	0.02	0.04	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3/06/86	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
3/13/86	0.01	0.01	0.21	0.19	0.23	0.01	0.011	0.01	0.01	0.01	0.01
3/20/86	0.01	0.01	0.23	0.23	0.30	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
3/27/86	0.01	0.01	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01
4/03/86	0.01	<0.01	<0.01	<0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01
4/10/86	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4/17/86	0.02	0.02	0.03	0.06	0.03	0.01	0.01	0.01	0.05	0.01	0.04
4/24/86	0.01	0.01	0.02	0.05	0.03	0.03	0.01	0.01	0.02	0.01	0.01
4/24/86	<0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01
5/01/86	0.02	<0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
5/08/86	<0.01	0.02	<0.01	0.03	0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01
5/15/86	0.01	0.01	0.03	0.06	0.05	0.01	0.01	<0.01	<0.01	<0.01	<0.01
5/22/86	0.02	0.05	0.18	0.33	0.09	0.08	0.05	0.02	0.03	0.04	0.02
5/29/86	0.08	0.09	0.19	0.16	0.09	0.21	0.09	0.09	0.03	0.01	0.01
6/05/86	0.01	0.03	0.01	0.05	0.03	0.01	0.01	0.01	0.03	0.02	0.02
6/12/86	0.03	0.04	0.06	0.05	0.05	0.02	0.01	0.02	0.01	0.01	0.02
6/19/86	0.02	0.02	0.06	0.09	0.05	0.05	0.07	0.05	0.03	0.01	0.02
6/26/86	0.01	0.01	0.12	0.15	0.05	0.12	0.11	0.03	0.02	0.11	0.03
7/03/86	0.00	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.03	<0.01
7/10/86	0.01	0.01	0.01	0.01	0.01	0.02	<0.01	0.01	<0.01	<0.01	0.02
7/17/86	0.02	0.15	0.42	0.49	0.09	0.03	0.10	0.03	0.03	0.02	0.11
7/24/86	0.02	0.01	0.06	0.04	0.11	0.09	0.09	0.07	0.07	0.04	0.04
7/31/86	<0.01	0.02	<0.01	0.02	0.01	0.02	0.02	0.03	0.01	0.01	0.01
8/07/86	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02
8/14/86	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.01	<0.01
8/21/86	0.02	0.01	0.04	0.02	0.01	0.01	<0.01	0.04	0.01	<0.01	0.01
8/28/86	0.06	0.13	0.30	0.51	0.18	0.39	0.19	0.07	0.06	0.05	0.04
9/04/86	0.02	0.02	0.03	0.06	0.03	0.05	0.05	0.03	0.04	0.04	0.02
9/11/86	0.02	0.05	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
9/18/86	0.02	0.03	0.23	0.19	0.44	0.05	0.13	0.07	0.03	0.01	0.02
9/25/86	<0.01	<0.01	0.02	0.02	0.01	0.03	0.06	0.01	0.01	<0.01	<0.01
10/02/86	0.00	0.03	0.04	0.04	0.03	0.04	0.03	0.04	0.10	0.03	0.02
10/09/86	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01
10/16/86	0.02	0.07	0.07	0.25	0.05	0.01	0.04	0.02	0.03	0.01	0.01
10/23/86	0.03	0.03	0.04	0.04	0.07	0.04	0.28	0.07	0.21	0.09	0.07
10/30/86	0.03	0.03	0.09	0.18	0.07	<0.01	0.15	0.09	0.08	0.06	0.03
11/06/86	0.01	<0.01	0.02	0.01	0.02	<0.01	0.02	0.01	0.01	0.03	0.02
11/13/86	0.01	<0.01	0.02	0.02	0.01	<0.01	<0.01	0.01	0.04	0.04	<0.01
11/20/86	0.01	0.01	<0.01	0.05	0.02	0.02	0.03	0.04	0.03	0.02	0.01
11/27/86	0.04	0.06	0.09	0.19	0.01	0.04	0.07	0.06	0.04	0.03	0.02
12/04/86	0.02	<0.01	0.02	0.07	0.01	0.03	0.05	0.04	0.05	0.02	0.01
12/11/86	0.01	0.01	0.01	0.02	0.01	<0.01	0.01	0.01	0.01	0.01	0.01
12/18/86	0.04	0.02	0.03	0.07	0.05	0.07	0.07	0.02	0.12	0.02	0.02
12/26/86	0.02	0.04	0.06	0.21	0.01	0.02	0.04	0.03	0.02	0.01	0.01

[a]See Fig. 4.2.1 (Oak Ridge Y-12 Plant).

Table 4.2.4. 1986 quarterly ambient fluoride in air concentration ($\mu g/m^3$)

		Station number: new (old)[a]										
		A61(1)	A62(2)	A63(3)	A64(4)	A65(5)	A66(6)	A67(7)	A68(8)	A69(9)	A70(10)	A71(11)
1st Qtr.	Max	0.02	0.02	0.23	0.23	0.30	0.01	0.02	0.02	0.02	0.02	0.02
(11 samples)	Min	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Av	0.01	<0.01	<0.05	<0.06	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2nd Qtr.	Max	0.08	0.10	0.18	0.33	0.09	0.21	0.11	0.10	0.05	0.10	0.04
(14 samples)	Min	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Av	<0.02	<0.02	<0.05	<0.08	0.04	<0.04	<0.03	<0.02	<0.02	<0.02	<0.01
3rd Qtr.	Max	0.06	0.15	0.42	0.51	0.44	0.39	0.19	0.07	0.07	0.05	0.11
(13 samples)	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Av	<0.02	<0.04	<0.09	<0.11	<0.07	<0.06	<0.06	<0.03	<0.03	<0.02	<0.03
4th Qtr.	Max	0.04	0.07	0.09	0.25	0.07	0.07	0.28	0.09	0.21	0.10	0.07
(13 samples)	Min	0.00	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01
	Av	0.02	<0.03	<0.04	0.09	0.03	<0.02	<0.06	0.04	0.06	0.03	<0.02
Annual Av		<0.02	<0.03	<0.06	<0.08	<0.05	<0.03	<0.04	<0.03	<0.03	<0.02	<0.02

[a]See Fig. 4.2.1 (Oak Ridge Y-12 Plant).

Table 4.2.5. 1986 suspended particulates in air at station A68[a]

Date off	Concentration[b,c] ($\mu g/m^3$)	Date off	Concentration ($\mu g/m^3$)	Date off	Concentration ($\mu g/m^3$)	Date off	Concentration ($\mu g/m^3$)
1/1	ND[d]	4/1	92	7/1	67	10/5	30
1/8	43	4/7	34	7/7	72	10/11	13
1/13	45	4/13	51	7/13	69	10/17	43
1/14	69[e]	4/19	ND	7/19	ND	10/23	137
1/19	44	4/25	49	7/25	103	10/29	5.9
1/26	19	5/1	73	7/31	95	11/4	64
1/31	69	5/7	94	8/6	124	11/10	96
2/6	38	5/13	73	8/12	83	11/16	79
2/12	26	5/19	29	8/18	95	11/22	99
2/18	90	5/26	87	8/24	71	11/28	40
2/23	35	6/1	103	8/30	79	12/4	84
3/2	16	6/7	93	9/5	58	12/10	27
3/8	66	6/13	104	9/11	85	12/16	170
3/14	27	6/20	74	9/17	114	12/22	230
3/20	40	6/25	70	9/23	93	12/28	24
3/26	62			9/29	111		

[a]West total suspended particulate (TSP) Station—A68(8). See Fig. 4.2.1.
[b]PR STD = primary standard = 260 $\mu g/m^3/24$ h; SC STD = secondary standard = 150 $\mu g/m^3/24$ h.
[c]Geometric mean = annual geometric mean (AGM): primary standard = 75 $\mu g/m^3$; secondary standard = 60 $\mu g/m^3$.
[d]ND = no data.
[e]Special sample.

Table 4.2.6. 1986 suspended particulates in air at station A72[a]

Date off	Concentration[b,c] (μg/m³)	Date off	Concentration (μg/m³)	Date off	Concentration (μg/m³)	Date off	Concentration (μg/m³)
1/1	ND[d]	4/1	70	7/1	43	10/5	34
1/8	23	4/7	29	7/7	53	10/11	13
1/13	11	4/13	50	7/13	78	10/17	37
1/14	57[e]	4/19	ND	7/19	ND	10/23	73
1/19	47	4/25	29	7/25	90	10/29	0.1
1/26	19	5/1	68	7/31	61	11/4	47
1/31	89	5/7	92	8/6	101	11/10	0.1
2/6	36	5/13	100	8/12	73	11/16	75
2/12	ND	5/19	28	8/18	71	11/22	74
2/18	88	5/29	51	8/24	74	11/28	40
2/23	29	6/1	121	8/30	66	12/4	51
3/2	26	6/7	105	9/5	54	12/10	12
3/8	67	6/13	96	9/11	78	12/16	57
3/14	31	6/19	107	9/17	88	12/22	32
3/20	14	6/25	53	9/23	86	12/28	8.8
3/26	45			9/29	79		

[a]East TSP Station—A72(12). See Fig. 4.2.1.
[b]PR STD = primary standard = 260 μg/m³/24 h; SC STD = secondary standard = 150 μg/m³/24 h.
[c]Geometric mean = annual geometric mean (AGM): primary standard = 75 μg/m³; secondary standard = 60 μg/m³.
[d]ND = no data.
[e]Special sample.

Chernobyl incident. Average concentrations (10^{-10} Ci/m³) of long-lived gross alpha and gross beta are <9.8 and <11, respectively, at remote stations, <11 and <21 at Reservation stations, <12 and <19 at ORNL perimeter stations, and <11 and <18 for all locations.

Because of improved data collection and calculation this year, it is not desirable to compare 1986 values with those of past years. Nevertheless, an attempt has been made to compare the values of 1986 and 1985. A few points can be made.

- Minimum concentrations for gross alpha and gross beta are higher this year because of the flow rate adjustment made in the calculation in 1986. Minimum concentrations for both years were actually unchanged. In both years, less-than-detectable levels of the instrument were reported, which corresponds to 9.8×10^{-15} Ci/m³ if the sampling flow rate is 0.075 m³/min and the sampling period is 7 d.
- Maximum concentrations for gross alpha at ORNL perimeter and remote stations were actually lower this year but were slightly higher at the Reservation stations. Maximum concentrations for gross beta at all locations were higher this year. Elevated values that occurred during May and June corresponds to the time of the Chernobyl incident.
- Average concentrations for gross alpha and gross beta are higher for all locations. Except at the ORNL perimeter stations, average concentrations of gross alpha were slightly lower in 1986. Causes of the changes could be worldwide deposition, adjustments made in the calculation, or improvement of the counting sensitivity.

Annual concentrations of atmospheric ^{131}I are summarized in Table 4.2.13. The instrumental background has been subtracted from the measured concentrations. Negative values represent concentrations below the instrument

Table 4.2.7. 1986 suspended particulates in air—first- and second-quarter data

New (old) station ID	Number of samples	24-h concentration[a] ($\mu g/m^3$)				Percentage of standard AGM[b]	
		Max	Min	Geometric mean	95%[c] CC	PR	SC
				First quarter			
A86 (SP1)[d]	14	80	4.8	19	13	25	32
A87 (SP2)[d]	15	43	2.5	15	6.2	19	24
A88 (SP3)[d]	13	57	5.2	21	11	27	34
A89 (SP4)[d]	8	38	9.3	18	9.9	23	29
A90 (SP5)[d]	28	37	2.7	12	3.3	16	20
A91 (SP6)[d]	30	42	3.8	16	3.2	20	25
A92 (SP7)[d]	25	35	6.7	15	2.8	20	25
A93 (SP8)[d]	24	38	3.3	13	3.5	17	21
A94 (SP9)[d]	35	39	3.2	14	2.8	19	24
A95 (SP10)[d]	33	30	6.5	15	2.2	20	25
A96 (SP11)[d]	16	47	9.0	20	5.4	27	34
A97 (SP12)[d]	1	11	11			14	17
				Second quarter			
A86 (SP)[d]	12	49	13	25	7	33	41
A87 (SP2)[d]	4	44	8.3	27	27	36	45
A88 (SP3)[d]	14	67	7.4	32	11	42	53
A89 (SP4)[d]	14	57	8.3	30	9.4	40	50
A90 (SP5)[d]	33	46	4.7	19	3.5	24	30
A91 (SP6)[d]	16	46	4.2	18	7.4	24	30
A92 (SP7)[d]	32	37	8.2	20	2.9	26	32
A93 (SP8)[d]	31	43	8.0	21	3.3	28	35
A94 (SP9)[d]	26	45	7.8	23	3.6	30	37
A95 (SP10)[d]	NS[e]	ND[f]	ND	ND	ND	ND	ND
A96 (SP11)[d]	22	58	16	30	4.3	39	39
A97 (SP12)[d]	NS	ND	ND	ND	ND	ND	ND

[a]PR STD = Primary standard = 260 $\mu g/m^3/24$ h;
SC STD = Secondary standard = 150 $\mu g/m^3/24$ h.
[b]Geometric mean = annual geometric mean (AGM):
Primary standard = 75 $\mu g/m^3$.
Secondary standard = 60 $\mu g/m^3$.
[c]95% confidence coefficient about geometric mean.
[d]These stations are not sited in accordance with 40 CFR Pt. 58 and are not fully satisfactory for judging compliance with ambient air quality standards. See Fig. 4.2.3 (ORGDP).
[e]NS = no sample collected.
[f]ND = no data available.

Table 4.2.8. 1986 suspended particulates in air—third- and fourth-quarter data

New (old) station ID	Number of samples	24-h concentration[a] ($\mu g/m^3$)				Percentage of standard AGM[b]	
		Max	Min	Geometric mean	95%[c] CC	PR	SC
				Third quarter			
A86 (SP1)[d]	16	92	21	36	10	48	60
A87 (SP2)[d]	NS[e]	ND[f]	ND	ND	ND	ND	ND
A88 (SP3)[d]	16	120	26	46	14	60	76
A89 (SP4)[d]	15	77	11	33	12	43	54
A90 (SP5)[d]	34	45	6.6	21	3.6	27	34
A91 (SP6)[d]	21	41	6.5	19	4.7	25	32
A92 (SP7)[d]	35	45	3.5	20	3.5	27	33
A93 (SP8)[d]	20	39	7.7	21	4.2	27	34
A94 (SP9)[d]	32	49	4.7	22	4.1	29	36
A95 (SP10)[d]	4	39	12	21	20	28	35
A96 (SP11)[d]	35	45	6.7	24	3.5	32	40
A97 (SP12)[d]	NS	ND	ND	ND	ND	ND	ND
				Fourth quarter			
A86 (SP1)[d]	2	44	14	25		32	40
A87 (SP2)[d]	NS[e]	ND[f]	ND	ND	ND	ND	ND
A88 (SP3)[d]	15	96	11	30	12	40	50
A89 (SP4)[d]	1[f]	34	34			45	56
A90 (SP5)[d]	20	50	6.2	18	5.9	23	29
A91 (SP6)[d]	8	37	6.3	16	8.6	20	26
A92 (SP7)[d]	32	37	4.1	16	3.6	21	27
A93 (SP8)[d]	26	38	5.6	16	4.1	21	26
A94 (SP9)[d]	33	36	2.3	14	3.4	18	23
A95 (SP10)[d]	8	35	9.1	18	7.8	23	29
A96 (SP11)[d]	28	43	5.4	15	4.0	20	25
A97 (SP12)[d]	1[g]	27	27			36	45

[a]PR STD = Primary standard = 260 $\mu g/m^3$/24 h;
SC STD = Secondary standard = 150 $\mu g/m^3$/24 h.

[b]Geometric mean = annual geometric mean (AGM):
Primary standard = 75 $\mu g/m^3$.
Secondary standard = 60 $\mu g/m^3$.

[c]95% confidence coefficient about geometric mean.

[d]These stations are not sited in accordance with 40 CFR Pt. 58 and are not fully satisfactory for judging compliance with ambient air quality standards. See Fig. 4.2.3 (ORGDP).

[e]NS = no sample collected.

[f]ND = no data available.

[g]Sample location changed.

Table 4.2.9. 1986 gross alpha and gross beta in air

Station number: new (old)[b]	Concentration (10^{-15} μCi/cm³)[a]					
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total	Yearly av
			Gross alpha			
A61(1)	13 ± 1.1	14 ± 1.1	1.9 ± 0.5	3.1 ± 0.78	31	7.8 ± 0.9
A62(2)	9.0 ± 0.9	6.6 ± 0.8	3.8 ± 0.7	4.7 ± 0.85	24	6.0 ± 0.8
A63(3)	23 ± 1.5	19 ± 1.3	12 ± 1.0	8.2 ± 1.01	62	15.6 ± 1.2
A64(4)	39 ± 2.0	26 ± 1.6	16 ± 1.2	10 ± 1.09	91	22.7 ± 1.5
A65(5)	16 ± 1.2	20 ± 1.4	9.3 ± 1.0	8.8 ± 1.02	54	13.5 ± 1.1
A66(6)	7.1 ± 0.8	12 ± 1.1	5.2 ± 0.7	2.7 ± 0.78	27.4	6.8 ± 0.8
A67(7)	10 ± 1.0	15 ± 1.1	5.7 ± 0.8	8.1 ± 0.99	39	9.7 ± 1.0
A68(8)	11 ± 1.0	22 ± 1.4	6.80 ± 0.8	8.8 ± 1.03	49	12.2 ± 1.1
A69(9)	17 ± 1.2	19 ± 1.3	8.84 ± 0.9	12 ± 1.16	57.3	14.3 ± 1.2
A70(10)	9.5 ± 0.9	15 ± 1.1	7.4 ± 0.8	5.9 ± 0.90	38	9.4 ± 1.0
A71(11)	9.1 ± 0.9	15 ± 1.1	3.8 ± 0.7	2.7 ± 0.77	30.2	7.6 ± 0.9
			Gross beta			
A61(1)	23 ± 1.7	47 ± 3.1	22 ± 1.6	20 ± 1.6	112	28.0 ± 2.0
A62(2)	25.3 ± 1.8	39 ± 2.7	22 ± 1.6	24 ± 1.8	110	28 ± 2.0
A63(3)	36 ± 2.4	47 ± 3.1	38.3 ± 2.6	21 ± 1.6	142	36 ± 2.4
A64(4)	61 ± 4.0	70 ± 4.5	49 ± 3.2	24 ± 1.8	205	51.18 ± 3.4
A65(5)	51 ± 3.3	58 ± 3.8	27 ± 2.0	25 ± 1.9	161	40.4 ± 2.7
A66(6)	26 ± 1.9	61 ± 3.9	24 ± 1.8	17 ± 1.4	128	32 ± 2.2
A67(7)	52 ± 3.4	62 ± 4.0	27 ± 1.9	28 ± 2.0	168	42.1 ± 2.8
A68(8)	26 ± 1.9	56 ± 3.7	23 ± 1.7	19 ± 1.5	123	31 ± 2.2
A69(9)	22 ± 1.7	50 ± 3.3	28 ± 2.0	26.4 ± 1.9	126	32 ± 2.2
A70(10)	21 ± 1.6	45 ± 3.0	23 ± 1.7	20.1 ± 1.6	108	27 ± 2.0
A71(11)	20 ± 1.5	44 ± 2.9	22 ± 1.6	18.4 ± 1.4	104	26 ± 1.9

[a]To convert from 10^{-15} μCi/cm³ to 10^{-11} Bq/cm³, multiply by 3.7.
[b]See Fig. 4.2.1 (Oak Ridge Y-12 Plant).

background level. The charcoal samples collected weekly at the air monitoring stations showed an increase in ^{131}I concentrations during the worldwide dispersion of a radioactive cloud resulting from the Chernobyl incident. Iodine-131 levels increased for approximately two months after the Chernobyl incident. Charcoal samples collected weekly at the air monitoring stations showed a significant decrease in ^{131}I concentrations in July, indicating that higher radioactivity levels observed in the Oak Ridge area during the second quarter as a result of the cloud from the Chernobyl incident are not continuing.

The annual maximum ^{131}I concentration at all stations increased significantly from 1985 because of the Chernobyl incident. Annual minimum concentrations are much lower this year because negative values were reported and used in the calculation. The annual average ^{131}I concentration shows only a slight increase from 1985 because the effect of the Chernobyl incident was short and because the minimum values of this year were lower. Information collected from Energy Systems monitors showed that effects of the Chernobyl incident on this area were minimal (see Fig. 4.2.6).

The average peak concentration of ^{131}I from the first peak is about 20×10^{-7} Bq/L (5×10^{-14} μCi/mL). The annual dose equivalent to the total body is about 3×10^{-4} millirem and to the thyroid (critical organ) is about 0.5 millirem, assuming that this concentration was the same all year long, that the standard breathing rate for Standard Man was used, and that the air at these stations was breathed for 24 h/d for 365 d/year.

Table 4.2.10. 1986 ^{238}U and ^{235}U in air

Station number: new (old)[b]	Concentration (10^{-15} $\mu Ci/cm^3$)[a]					
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total	Yearly av
			^{238}U			
A61(1)	0.17 ± 0.04	0.38 ± 0.07	0.25 ± 0.05	0.33 ± 0.06	1.1	0.28 ± 0.05
A62(2)	0.16 ± 0.04	0.46 ± 0.07	0.40 ± 0.06	0.29 ± 0.06	1.3	0.32 ± 0.06
A63(3)	0.31 ± 0.06	0.80 ± 0.10	1.0 ± 0.17	0.43 ± 0.07	2.6	0.64 ± 0.09
A64(4)	0.52 ± 0.07	1.2 ± 0.12	1.5 ± 0.15	0.64 ± 0.11	3.8	0.96 ± 0.11
A65(5)	0.62 ± 0.09	1.3 ± 0.13	1.1 ± 0.13	0.57 ± 0.09	3.6	0.89 ± 0.11
A66(6)	0.24 ± 0.05	1.6 ± 0.17	0.90 ± 0.16	0.33 ± 0.07	3.0	0.76 ± 0.10
A67(7)	0.58 ± 0.09	1.4 ± 0.15	0.72 ± 0.09	0.40 ± 0.07	3.1	0.77 ± 0.10
A68(8)	0.43 ± 0.07	1.20 ± 0.27	0.70 ± 0.09	0.64 ± 0.11	3.01	0.75 ± 0.13
A69(9)	0.11 ± 0.03	1.7 ± 0.20	0.99 ± 0.12	0.88 ± 0.13	3.7	0.91 ± 0.12
A70(10)	0.38 ± 0.06	1.1 ± 0.13	0.70 ± 0.10	0.47 ± 0.08	2.6	0.65 ± 0.09
A71(11)	0.11 ± 0.03	0.91 ± 0.11	0.37 ± 0.06	0.40 ± 0.09	1.8	0.45 ± 0.07
			^{235}U			
A61(1)	0.22 ± 0.05	0.30 ± 0.07	0.13 ± 0.04	0.10 ± 0.04	0.75	0.19 ± 0.04
A62(2)	0.11 ± 0.04	0.13 ± 0.04	0.19 ± 0.05	0.10 ± 0.03	0.53	0.13 ± 0.04
A63(3)	0.32 ± 0.06	0.53 ± 0.09	0.10 ± 0.05	0.32 ± 0.07	1.3	0.32 ± 0.07
A64(4)	1.43 ± 0.17	0.57 ± 0.08	0.38 ± 0.06	0.30 ± 0.08	2.7	0.67 ± 0.10
A65(5)	0.33 ± 0.07	0.57 ± 0.08	0.33 ± 0.07	0.30 ± 0.07	1.52	0.38 ± 0.07
A66(6)	0.18 ± 0.05	0.39 ± 0.07	0.07 ± 0.03	0.15 ± 0.05	0.80	0.20 ± 0.05
A67(7)	0.18 ± 0.05	0.24 ± 0.05	0.12 ± 0.04	0.25 ± 0.06	0.78	0.20 ± 0.05
A68(8)	0.27 ± 0.05	0.51 ± 0.19	0.12 ± 0.04	0.34 ± 0.08	1.2	0.31 ± 0.09
A69(9)	0.53 ± 0.09	0.50 ± 0.10	0.35 ± 0.07	0.47 ± 0.09	1.8	0.46 ± 0.09
A70(10)	0.12 ± 0.04	0.34 ± 0.07	0.12 ± 0.04	0.46 ± 0.02	1.0	0.26 ± 0.04
A71(11)	0.20 ± 0.05	0.31 ± 0.07	0.08 ± 0.03	0.85 ± 0.04	0.67	0.17 ± 0.05

[a]To convert from 10^{-15} $\mu Ci/cm^3$ to 10^{-11} Bq/cm^3, multiply by 3.7.
[b]See Fig. 4.2.1 (Oak Ridge Y-12 Plant).

National Emission Standard for Hazardous Air Pollutants (NESHAP) is 25 millirem to the total body and 75 millirem to the critical organ. These concentrations caused no significant dose to the population. Although ^{131}I was detected in samples from the charcoal samplers, it was not detected on real-time perimeter air monitors because the low concentrations were below the sensitivity of these monitors.

Monthly samples for atmospheric tritium are collected from two ORNL perimeter stations (A3 and A7) and one Reservation station (A8). Atmospheric tritium in the form of water vapor is removed from the air by silica gel. The silica gel is heated in a distillation flask to remove the moisture, and the distillate is counted in a liquid scintillation counter. The concentration of tritium in air is calculated by dividing total activity accumulated per month by total volume of air sampled. An annual summary of atmospheric tritium concentrations is shown in Table 4.2.14. The average tritium concentration in the atmosphere was 21 pCi/m^3 in 1986.

Weekly filter papers were also composited and analyzed quarterly for specific radionuclides. For the first quarter of 1986, composite air filters were analyzed from ORNL perimeter stations (A3, A7, and A9), Reservation stations (excluding stations A36, A40, and A41), remote stations (A51–53 and A55–57), and individual stations (A36, A40, and A41). Filters from both old and new sampling apparatus were combined for subsequent analysis. Because of the importance and visibility of the White Oak Dam station (station A34), starting with the second quarter, filters from this station were analyzed

Table 4.2.11. 1986 ^{234}U and ^{236}U in air

Station number: new (old)[b]	Concentration (10^{-15} $\mu Ci/cm^3$)[a]					
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total	Yearly av
			^{234}U			
A61(1)	7.9 ± 0.66	12 ± 0.97	1.6 ± 0.17	2.63 ± 0.27	24	6.0 ± 0.5
A62(2)	4.9 ± 0.45	4.1 ± 0.39	2.6 ± 0.24	3.43 ± 0.35	15	3.8 ± 0.3
A63(3)	15 ± 1.26	15 ± 1.16	9.8 ± 1.09	6.40 ± 0.62	46	11.6 ± 1.0
A64(4)	26 ± 2.08	18 ± 1.33	11 ± 0.81	8.67 ± 0.94	63	15.7 ± 1.2
A65(5)	11 ± 0.92	14 ± 1.07	9.02 ± 0.76	5.83 ± 0.59	39	9.8 ± 0.8
A66(6)	4.2 ± 0.37	11.1 ± 0.91	3.8 ± 0.35	2.66 ± 0.30	22	5.4 ± 0.4
A67(7)	4.92 ± 0.45	8.4 ± 0.69	3.0 ± 0.28	5.68 ± 0.58	22	5.5 ± 0.5
A68(8)	6.9 ± 0.56	11 ± 1.6	4.2 ± 0.37	6.89 ± 0.75	29	7.2 ± 0.8
A69(0)	12 ± 1.03	14 ± 1.3	8.7 ± 0.76	11.2 ± 1.12	46	11.6 ± 1.0
A70(10)	4.8 ± 0.41	11 ± 0.91	3.8 ± 0.36	4.00 ± 0.42	23	5.9 ± 0.5
A71(11)	5.7 ± 0.51	9.9 ± 0.83	1.86 ± 0.19	2.57 ± 0.330	20	5.0 ± 0.4
			^{236}U			
A61(1)	0.52 ± 0.08	0.11 ± 0.05	0.11 ± 0.03	0.09 ± 0.028	0.87	0.22 ± 0.05
A62(2)	0.10 ± 0.04	0.13 ± 0.04	0.09 ± 0.03	0.08 ± 0.029	0.41	0.10 ± 0.03
A63(3)	1.27 ± 0.15	0.37 ± 0.07	0.25 ± 0.07	0.10 ± 0.032	1.99	0.50 ± 0.08
A64(4)	1.92 ± 0.20	0.45 ± 0.07	0.28 ± 0.05	0.15 ± 0.05	2.80	0.70 ± 0.09
A65(5)	0.36 ± 0.07	0.43 ± 0.07	0.13 ± 0.04	0.22 ± 0.06	1.13	0.28 ± 0.06
A66(6)	0.09 ± 0.03	0.32 ± 0.06	0.14 ± 0.04	0.03 ± 0.02	0.59	0.15 ± 0.04
A67(7)	0.14 ± 0.04	0.25 ± 0.06	0.11 ± 0.03	0.14 ± 0.03	0.64	0.16 ± 0.04
A68(8)	0.26 ± 0.05	0.076 ± 0.13	0.11 ± 0.03	0.25 ± 0.06	0.69	0.17 ± 0.07
A69(9)	0.49 ± 0.08	0.32 ± 0.08	0.19 ± 0.05	0.16 ± 0.05	1.16	0.29 ± 0.06
A70(10)	0.19 ± 0.04	0.26 ± 0.06	0.11 ± 0.03	0.08 ± 0.03	0.65	0.16 ± 0.04
A71(11)	0.43 ± 0.07	0.14 ± 0.05	0.07 ± 0.03	0.12 ± 0.04	0.77	0.19 ± 0.05

[a]To convert from 10^{-15} $\mu Ci/cm^3$ to Bq/cm^3, multiply by 3.7.
[b]See Fig. 4.2.1 (Oak Ridge Y-12 Plant).

Table 4.2.12. 1986 long-lived gross alpha and gross beta activities in air

	Concentration (10^{-15} Ci/m^3)[a]									
	Gross alpha					Gross beta				
Location	No. of samples	Max	Min	Av	95% CC[b]	No. of samples	Max	Min	Av	95% CC[b]
ORNL stations[c]										
A3	23	<14	<11	<20	0.35	23	52	<20	<20	4.1
A7	47	<14	<10	<20	0.25	47	47	<10	<20	2.5
A9	16	<14	<10	<10	0.56	16	45	<10	<20	5.6
Network summary	86	<14	<10	<20	0.26	86	52	<10	<20	2.1
Oak Ridge Reservation stations[d]										
A38	47	<10	<9	<10	0.32	47	59	<10	<20	3.4
A23	25	<10	<9	<10	0.41	25	56	<10	<30	4.8
A31	43	<20	<9	<10	0.68	43	54	<9	<20	4.0
A33	46	<20	<9	<10	0.73	46	110	<9	<20	4.6
A34	44	<10	<9	<10	0.30	44	82	<9	<20	4.5
A36	47	<10	<9	<10	0.39	47	59	<10	<20	3.1
A40	45	<20	<9	<10	0.46	45	150	<10	<20	7.1
A41	38	<20	<10	<10	0.70	38	190	<10	<27	9.7
A42	41	<10	<9	<10	0.25	47	43	<9	<20	2.7
A43	45	<10	<10	<10	0.38	45	40	<10	<20	2.7
A44	45	<20	<9	<10	0.43	45	120	<9	<20	5.6
A45	38	<20	<9	<10	0.71	38	160	<9	<20	8.9
A46	8	<10	<10	<10	0.41	8	41	<10	<20	7.4
Network summary	518	<20	<9	<11	0.16	518	190	<9	<30	1.5
Remote stations[e]										
A51	45	<10	<10	<9.8	0	45	44	<6	<11	2.1
A52	45	<10	<10	<9.8	0	45	13	<6	<10	0.24
A53	40	<10	<10	<9.8	0	40	35	<5	<10	1.3
A55	39	<10	<10	<9.8	0	39	39	<6	<11	1.9
A56	43	<10	<6	<9.7	0.17	43	47	<7	<11	1.9
A57	48	<10	<5	<9.7	0.21	48	32	<5	<10	1.4
Network summary	260	<10	<5	<10	0.048	260	47	<5	<11	0.65
Overall summary	865	<20	<5	<10	0.10	865	190	<5	<20	1.0

[a] 1 Ci = 3.7×10^{10} Bq.
[b] 95% confidence coefficient about the average of more than two samples.
[c] See Fig. 4.2.2.
[d] See Fig. 4.2.4.
[e] See Fig. 4.2.5.

Table 4.2.13. 1986 iodine-131 in air

Location	No. of samples	Concentration (10^{-15} Ci/m³)[a] Max	Min	Av	95% CC[b]
ORNL perimeter stations[c]					
A3	23	3.8	−1.4	−0.034	0.50
A7	50	120	−1.7	6.2	5.6
A9	16	3.8	−1.7	0.90	0.77
Network summary	89	120	−1.7	3.6	3.2
Oak Ridge Reservation stations[d]					
A8	50	310	−1.6	10	13
A23	25	3.8	−1.8	0.55	0.56
A31	45	57	−1.5	3.2	2.7
A33	49	34	−2.2	2.1	2.0
A34	46	60	−1.6	3.0	3.0
A36	50	62	−5.0	3.5	2.8
A40	48	53	−1.9	3.5	3.2
A41	41	99	−3.0	6.1	6.5
A42	50	43	−1.1	2.9	2.0
A43	48	70	−2.4	2.7	3.1
A44	48	210	−1.3	8.4	9.2
A45	41	60	−1.9	4.0	3.9
A46	8	1.0	−0.85	0.31	0.52
Network summary	549	310	−5.0	4.3	1.7
Overall summary	638	310	−5.0	4.2	1.5

[a] 1 Ci = 3.7 × 10^{10} Bq.
[b] 95% confidence coefficient about the average of more than two samples.
[c] See Fig. 4.2.2.
[d] See Fig. 4.2.4.

Table 4.2.14. 1986 tritium activity in air

Location[a]	No. of samples	Concentration (pCi/m³)[b] Max	Min	Av	95% CC[c]
A3	12	92	5.4	18	14
A7	12	60	0.77	33	11
A8	12	41	0	11	7.8
Overall summary	36	92	0	21	6.9

[a] See Fig. 4.2.2.
[b] 1 Ci = 3.7 × 10^{10} Bq.
[c] 95% confidence coefficient about the average of more than two samples.

separately. As a result of special interest in stations A45 (Oak Ridge Y-12 Plant west) and A46 (Scarboro), filters from station A45 were composited and analyzed separately starting with the third quarter, and filters from station A46 were composited and analyzed separately starting with the fourth quarter. All other samples were composited the same way as in the first quarter. The summaries of specific radionuclide analyses of composited air filters for 1986 for ORNL perimeter stations are given in Table 4.2.15.

Summaries of specific radionuclide analyses of composited air filters from ORR stations for 1986 are given in Tables 4.2.16 through 4.2.22.

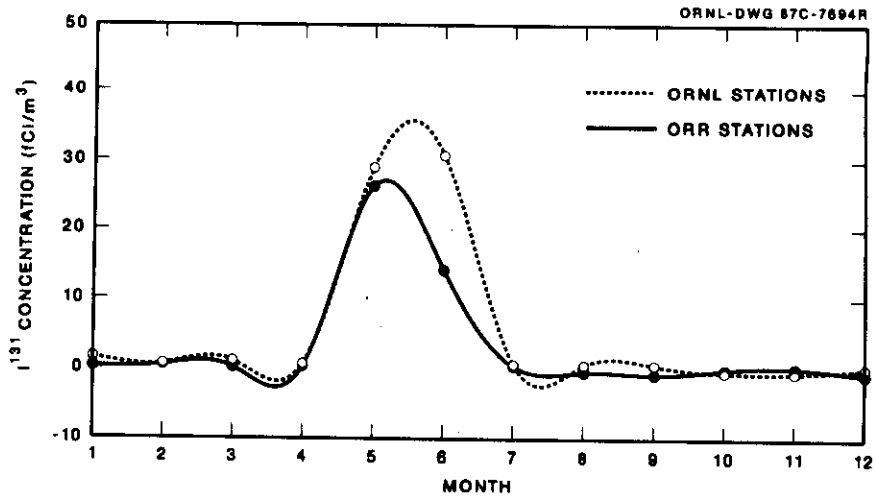

Fig. 4.2.6. 1986 concentration of ^{131}I in air at ORNL and ORR monitoring stations.

Table 4.2.15. 1986 continuous air monitoring data for specific radionuclides (composite samples) at ORNL perimeter stations[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3)			
		Max	Min	Av	95% CC[d]
^{134}Cs	1	21	21	21	
^{137}Cs	4	41	<0.07	<11	20
^{40}K	1	5.6	5.6	5.6	
^{238}Pu	4	0.0017	<0.0007	<0.002	0.0004
^{239}Pu	4	0.007	<0.001	<0.003	0.0027
^{103}Ru	1	32	32	32	
^{106}Ru	1	16	16	16	
^{90}Sr	4	1.1	0.044	0.66	0.45
^{228}Th	4	0.13	0.0039	0.061	0.052
^{230}Th	4	0.13	0.0061	0.052	0.054
^{232}Th	4	0.14	0.006	0.056	0.062
^{234}U	4	0.53	0.06	0.3	0.2
^{235}U	4	0.05	0.0042	0.028	0.021
^{238}U	4	0.21	0.018	0.1	0.088

[a]See Fig. 4.2.2.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.16. 1986 continuous air monitoring data for specific radionuclides (composite samples) at Oak Ridge Reservation stations[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3)			
		Max	Min	Av	95% CC[d]
^{134}Cs	1	1.4	1.4	1.4	
^{137}Cs	4	2.9	<0.05	<0.8	1.4
^{40}K	1	2.3	2.3	2.3	
^{238}Pu	4	0.00053	<0.00003	<0.0003	0.00024
^{239}Pu	4	0.0022	<0.0005	<0.002	0.00092
^{103}Ru	1	2.1	2.1	2.1	
^{106}Ru	1	1.2	1.2	1.2	
^{90}Sr	4	0.13	0.028	0.068	0.044
^{228}Th	4	0.03	0.0022	0.017	0.012
^{230}Th	4	0.028	0.0019	0.013	0.011
^{232}Th	4	0.034	0.0019	0.015	0.014
^{234}U	4	0.85	0.035	0.51	0.36
^{235}U	4	0.063	0.0032	0.039	0.026
^{238}U	4	0.17	0.0074	0.1	0.069

[a]Stations A8, A23, A31, A33, A42, A43, and A44, Fig. 4.2.4.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.17. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A34[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3) Max	Min	Av	95% CC[d]
^{137}Cs	3	2.6	<0.2	<1.0	1.6
^{40}K	1	5.8	5.8	5.8	
^{238}Pu	3	<0.011	<0.002	<0.007	0.0055
^{239}Pu	3	0.011	<0.002	<0.006	0.006
^{90}Sr	3	0.42	<0.2	<0.3	0.13
^{228}Th	3	0.074	0.006	0.032	0.042
^{230}Th	3	0.018	0.006	0.012	0.007
^{232}Th	3	0.015	<0.004	<0.01	0.0067
^{234}U	3	0.21	0.092	0.15	0.066
^{235}U	3	0.026	0.0041	0.013	0.013
^{238}U	3	0.058	0.037	0.045	0.014

[a]White Oak Dam (see Fig. 4.2.4).
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the three quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.18. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A36[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3) Max	Min	Av	95% CC[d]
^{134}Cs	1	1.6	1.6	1.6	
^{137}Cs	4	2.3	<0.01	<0.7	1.1
^{40}K	1	4.9	4.9	4.9	
^{238}Pu	4	0.006	<0.0003	<0.003	0.0026
^{239}Pu	4	0.0032	<0.002	<0.003	0.00072
^{103}Ru	1	1.6	1.6	1.6	
^{90}Sr	4	0.34	0.052	0.18	0.12
^{228}Th	4	0.097	0.0078	0.05	0.037
^{230}Th	4	0.041	0.013	0.029	0.013
^{232}Th	4	0.045	0.009	0.027	0.019
^{234}U	4	0.48	0.027	0.23	0.19
^{235}U	4	0.032	0.0014	0.02	0.014
^{238}U	4	0.11	0.0058	0.066	0.046

[a]West Turnpike (see Fig. 4.2.4).
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.19. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A40[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3) Max	Min	Av	95% CC[d]
^{134}Cs	1	2.5	2.5	2.5	
^{137}Cs	4	5.2	<0.2	1.5	2.5
^{238}Pu	4	0.0037	<0.0004	<0.0021	0.0015
^{239}Pu	4	0.0037	<0.003	<0.003	0.00063
^{103}Ru	1	5.2	5.2	5.2	
^{106}Ru	1	2.1	2.1	2.1	
^{90}Sr	4	0.32	0.17	0.25	0.064
^{228}Th	4	0.1	0.0064	0.06	0.043
^{230}Th	4	0.1	0.013	0.044	0.041
^{232}Th	4	0.11	0.0035	0.04	0.049
^{234}U	4	2.3	0.11	1.0	0.9
^{235}U	4	0.14	0.018	0.071	0.052
^{238}U	4	0.29	0.018	0.14	0.11

[a]See Fig. 4.2.4.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.20. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A41[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3) Max	Min	Av	95% CC[d]
^{134}Cs	1	3.0	3.0	3.0	
^{137}Cs	4	7.5	<0.2	<2.0	3.6
^{238}Pu	4	0.0072	<0.0004	<0.0034	0.0028
^{239}Pu	4	0.0073	<0.0005	<0.0055	0.0034
^{103}Ru	1	4.8	4.8	4.8	
^{106}Ru	1	3.2	3.2	3.2	
^{90}Sr	4	1.1	0.074	0.55	0.41
^{228}Th	4	0.11	0.010	0.072	0.043
^{230}Th	4	0.087	<0.007	<0.05	0.038
^{232}Th	4	0.084	0.0043	0.039	0.04
^{234}U	4	0.62	0.023	0.38	0.27
^{235}U	4	0.079	0.0015	0.039	0.034
^{238}U	4	0.24	0.012	0.11	0.095

[a]See Fig. 4.2.4.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.21. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A45[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3)			
		Max	Min	Av	95% CC[d]
^{137}Cs	2	0.59	0.25	0.42	0.34
^{40}K	1	8.3	8.3	8.3	
^{238}Pu	2	0.012	0.0042	0.008	0.0077
^{239}Pu	2	0.012	0.0042	0.008	0.0077
^{90}Sr	2	1.1	0.2	0.63	0.86
^{228}Th	2	0.13	0.036	0.082	0.093
^{230}Th	2	0.041	0.025	0.033	0.017
^{232}Th	2	0.017	0.012	0.014	0.0048
^{234}U	2	2.0	0.4	1.2	1.6
^{235}U	2	0.16	0.032	0.095	0.13
^{238}U	2	0.27	0.17	0.22	0.10

[a]See Fig. 4.2.4.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the two quarterly composites.
[c]1 Ci = 3.7 × 10^{10} Bq.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.22. 1986 continuous air monitoring data for specific radionuclides (composite samples) at station A46[a]

Radionuclide	Number of samples	Concentration[b] (10^{-15} Ci/m^3)	
		Max	Min
^{137}Cs	1	0.29	0.29
^{40}K	1	0.41	0.41
^{238}Pu	1	0.0041	0.0041
^{239}Pu	1	0.0041	0.0041
^{90}Sr	1	0.23	0.23
^{228}Th	1	0.11	0.11
^{230}Th	1	0.041	0.041
^{232}Th	1	0.0082	0.0082
^{234}U	1	0.57	0.57
^{235}U	1	0.045	0.045
^{238}U	1	0.078	0.078

[a]Scarboro (see Fig. 4.2.4); only one sample.
[b]1 Ci = 3.7 × 10^{10} Bq.

In the second quarter, during the Chernobyl worldwide deposition, three relatively short-lived radionuclides (^{134}Cs, ^{103}Ru, and ^{106}Ru) along with an elevated level of ^{137}Cs at all sampling stations were detected. This elevated ^{137}Cs level caused a slightly higher increase in the maximum and average concentrations of ^{137}Cs in 1986. In spite of the Chernobyl incident, no significant differences were found in atmospheric concentrations between 1985 and 1986 for ^{90}Sr, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{238}U, and ^{239}Pu (ESR, 1986). In the fourth quarter of 1986, ^{40}K was detected.

When compared with the East Tennessee background level (remote stations in Table 4.2.23), the following conclusions were drawn:

(1) At all locations, average concentrations for ^{137}Cs, ^{90}Sr, ^{228}Th, ^{230}Th, ^{232}Th, ^{238}Pu, and ^{239}Pu remained comparable.

(2) At stations A34, A36, A40, and A41, average concentrations of ^{234}U and ^{235}U were slightly elevated.

(3) At station A45, the average concentration of ^{238}U was slightly elevated.

(4) Station A46 was installed in the fourth quarter of 1986. Only one analysis was performed. Based on the limited information, it appears that average concentrations at this station were comparable to those at other stations.

Lead-containing material is introduced into the environment from a variety of sources (Boggess, 1978). Natural sources seem to contribute only insignificantly to current concentrations of lead in the atmosphere (NAS, 1972). Natural concentrations have been estimated at ~0.0005 $\mu g/m^3$. The national ambient air quality standard for lead is 1.5 $\mu g/m^3$ for a three-month average. Airborne concentrations of lead around ORGDP were determined during 1986 and are reported in Table 4.2.24. Maximum concentrations of lead at these locations range from a low of <0.001 to a high of 0.899 $\mu g/m^3$. The maximum percentage of the lead standard was 31. The sources of this lead are unknown. The uranium concentrations

Table 4.2.23. 1986 continuous air monitoring data for specific radionuclides (composite samples) at Oak Ridge remote stations[a]

Radionuclide	Number of samples[b]	Concentration[c] (10^{-15} Ci/m^3)			
		Max	Min	Av	95% CC[d]
^{134}Cs	1	0.5	0.5	0.5	
^{137}Cs	4	1.1	<0.022	<0.31	0.53
^{40}K	1	7.0	7.0	7.0	
^{238}Pu	4	0.00028	<0.00003	<0.0002	0.00011
^{239}Pu	4	0.0005	<0.00003	<0.0002	0.0002
^{103}Ru	1	0.69	0.69	0.69	
^{106}Ru	1	0.5	0.5	0.5	
^{90}Sr	4	0.18	0.027	0.075	0.07
^{228}Th	4	0.053	0.023	0.031	0.015
^{230}Th	4	0.039	0.020	0.026	0.0092
^{232}Th	4	0.048	0.021	0.03	0.012
^{234}U	4	0.059	0.0026	0.033	0.023
^{235}U	4	0.0026	0.00027	0.0014	0.0011
^{238}U	4	0.045	0.0020	0.025	0.018

[a]See Fig. 4.2.5.
[c]1 Ci = 3.7 × 10^{10} Bq.
[b]A value of one indicates a gamma-emitting radionuclide that was detected in one of the four quarterly composites.
[d]95% confidence coefficient about the average of more than two samples.

Table 4.2.24. 1986 lead in air

New (old)[a] station ID	Concentration[b] ($\mu g/m^3$) A86 (SP1)	A87 (SP2)	A88 (SP3)	A89 (SP4)	A90 (SP5)	A91 (SP6)	A92 (SP7)	A93 (SP8)	A94 (SP9)	A96 (SP11)
1st Quarter										
Number of samples	1	1	1	1	1	1	NS[c]	NS	1	NS
Concentration	0.408	0.292	0.899	0.409	0.297	0.195	ND[d]	ND	0.421	ND
2nd Quarter										
Number of samples	2	1	2	2	2	2	2	2	2	1
Max	0.072	0.161	0.141	0.090	0.028	0.191	0.191	0.371	0.103	0.020
Min	<0.001	0.161	<0.001	<0.001	0.007	0.060	0.005	0.324	0.006	0.020
3rd Quarter										
Number of samples	1	NS	1	1	1	1	1	1	1	1
Concentration	0.026	ND	0.051	0.033	0.042	0.039	0.026	0.024	0.036	0.069
4th Quarter										
Number of samples[e]	NS	NS	1	NS	NS	1	1	1	1	1
Concentration	ND	ND	0.118	ND	ND	0.068	0.047	0.042	0.050	0.044
Annual										
Number of samples	4	2	5	4	4	5	4	4	5	3
Max	0.408	0.292	0.899	0.409	0.297	0.195	0.191	0.371	0.421	0.069
Min	<0.001	0.161	<0.001	<0.001	0.007	0.006	0.005	0.024	0.006	0.020
Geometric mean	<0.127	NA[f]	<0.242	<0.133	0.093	0.100	0.067	0.190	0.123	0.044
95% CC	0.302	NA	0.461	0.299	0.217	0.109	0.134	0.291	0.211	0.061

[a] See Fig. 4.2.3 (ORGDP).
[b] Standard = 1.5 $\mu g/m^3$ per quarter.
[c] NS = no sample.
[d] ND = no data.
[e] During fourth quarter, a sample was taken from A97; the concentration was 0.067 $\mu g/m^3$.
[f] NA = not applicable.

around ORGDP are given in Table 4.2.25. Chromium concentrations around ORGDP were all <0.014 $\mu g/m^3$, with about 65 samples being taken each quarter.

Table 4.2.25. 1986 uranium concentrations in air

New (old) station ID	Number of samples	Concentrations ($\mu g/m^3$)		
		Max	Min	Av
		First quarter		
A81 (F1)	12	ND	ND	ND
A82 (F2)	10	ND	ND	ND
A83 (F4)	9	ND	ND	ND
A84 (F5)	12	ND	ND	ND
A85 (F6)	11	ND	ND	ND
		Second quarter		
A81 (F1)	13	0.005	<0.001	<0.002
A82 (F2)	13	0.002	<0.001	<0.001
A83 (F4)	13	0.004	<0.001	<0.002
A84 (F5)	13	0.002	<0.001	<0.001
A85 (F6)	13	0.002	<0.001	<0.001
		Third quarter		
A81 (F1)	12	0.016	<0.001	<0.004
A82 (F2)	12	0.011	<0.001	<0.005
A83 (F4)	13	0.005	<0.001	<0.002
A84 (F5)	13	0.004	<0.001	<0.002
A85 (F6)	13	0.006	<0.001	<0.003
		Fourth quarter		
A81 (F1)	11	0.006	<0.001	<0.002
A82 (F2)	11	0.004	<0.001	<0.002
A83 (F4)	5	<0.001	<0.001	<0.001
A84 (F5)	11	0.004	<0.001	<0.002
A85 (F6)	12	0.020	<0.001	<0.010

ND = no data.

4.3 METEOROLOGICAL MEASUREMENTS

Computer-aided atmospheric dispersion modeling is used to determine the effects of Oak Ridge installations' present and future operations with regard to the transport of air contaminants. Air pollution modeling is an accurate way of predicting impacts from emissions sources if meteorological and emission data used in the model are accurate.

Meteorological data are provided through a network of observation towers at the Oak Ridge Y-12 Plant. The network consists of eight towers [one at ORGDP, three at ORNL, two at Oak Ridge Y-12 Plant, one at Walker Branch watershed, and one at the Clinch River Breeder Reactor Project (CRBRP) site]. Although meteorological tower 7 is equipped for research, real-time data could be used as needed but are not useful for routine plant release calculations. Because the CRBRP tower data collection system is inoperative, 1986 data are not available. The locations of these towers on the ORR are shown in Fig. 4.3.1. The valid data points for all stability classes at each measurement height from meteorological towers 1 through 6 are given in Tables 4.3.1 through 4.3.13.

Several problems with Tower 4 resulted in the large percentage of invalid data (more than 60%; see Tables 4.3.8 and 4.3.9). These problems were solved during the last quarter of 1986; subsequently there has been more than 95% "good" data.

Examination of annual wind roses reveals that prevailing winds are almost equally split between winds from the SW to WSW sector, and winds from the NE to ENE sector. The winds are so strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. These ridges and valleys are oriented along a WSW-ENE line (with respect to true north), causing winds at the lower layers of the atmosphere to flow along the valleys without crossing the ridges. The alignment of winds is not so pronounced at Tower 1, which is located in a relatively open area where the ridges are not as high or structured. Another wind rose feature clearly observed is that the wind speed increases with height (tower level) at each of the towers. On the average, wind speed can be expected to increase steadily from ground level to 100 m.

ORNL-DWG 87-7052

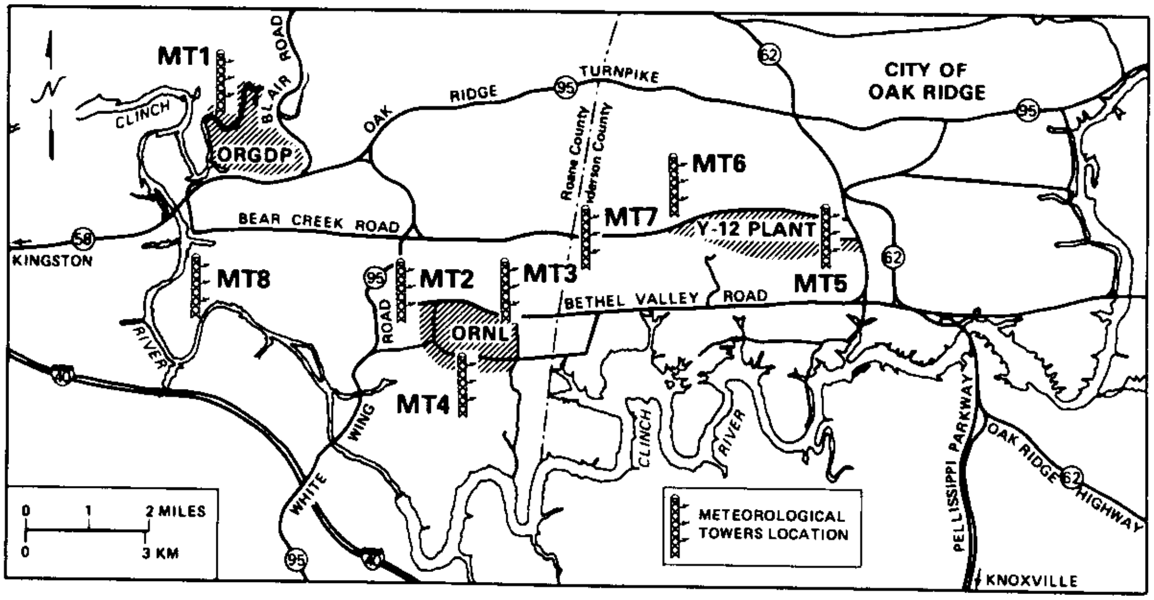

Fig. 4.3.1. Locations of meteorological towers on the Oak Ridge Reservation.

Table 4.3.1. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 1[a,b]

Direction	Wind speed (mph)[c]						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	234	65	45	0	1	0	345
NNE	268	83	18	0	0	0	369
NE	322	169	37	0	0	0	528
ENE	265	197	36	0	1	0	499
E	115	57	5	0	0	0	177
ESE	83	29	2	0	0	0	114
SE	91	20	0	0	0	0	119
SSE	92	29	4	2	0	0	127
S	131	57	32	12	5	1	238
SSW	258	188	140	62	7	0	655
SW	357	270	199	67	11	4	908
WSW	319	176	99	21	11	4	630
W	240	96	54	20	2	0	412
WNW	162	72	111	44	1	0	390
NW	163	55	170	112	14	0	514
NNW	217	85	105	31	4	1	443
Total	3317	1656	1057	371	57	10	6468

[a]See Fig. 4.3.1.

[b]Percentages of questionable and invalid data are not available for 1986.

[c]Values are in mph because instruments are calibrated to mph.

Table 4.3.2. Number of valid data points for each direction and wind speed at 60-m level of Meteorological Tower 1[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	146	126	109	25	0	0	406
NNE	140	105	58	2	0	0	305
NE	191	200	155	35	3	0	584
ENE	172	249	222	55	13	0	711
E	113	75	16	2	0	0	206
ESE	68	41	10	0	0	0	119
SE	49	33	9	0	0	0	91
SSE	54	44	16	1	1	0	116
S	77	88	40	33	11	0	249
SSW	123	165	181	71	35	1	576
SW	138	292	276	92	35	0	833
WSW	150	220	169	48	13	0	600
W	117	125	96	38	9	0	385
WNW	134	117	106	82	21	0	460
NW	105	95	120	145	50	1	516
NNW	101	77	81	45	7	0	311
Total	1878	2052	1664	674	198	2	6468

[a]See Fig. 4.3.1.

[b]Percentage of questionable and invalid data are not available for 1986.

Table 4.3.3. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 2[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	357	61	13	0	0	0	431
NNE	366	39	2	0	0	0	407
NE	406	121	6	0	0	0	533
ENE	319	242	57	0	0	0	618
E	100	170	53	0	0	0	323
ESE	104	62	3	0	0	0	169
SE	54	40	0	0	0	0	94
SSE	48	28	3	0	0	0	79
S	68	52	13	4	0	0	137
SSW	108	111	55	2	0	0	276
SW	243	359	240	13	0	0	855
WSW	497	375	119	2	0	0	993
W	511	210	158	1	0	0	880
WNW	397	102	103	2	0	0	604
NW	376	53	7	0	0	0	436
NNW	363	69	10	0	0	0	442
Total	4317	2094	842	24	0	0	7277

[a]Number of I (invalid) data = 470
Numer of Q (questionable) data = 270
Number of "good" data = 7277
Total number of data = 8014
Percentage of I data = 5.9
Percentage of Q data = 3.4
Percentage of "good" data = 90.8
[b]See Fig. 4.3.1.

Table 4.3.4. Number of valid data points for each direction and wind speed at 30-m level of Meteorological Tower 2[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	117	81	27	0	0	0	225
NNE	172	101	26	0	0	0	299
NE	504	196	126	2	0	0	828
ENE	811	395	212	10	0	0	1428
E	196	88	38	0	0	0	322
ESE	131	43	3	0	0	0	177
SE	66	28	1	0	0	0	95
SSE	64	24	5	0	0	0	93
S	67	52	13	8	0	0	140
SSW	130	166	83	14	1	0	394
SW	332	436	333	76	5	0	1182
WSW	334	398	181	14	0	0	927
W	153	174	183	16	0	0	526
WNW	101	127	160	25	1	0	414
NW	88	66	23	0	0	0	177
NNW	80	74	23	1	0	0	178
Total	3346	2449	1437	166	7	0	7405

[a]Number of I (invalid) data = 342
Numer of Q (questionable) data = 267
Number of "good" data = 7405
Total number of data = 8014
Percentage of I data = 4.3
Percentage of Q data = 3.3
Percentage of "good" data = 92.4
[b]See Fig. 4.3.1.

Table 4.3.5. Number of valid data points for each direction and wind speed at 100-m level of Meteorological Tower 2[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	61	93	84	18	0	0	256
NNE	73	136	111	39	0	0	359
NE	88	236	324	159	5	0	812
ENE	110	383	376	66	9	0	944
E	105	168	29	0	0	0	302
ESE	70	65	10	0	0	0	145
SE	39	51	9	0	0	0	99
SSE	56	58	19	2	0	0	135
S	57	101	48	16	13	0	235
SSW	54	165	216	77	16	1	529
SW	66	273	499	208	69	1	1116
WSW	51	251	384	101	12	0	799
W	52	189	238	92	8	0	579
WNW	55	112	214	163	32	1	577
NW	42	76	110	35	1	0	264
NNW	48	79	84	19	0	0	230
Total	1027	2436	2755	995	165	3	7381

[a]Number of I (invalid) data = 364
Numer of Q (questionable) data = 269
Number of "good" data = 7381
Total number of data = 8014
Percentage of I data = 4.5
Percentage of Q data = 3.4
Percentage of "good" data = 92.1

[b]See Fig. 4.3.1.

Table 4.3.6. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 3[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	181	19	0	0	0	0	200
NNE	260	22	0	0	0	0	282
NE	513	95	2	0	0	0	610
ENE	613	126	0	0	0	0	739
E	258	60	0	0	0	0	318
ESE	113	20	0	0	0	0	133
SE	56	10	0	0	0	0	66
SSE	82	7	0	0	0	0	89
S	96	13	0	0	0	0	109
SSW	264	94	4	0	0	0	362
SW	660	162	3	0	0	0	825
WSW	933	161	0	0	0	0	1094
W	529	114	3	0	0	0	646
WNW	175	36	1	0	0	0	212
NW	167	18	0	0	0	0	185
NNW	141	25	0	0	0	0	166
Total	5041	982	13	0	0	0	6038

[a]Number of I (invalid) data = 1715
Numer of Q (questionable) data = 172
Number of "good" data = 6036
Total number of data = 7918
Percentage of I data = 21.7
Percentage of Q data = 2.2
Percentage of "good" data = 76.2

[b]See Fig. 4.3.1.

Table 4.3.7. Number of valid data points for each direction and wind speed at 30-m level of Meteorological Tower 3[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	51	69	14	0	0	0	134
NNE	80	87	29	0	0	0	196
NE	153	189	119	0	0	0	461
ENE	263	527	173	0	0	0	963
E	170	190	40	0	0	0	400
ESE	73	55	8	0	0	0	136
SE	42	32	9	0	0	0	83
SSE	52	44	11	0	0	0	107
S	55	48	15	0	0	0	118
SSW	94	147	146	2	1	0	390
SW	135	410	301	6	0	0	852
WSW	324	767	168	2	0	0	1261
W	208	248	143	0	0	0	599
WNW	82	74	100	2	0	0	258
NW	47	50	37	1	0	0	135
NNW	36	63	27	0	0	0	126
Total	1865	3000	1340	13	1	0	6219

[a]Number of I (invalid) data = 1535
Numer of Q (questionable) data = 170
Number of "good" data = 6219
Total number of data = 7918
Percentage of I data = 19.4
Percentage of Q data = 2.1
Percentage of "good" data = 78.5

[b]See Fig. 4.3.1.

Table 4.3.8. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 4[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	65	25	2	0	0	0	92
NNE	200	35	6	0	0	0	241
NE	572	182	26	0	0	0	780
ENE	261	125	16	0	0	0	402
E	90	35	3	0	0	0	128
ESE	61	12	0	0	0	0	73
SE	54	14	3	0	0	0	71
SSE	59	8	0	0	0	0	67
S	52	9	0	0	0	0	61
SSW	77	49	9	0	0	0	135
SW	73	140	24	0	0	0	237
WSW	57	82	21	0	0	0	160
W	33	49	11	0	0	0	93
WNW	28	18	6	0	0	0	52
NW	29	15	6	0	0	0	50
NNW	48	15	4	0	0	0	67
Total	1759	813	137	0	0	0	2709

[a]Number of I (invalid) data = 5227
Numer of Q (questionable) data = 159
Number of "good" data = 2709
Total number of data = 8077
Percentage of I data = 64.7
Percentage of Q data = 2.0
Percentage of "good" data = 33.5

[b]See Fig. 4.3.1.

Table 4.3.9. Number of valid data points for each direction and wind speed at 30-m level of Meteorological Tower 4[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	24	20	6	0	0	0	50
NNE	71	45	11	0	0	0	127
NE	374	374	99	8	0	0	855
ENE	236	150	48	1	0	0	435
E	94	38	5	0	0	0	137
ESE	42	33	1	0	0	0	76
SE	32	16	2	0	0	0	50
SSE	29	8	2	0	0	0	39
S	35	11	5	0	0	0	51
SSW	61	38	27	0	0	0	126
SW	91	176	75	0	0	0	342
WSW	69	92	45	3	0	0	209
W	30	52	35	2	0	0	119
WNW	26	28	13	1	0	0	68
NW	15	11	5	0	0	0	31
NNW	28	14	10	0	0	0	52
Total	1257	1106	389	15	0	0	2767

[a]Number of I (invalid) data = 5175
Numer of Q (questionable) data = 152
Number of "good" data = 2767
Total number of data = 8077
Percentage of I data = 64.1
Percentage of Q data = 1.9
Percentage of "good" data = 34.3

[b]See Fig. 4.3.1.

Table 4.3.10. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 5[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	254	38	1	0	0	0	293
NNE	328	45	1	0	0	0	374
NE	548	213	82	0	0	0	843
ENE	803	246	173	1	0	0	1223
E	415	186	43	0	0	0	644
ESE	158	53	0	0	0	0	211
SE	104	22	2	0	0	0	128
SSE	103	12	0	0	0	0	115
S	76	31	1	0	0	0	108
SSW	114	101	13	0	0	0	228
SW	98	230	129	3	0	0	460
WSW	93	201	264	28	0	0	586
W	159	203	101	1	0	0	464
WNW	147	52	7	0	0	0	206
NW	102	19	0	0	0	0	121
NNW	193	25	2	0	0	0	220
Total	3695	1677	819	33	0	0	6224

[a]Number of I (invalid data) = 122
Number of Q (questionable) data = 0
Number of 999 data = 0
Number of "good" data = 6224
Total number of data = 6346
Percentage of I data = 1.9
Percentage of Q data = 0.0
Percentage of 999 data = 0.0
Percentage of "good" data = 98.1

[b]See Fig. 4.3.1.

Table 4.3.11. Number of valid data points for each direction and wind speed at 30-m level of Meteorological Tower 5[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	249	37	9	0	0	0	295
NNE	250	81	5	0	0	0	336
NE	288	229	175	9	0	0	701
ENE	417	276	236	19	0	0	948
E	473	197	56	0	0	0	726
ESE	182	66	9	0	0	0	257
SE	99	36	4	0	0	0	139
SSE	72	25	0	1	0	0	98
S	84	39	1	0	0	0	124
SSW	96	112	41	0	0	0	249
SW	79	227	245	48	0	0	599
WSW	92	169	265	62	4	0	592
W	109	177	152	16	0	0	454
WNW	95	96	36	3	0	0	230
NW	132	36	9	0	0	0	177
NNW	223	48	28	0	0	0	299
Total	2940	1851	1271	158	4	0	6224

[a]Number of I (invalid data) = 122
Number of Q (questionable) data = 0
Number of 999 data = 0
Number of "good" data = 6224
Total number of data = 6346
Percentage of I data = 1.9
Percentage of Q data = 0.0
Percentage of 999 data = 0.0
Percentage of "good" data = 98.1

[b]See Fig. 4.3.1.

Table 4.3.12. Number of valid data points for each direction and wind speed at 100-m level of Meteorological Tower 5[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	31	78	98	17	0	0	224
NNE	30	103	136	21	0	0	290
NE	38	176	390	221	19	0	844
ENE	43	247	427	123	11	0	851
E	56	160	96	9	0	0	321
ESE	42	88	29	2	0	0	161
SE	50	73	16	1	0	0	140
SSE	41	47	12	2	0	0	102
S	46	77	21	0	0	0	144
SSW	39	79	70	16	0	0	204
SW	46	148	254	129	23	0	600
WSW	40	230	482	207	47	0	1006
W	46	170	326	100	19	0	661
WNW	45	94	115	66	9	0	329
NW	45	67	50	20	3	0	185
NNW	34	58	36	30	4	0	162
Total	672	1895	2558	964	135	0	6224

[a]Number of I (invalid data) = 122
Number of Q (questionable) data = 0
Number of 999 data = 0
Number of "good" data = 6224
Total number of data = 6346
Percentage of I data = 1.9
Percentage of Q data = 0.0
Percentage of 999 data = 0.0
Percentage of "good" data = 98.1

[b]See Fig. 4.3.1.

Table 4.3.13. Number of valid data points for each direction and wind speed at 10-m level of Meteorological Tower 6[a,b]

Direction	Wind speed (mph)						
	0–3	4–6	7–11	12–16	17–25	>25	Total
N	147	63	0	0	0	0	210
NNE	158	176	23	0	0	0	357
NE	265	423	259	5	0	0	952
ENE	264	290	217	12	0	0	783
E	131	107	35	2	0	0	275
ESE	102	46	15	0	0	0	163
SE	55	33	8	0	0	0	96
SSE	71	27	6	0	0	0	104
S	111	44	18	0	0	0	173
SSW	138	125	74	6	0	0	343
SW	275	419	248	6	0	0	948
WSW	232	314	120	4	0	0	670
W	222	269	66	0	0	0	557
WNW	133	95	7	0	0	0	235
NW	110	59	0	0	0	0	169
NNW	120	31	2	0	0	0	153
Total	2534	2521	1098	35	0	0	6188

[a]Number of I (invalid data) = 152
Number of Q (questionable) data = 0
Number of 999 data = 0
Number of "good" data = 6188
Total number of data = 6340
Percentage of I data = 2.4
Percentage of Q data = 0.0
Percentage of 999 data = 0.0
Percentage of "good" data = 97.6

[b]See Fig. 4.3.1.

5. WATERBORNE DISCHARGES AND SURFACE WATER MONITORING

5.1 WATERBORNE DISCHARGES

In 1899 the United States Congress passed the River and Harbor Act, which mandated that the U.S. Army Corps of Engineers preside as the regulatory body over U.S. navigable waters. A 1975 Federal District decision further expanded the Corps' regulatory power by ordering it to regulate all U.S. waters, as mandated in the Clean Water Act (CWA). The CWA amendments of 1977 expanded the Corps' regulatory power to include the discharge of dredged or fill material into U.S. waters. Today, it is the Corps' responsibility to restore and maintain the physical, chemical, and biological integrity of the nation's waters. To carry out this charge, the Corps has developed a permitting program requiring that all work performed within U.S. waters be authorized. In response, each DOE Oak Ridge installation has a Spill Prevention Control, Countermeasures, and Contingency (SPCC&C) Plan.

5.1.1 ORR Raw and Treated Water Supply

ORR facilities receive water from the DOE treatment plant, the ORGDP treatment plant, and raw water pump stations. Periodic low volume rates are taken from Melton Hill Lake and groundwater wells.

The DOE treatment plant has the capacity to treat 106 million liters of raw water a day, but currently treats only 58.7 million liters. The inlet is located at the Clinch River kilometer (CRK) 66.8 and is operated by Rust Engineering for DOE. The DOE plant supplies treated water to the Oak Ridge Y-12 Plant including Rust operations, ORNL, the city of Oak Ridge, the Industrial Park off Bear Creek Road, and the Scarboro Facility operated by ORAU. About 43% of the treated water at the DOE plant is used by Y-12, 28% is used by ORNL, and 29% by Oak Ridge. Of the Oak Ridge usage, 98.7% is used by the city of Oak Ridge (17.4 million liters) per day, 0.3% by the Industrial Park (0.06 million liters) per day, and 1% by the Scarboro facility (0.16 million liters)per day.

The ORGDP treatment plant has a capacity of 30.28 million liters per day (with pumping capacity limited to 15.1 million liters per day). The plant currently treats 8 million liters per day. It is located on CRK 23.3. Treated water is supplied to ORGDP.

Raw water is pumped from CRK 66.8 to the Oak Ridge Y-12 Plant and from CRK 18.5 to ORGDP. The Oak Ridge Y-12 Plant uses approximately 9.1 million liters per day and ORGDP uses 2.3 million liters per day. Well water was used for aquatic experiments in the Environmental Sciences Division from 1972–1983 at a rate of 378–757 liters per minute. Future' uses for the aquatic lab are expected to be 946 liters per minute.

The Clark Center Recreation Area uses water from Melton Hill Lake. The recreation center has a small package treatment unit to filter the water for sanitary purposes. Treated water is available to the facilities from the middle of April through the end of October; usage averages 151 liters per day. Water from the drinking fountains is discharged back to Melton Hill Lake. The sanitary sewage is collected in a holding tank whose contents are collected by a private contractor and hauled to a sewage treatment plant selected by the contractor.

5.1.2 ORR Discharges

Treated and raw water is discharged either directly or indirectly to the Clinch River through

NPDES permitted point source outfalls. These discharges total 52.2 million liters per day. This includes 10.6 million liters per day from ORNL to White Oak Creek, 29.5 million liters per day from the Oak Ridge Y-12 Plant to East Fork Poplar Creek and Rogers Quarry, 2.3 million liters per day from the Oak Ridge Y-12 Plant to the Oak Ridge sewage treatment plant, and 9.8 million liters per day from ORGDP to the Clinch River. The Energy Systems facilities on the ORR discharges include cooling water, process water, sanitary water, steam plant wastewater, and leakages. Table 5.1.1 shows discharges of radionuclides in 1986.

5.1.3 Oak Ridge Y-12 Plant Water Use (Including ORNL On-Site)

The Oak Ridge Y-12 Plant has separate piping systems for raw and treated water. Raw water, used for ash sluicing at the steam plant, is routed to the Oak Ridge Y-12 Plant by two lines, one from the booster station and one from the filtration plant. The average raw water usage at the Oak Ridge Y-12 Plant is approximately 9 million liters per day.

Treated water is routed from the DOE filtration plant to the Oak Ridge Y-12 Plant by three lines. The treated water system supplies the cooling systems, fire protection system, process operations, sanitary requirements, and boiler feed at the steam plant. The average treated water usage for the Oak Ridge Y-12 Plant is approximately 22–27 million liters per day. The major water users at the Oak Ridge Y-12 Plant are listed in Table 5.1.2.

5.1.4 ORNL Water Use

Water is supplied to the ORNL plant site through a single main line from the DOE water treatment plant. An 11-million-liter storage tank is located on the south slope of Chestnut Ridge near the Bethel Valley site. Two 5.7-million-liter tanks are also located on Haw Ridge. Water is distributed to ORNL facilities through two separate systems: potable and process. Process water has the potential for becoming contaminated and therefore unfit for human consumption. The potable water system supplies the process system and is protected from back contamination by reduced-pressure backflow-preventer valves. Cooling water is obtained from the process water system. Treated water usage at ORNL varies from approximately 11 to 19 million liters per day (ORNL 1985 and Kelly 1984); the major water users at ORNL are summarized in Table 5.1.3.

Several improvements could be implemented to upgrade the potable and process water systems at ORNL. Because there are no flow meters at the points of usage or at the locations where the process water lines tie into the potable water system, there is a lack of accurate flow data. Several improvements have been identified that would provide needed reliability for fire protection at or near the points of use on the

Table 5.1.1. Discharges of radionuclides in water 1986

Radionuclide	Flow (10^6 L)	Discharge (Ci)	Concentration (pCi/L)
	Melton Branch		
^{60}Co	1600	0.53	340
^{137}Cs	1600	0.0094	6.0
^{3}H	1600	2900	1,900,000
Total Sr[a]	1600	0.34	210
	Sewage Treatment Plant		
^{60}Co	300	0.0016	5.5
^{137}Cs	300	0.0035	12
Total Sr[a]	300	0.055	190
	White Oak Creek		
^{60}Co	8100	0.25	30
^{137}Cs	8100	1.1	130
^{3}H	8100	260	32,000
Total Sr	8100	1.2	150
	White Oak Dam[b]		
^{60}Co	10,000	0.54	52
^{137}Cs	10,000	1.0	100
Gross alpha	10,000	0.85	82
Gross beta	10,000	6.6	640
^{3}H	10,000	2600	250,000
Total Sr[a]	10,000	1.8	180
Transuranics	10,000	0.024	2.4

[a]Samples were analyzed for ^{90}Sr or total Sr.
[b]Concentration is a flow weighted average of weekly samples; discharge is the total for the year.

Table 5.1.2. Major water users at the Y-12 Plant[a,b]

Users	Flow[c] (L × 10⁶/d)		Discharges[d] (L × 10⁶/d)		Total usage (%)
Treated water					
Cooling systems (cooling tower and once-through cooling water makeup)	15.1	(4.0)	12.8	(3.4)	61
Process systems	6.4	(1.7)	6.4	(1.7)	26
Sanitary water	2.3	(0.6)	2.3	(0.6)	9
Steam plant	0.76	(0.2)	0.76	(0.2)	3
Leakage	0.4	(0.1)	0.4	(0.1)	1
Total	22–26.5	(6–7.0)			
Average total	25.0	(6.6)			
Raw water usage, steam plant fly ash sluice, and boiler cleaning	9.1	(2.4)	9.1	(2.4)	
Total			31.76	(8.4)	

[a]*Source*: J. L. Kasten, *Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation*, ORNL/ESH-1/V21, November 1986.

[b]Total water usage at the steam plant is metered; water use for the cooling towers is calculated; sanitary water usage is estimated from the amount treated at the sewage plant; cooling water, process water, and leakage are estimated.

[c]Millions of gallons per day are shown in parentheses.

[d]Discharges to EFPC and Rogers Quarry.

Table 5.1.3. Major water users at ORNL[a,b]

Users	Flow[c] (L × 10⁶/d)		Discharges[d] (L × 10⁶/d)		Total usage (%)
Treated water					
Cooling systems (cooling tower and once-through cooling water makeup)	9.0	(2.4)	3.2	(0.9)	56
Process systems	3.8	(1.0)	3.8	(1.0)	23
Sanitary water	1.2	(0.3)	1.2	(0.3)	7
Steam plant	1.2	(0.3)	1.2	(0.3)	7
Leakage	1.2	(0.3)	1.2	(0.3)	7
Total	11–19.0	(3–5.0)	10.6	(2.8)	
Average total	16.4	(4.3)			

[a]*Source*: J. L. Kasten, "Resource Management Plan for the Oak Ridge Reservation Volume 21: Water Conservation Plan for the Oak Ridge Reservation," ORNL/ESH-1/V21, November 1986.

[b]Total water usage at the steam plant is metered; water use for the cooling tower is calculated; sanitary water is estimated from the amount treated at the sewage treatment plant; cooling water, process water, and leakage are estimated.

[c]Millions of gallons per day are shown in parentheses.

[d]Discharges to WOC.

process system, and appropriate projects have been proposed. The fact that ORNL is supplied water through a single line makes the Laboratory vulnerable to outages. This lack of a backup supply line is the major deficiency in the water system at ORNL.

5.1.5 ORGDP Water Use

The average daily use of treated water at ORGDP before the plant was placed in a standby mode was approximately 15 million liters per day. At present, it is approximately 8 million liters per day. Potable water is used primarily for sanitary and process purposes. Processes requiring potable water include production of steam, preparation of metal treatment and cleaning solutions, chemical processing, laboratory use, laundry purposes, and once-through cooling.

The raw water makeup supply for the recirculating cooling water (RCW) system can be taken from the Clinch River pumping station or Poplar Creek, but it is usually taken from the Clinch because its water quality is better. Makeup water is required for the RCW system to replace the water lost by evaporation and blowdown. The fire protection water system is supplied by the nonchromated, but softened and treated, water loop of the RCW system. Total raw water used before ORGDP was put in standby mode was 44 million liters per day. At present, raw water is required only for the fire water system, at a rate of 2.3 million liters per day because the RCW system has been shut down (Daugherty, 1984, and ORGDP, 1985). The major ORGDP water users are listed Table 5.1.4.

5.1.6 Wastewater Controls

Numerous wastewater collection and storage facilities are to be built at the three installations

Table 5.1.4. Major water users at ORGDP[a,b]

User	Full-scale operation		Standby mode		Discharges[d] (L × 10⁶/d)
	Flow[c] (L × 10⁶/d)	Total (%)	Flow[c] (L × 10⁶/d)	Total (%)	
	ORGDP potable water treatment facility				
Cooling systems (including small once-through systems)	9.8 (2.6)	62	4.5 (1.2)	60	4.5 (1.2)
Sanitary water	2.3 (0.6)	14	1.2 (0.3)	15	1.2 (0.3)
Process water	1.9 (0.5)	12	1.43 (0.38)	12	1.43 (0.38)
Steam plant	1.5 (0.4)	10	0.57 (0.15)	8	0.57 (0.15)
Leakage	0.4 (0.1)	2	0.4 (0.1)	5	0.4 (0.10)
Total	15.9 (4.2)		8.1 (2.13)		
	Raw water				
RCW system	41.6 (11.0)	95			
Fire water system	2.3 (0.6)	5	2.3 (0.6)[e]	100	1.7 (0.44)
Total	43.9 (11.6)		2.3 (0.6)		9.8 (2.6)

[a] *Source*: J. L. Kasten, *Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation*, ORNL/ESH-1/V21, November 1986.

[b] Total water usage at the steam plant is metered; water use for the cooling towers is calculated; sanitary water is estimated from the amount treated at the sewage plant; the remainder of cooling water, process systems water, and leakage are estimated.

[c] Water usage in millions of gallons per day is shown in parentheses.

[d] Discharges to either White Oak Creek or the Clinch River (standby mode).

[e] Upon completion of AVLIS, fire water use will be reduced to 1.5 MLPD (0.4 MGPD).

as part of the installations' water pollution control programs. Wastewaters of a volume too large to justify a storage system (e.g., coal-pile runoff and plating rinse waters from the main plating shop) will be directly piped to their corresponding treatment facilities upon completion of construction. Some process wastewaters are discharged with minimal treatment. These waste streams will continue to discharge to area creeks as long as toxicity testing shows the effluents to be nontoxic.

In addition to strategy for eliminating wastewater discharges, strategies exist for minimizing pollutants reaching waters of the state. Best management practices (BMPs) will be used to minimize the discharge of pollutants to receiving waters. BMPs include (but are not limited to) using better process controls, preventive maintenance programs, inspection programs, and adequate planning to mitigate accidental spills. Each new wastewater system is designed to meet discharge limits.

The sanitary wastewater treatment facility, located in Building 2521 at the west end of ORNL near the steam plant, serves a major part of the installation. Sanitary wastes from the main site and from the HFIR are treated by the facility before release to White Oak Creek.

The facility consists of a waste influent pump station equipped with communitors and level controls, chlorination equipment, flow recording and effluent equipment, a Parshall flume and chlorine contact basin, and a control/laboratory building.

Upgrading of the sewage treatment plant involved the addition of a packaged extended-aeration treatment plant, an average/peak flow head box system, a sewage pump station, and a tertiary filter system; inflow/infiltration rehabilitation of the sewage piping; and modifications to existing facilities, including the West Lagoon, the sludge drying beds, and the pump station.

All incoming wastewater flow equal to or less than 1,100,000 L/d is pumped via the modified pump station directly to the new extended-aeration treatment system. Flow in excess of 1,100,000 L/d is diverted to the existing West Lagoon. The stored wastewater is returned to the new extended-aeration treatment system whenever incoming flow is less than 1,100,000 L/d.

The new extended-aeration activated sludge treatment system consists of an aeration tank, a clarifier, sludge holding and recirculation equipment, aeration equipment, and sludge wastage piping. Influent to the treatment system is directed to the aeration tank and then to the clarifier. Excess sludge from the clarifier is sent to the modified existing sludge drying beds. After heavy metal determination, dewatered sludge is sent to the landfill.

Wastewater effluent from the final clarifier flows to the filter system and then to the existing Parshall flume-chlorine contact structure, where it is measured, sampled, and chlorinated before discharge to the chlorine contact basin. The existing chlorination system feeds a chlorine solution in the upstream portion of the chlorine contact basin. After sufficient contact time (chlorine is toxic to aquatic life), the basin effluent is discharged into WOC. Figure 5.1.1 is a flow diagram for the new sewage treatment plant.

Phases I and II of the inflow and infiltration reduction project reduced the excess in sewage flow caused by rain by approximately 30% (about 550,000 L/d). This has enhanced the effectiveness of sewage treatment and improved ORNL's capability for achieving NPDES compliance by (1) maintaining a more nearly constant hydraulic loading and (2) keeping the nutrient concentration at a higher level.

The coal yard, with an area of 1.0 ha (2.5 acres), has a storage capacity of approximately 22,000 tons. Runoff from rainfall is currently collected in a 1135-m^3 basin. Discharge from the collection basin may be as high as 24,600 m^3 per year. The runoff from the coal pile is acidic and also contains coal fines and trace amounts of heavy metals leached from the coal.

A new treatment system for the coal yard runoff has been provided by an outside contractor under a turnkey design and construction project. This new system has placed this stream in compliance with the CWA, which calls for "best

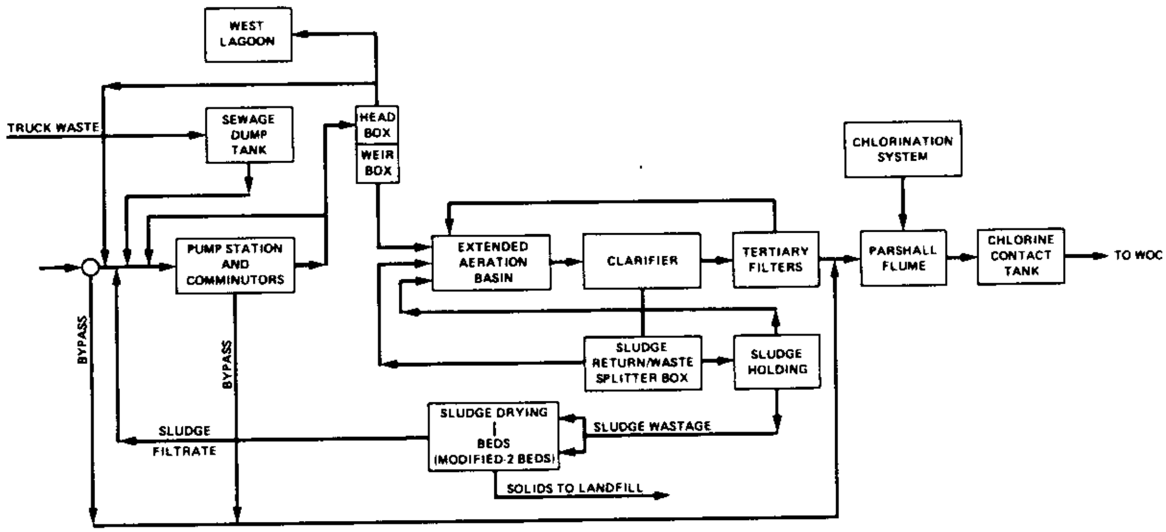

Fig. 5.1.1. Block flow diagram for new ORNL Sewage Treatment Plant.

available treatment economically achieveable" (BATEA), necessitating the neutralization of coal yard runoff and removal of heavy metals before discharge to WOC.

The acidic runoff from the ORNL coal yard is currently collected in the upper coal yard runoff basin and processed through an existing neutralization system. Recent upgrades include an improved feed system, an improved neutralization system, a new dewatering system, instrumentation, and a prefabricated building.

The improved system provides controlled lime neutralization of runoff, sludge collection and dewatering, and discharge of the liquid effluent to WOC.

The clear water overflows to a recycle tank and then to a monitoring station. If quality is within standards, the water is sent to the discharge basin and then to WOC; otherwise it is returned to the collection basin.

Neutralization solids from the clarifier are transferred to a sludge holding tank and then to a vacuum filter for dewatering. Dewatered sludge is discharged to a collection box for transfer to a landfill. Water from the vacuum filter is routed to the recyle tank and returned to the collection basin. The coal yard runoff treatment facility is in compliance with NPDES permit requirements.

There are 26 operating cooling towers at the ORNL site. Chemical pollution associated with operation of all 26 cooling towers and potential radioactive pollution associated with operation of the 3 cooling towers that service the ORNL nuclear reactors are controlled through the Water Pollution Control Program.

Cooling tower effluent releases are regulated under several sections of the NPDES permit. Chemical pollutants are regulated through miscellaneous sources and toxicity control and monitoring. Radioactivity in wastewater is regulated in two ways: (1) a plan for radiological monitoring of all outfalls that have the potential of discharging radioactivity to the watershed must be submitted; and (2) radioactivity in wastewater discharges must meet an annual average limit.

Effective April 1, 1986, NPDES permit requirements were imposed on cooling tower discharges at ORNL to regulate two types of chemical pollutants. These requirements are specified in the permit under the sections entitled Miscellaneous Source Discharges and Toxicity Control and Monitoring Program.

These limits apply to cooling tower discharges that do not mix with other discharges (e.g., storm drainage) and have flow rates greater than 37,900 L/d. The plan for minimizing chemical water pollution due to cooling tower discharge takes a conservative approach by addressing all active cooling towers at ORNL under the miscellaneous category of the NPDES permit even though 79% of cooling water blowdown does mix with other discharges and 75% of the cooling towers have blowdown rates less than 37,900 L/d. This comprehensive program will ensure that cooling tower effluents will have a negligible effect on receiving streams by minimizing the use of chlorine for algae control and ensuring that cooling tower effluents are monitored for chlorine, which is the parameter of concern.

The storm sewer system for ORNL handles water from roof drains, storm drains, and parking lot drains. Category I discharges are composed of rainwater. Category II discharges include drainage from buildings and areas with no process effluents (i.e., building roof drains, parking lot runoff, cooling water discharges, etc.). Category III discharges include drainage from buildings and areas that indicate the presence of untreated PW. A preliminary investigation into the composition of the flow discharged from the storm sewer system indicated that there are Category III discharges entering surface waters before treatment. The storm sewer system will be characterized to determine how to eliminate the discharge of untreated PW, which will include (1) identifying the category of discharge from storm sewers throughout ORNL, (2) identifying the sources of discharges that require treatment before their release to the environment, and (3) piping modifications.

The PW system, shown schematically in Fig. 5.1.2, collects and processes liquid wastes that are normally not radioactively contaminated but have the potential to be contaminated and to contain varying amounts of chemicals. The system also collects water that is contaminated with very low levels of radioactivity, including groundwater, in addition to condensate from the LLW evaporator. Approximately 60% of these wastes are diverted to the Process Waste Treatment Plant (PWTP) for treatment by filtration and ion exchange and then discharged to WOC. The remaining 40% is collected in PW ponds and monitored for radioactivity; if release criteria are met, it is also discharged to WOC. If release criteria are exceeded, the wastes are pumped to the PWTP for processing. The bulk of radioactive material is removed from the waste in the PWTP. Until September 1985, the concentrated radioactive material resulting from the regeneration of the PWTP ion exchange columns was sent to the LLW system. Currently this waste stream is evaporated to 46% solids at the PWTP and transferred to storage tanks at the LLW evaporator building.

The LLW system at ORNL is used to collect, neutralize, concentrate, and store aqueous radioactive waste solutions from various sources (Fig. 5.1.3). The system is designed to accommodate waste solutions having an activity content as high as 5.28 Ci/L. These waste solutions come from hot sinks and drains in R&D laboratories, radiochemical pilot plants, nuclear reactors located in Bethel and Melton valleys,

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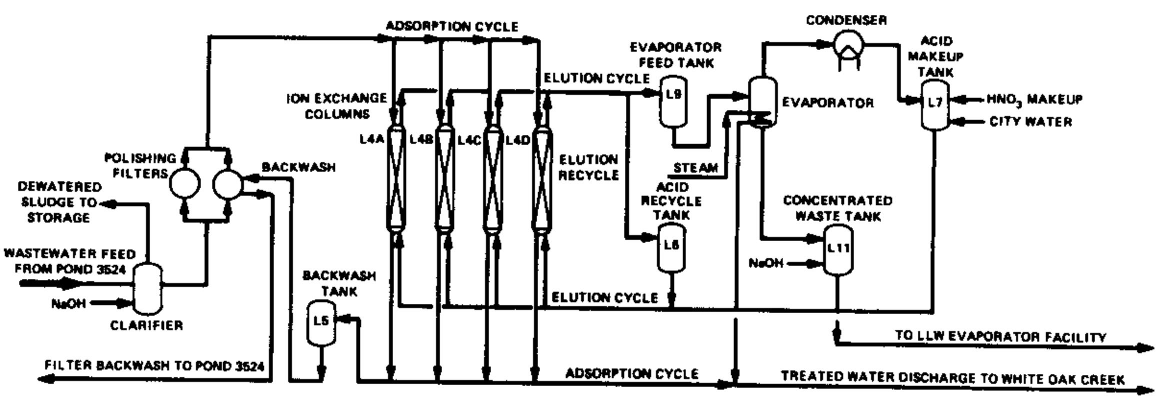

Fig. 5.1.2. ORNL Process Waste Treatment Plant.

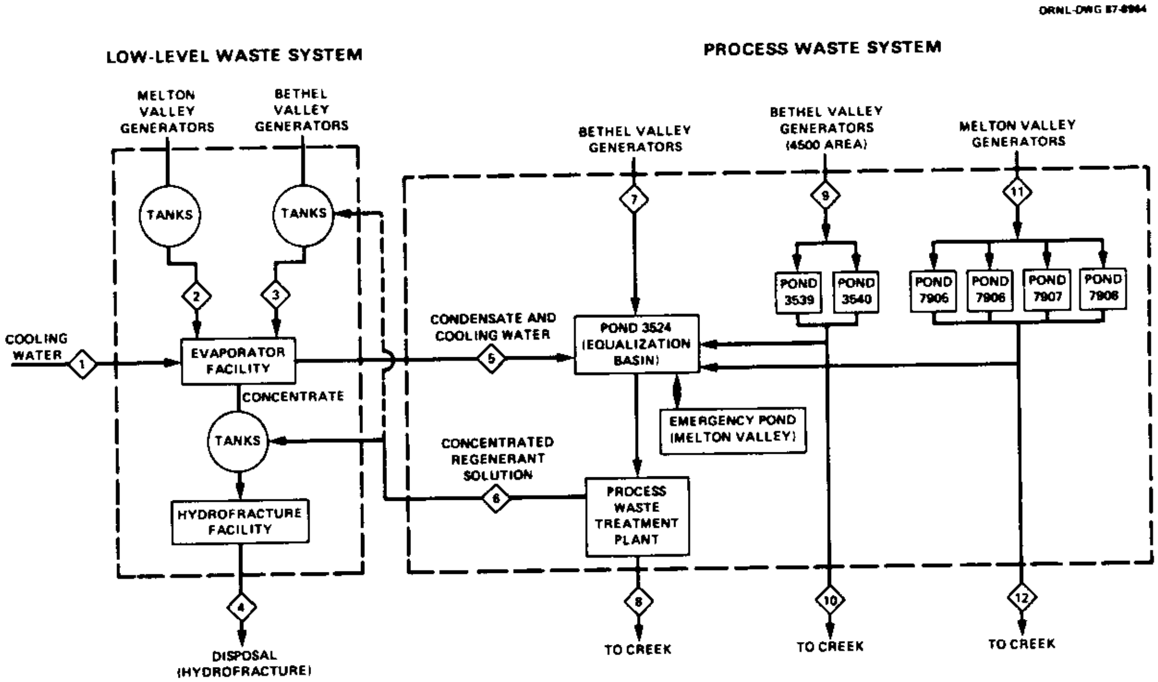

Fig. 5.1.3. ORNL liquid radioactive waste system.

and in the PWTP. Approximately 350 m^3 of LLW is generated each month. The majority of LLW comes from the PWTP, 16% by volume and 80% by weight. Other significant generators are the HFIR, 11%; the Oak Ridge Research Reactor, 7%; the Fission Products Development Laboratory, 10%; and Isotopes, 16%.

The waste solutions are discharged from the source buildings to 24 collection tanks, 1 of which is located near each source building. Each collection tank is equipped with liquid-level instrumentation and a filtered vent to the atmosphere or to the off-gas system of the facility it serves. The waste solutions that accumulate in the collection tanks are periodically transferred to 189,250-L stainless steel storage tanks near the evaporator annex. These tanks are enclosed in underground stainless-steel-lined concrete vaults. A network of 0.05- and 0.08-m stainless steel lines buried directly in the ground connects the collection tanks to a 0.15-m doubly contained stainless steel collection header that directs the flow to storage tanks. Wastes are transferred by pump or steam jet.

Wastes from storage tanks are transferred to one of two evaporators, in which aqueous solution is concentrated. The volume-reduction factor ranges from 7:1 to 13:1 and averages 9:1. The overheads from the evaporator that contain minor amounts of radioactivity are sent to the PW system for further cleanup before discharge to the environment. The volume of solution in the evaporator is reduced until a predetermined specific gravity is reached ranging from 1.25 to 1.5 depending on current system capacity.

Design limits for a new ORNL sewage treatment plant are given in Table 5.1.5. Each new system requires input specifications, as given in Table 5.1.6 for the ORNL coal pile. Other systems, such as cooling towers, also have discharge limits, as shown in Table 5.1.7. Furthermore, various spill prevention programs are directed at areas where potential exists for accidental spills.

DOE Order 5480.1A requires all DOE facilities to maintain radionuclide effluents at levels as-low-as-reasonably-achievable (ALARA). Consistent with this policy, the Oak Ridge Y-12 Plant has initiated a number of programs to complement the ALARA philosophy. Such programs serve to minimize and eliminate conventional and hazardous pollutants and

Table 5.1.5. Design conditions for new sewage treatment plant: effluent discharge limitations

Parameter	Concentration
Ammonia nitrogen	1.8 mg/L
BOD5	5.0 mg/L
Chlorine, residual	0.5–2.0 mg/L
Fecal coliform	200/100 mL monthly mean 400/100 mL weekly mean
pH	6.0–9.0 units
Settleable solids	0.5 ml/L
Suspended solids	10.0 mg/L

Table 5.1.6. Coal pile specifications

Total moisture, maximum	8%
Ash (dry basis), maximum	8%
Sulfur (dry basis)	2 to 3%
Delivered heat content, minimum	13,000 Btu/lb
Ash softening temperature, minimum	2300°F
Size	3/8 to 1¼ in.
Fines, maximum	5%
Other	*a*

[a]Washed and substantially free of surface impurities such as earth, wood, rock, slate, or pyrite.

Table 5.1.7. Chemical pollutant limits for cooling tower discharges

Parameter	Average	Maximum	Sample frequency
Chromium		1.0 mg/L	Quarterly
Zinc	0.5 mg/L	1.0 mg/L	Quarterly
Copper	0.5 mg/L	1.0 mg/L	Quarterly
Chlorine, residual		0.2 mg/L	Quarterly
Temperature, °C	35	38	Quarterly
pH	6.0–9.0		Quarterly

include waste collection and treatment, BMPs, source identification, and compliance monitoring. The Oak Ridge Y-12 Plant will continue to improve and expand programs to ensure compliance with the ALARA philosophy.

5.2 SURFACE WATER MONITORING

Water samples are collected and analyzed regularly for radiological content from the following stations (Fig. 5.2.1).

- Melton Hill Dam (station W1)—in the Clinch River 3.7 km above the White Oak Creek outfall as reference point. Flow proportional samples are collected daily and composited for quarterly analysis.
- White Oak Dam (station W3)—ORNL discharge point from White Oak Creek to the Clinch River. Flow proportional samples are collected daily and composited for weekly analysis.
- ORNL tap water—reference samples are collected daily and composited for quarterly analysis.
- ORGDP sanitary water (station W30)—10 km downstream from the confluence of White Oak Creek and the Clinch River. A grab sample is collected and analyzed quarterly.
- Water plant near Kingston (station W55)—downstream from the entry of White Oak Creek. A sample is collected daily and composited for quarterly analysis.
- A number of additional water sampling stations in WOC and Melton Branch, Bear Creek, and Poplar Creek.

Fission product radionuclide concentrations are determined by specific radionuclide analysis and gamma spectrometry. Uranium analysis is by the fluorometric method or mass spectrometry. Transuranic alpha emitters are determined by radiochemical separation and alpha spectrometry.

Water samples are collected for analysis of nonradioactive substances at locations on and off the ORR. Samples are composited for monthly analyses; $NO_3(N)$ values are determined from a monthly grab sample. EPA-approved methods are used to the determine chemicals in water. Concentrations of chemicals in streams and creeks on or around the ORR have been compared with Tennessee's in-stream allowable concentrations, which are based on the long-term protection of domestic water supply, fish and aquatic life, and recreation classifications and recommendations made by TDHE to DOE Oak Ridge Operations (ESR, 1985). Concentrations of chemicals in the inlet for the ORGDP sanitary water plant are compared with Tennessee water quality criteria for domestic water supply.

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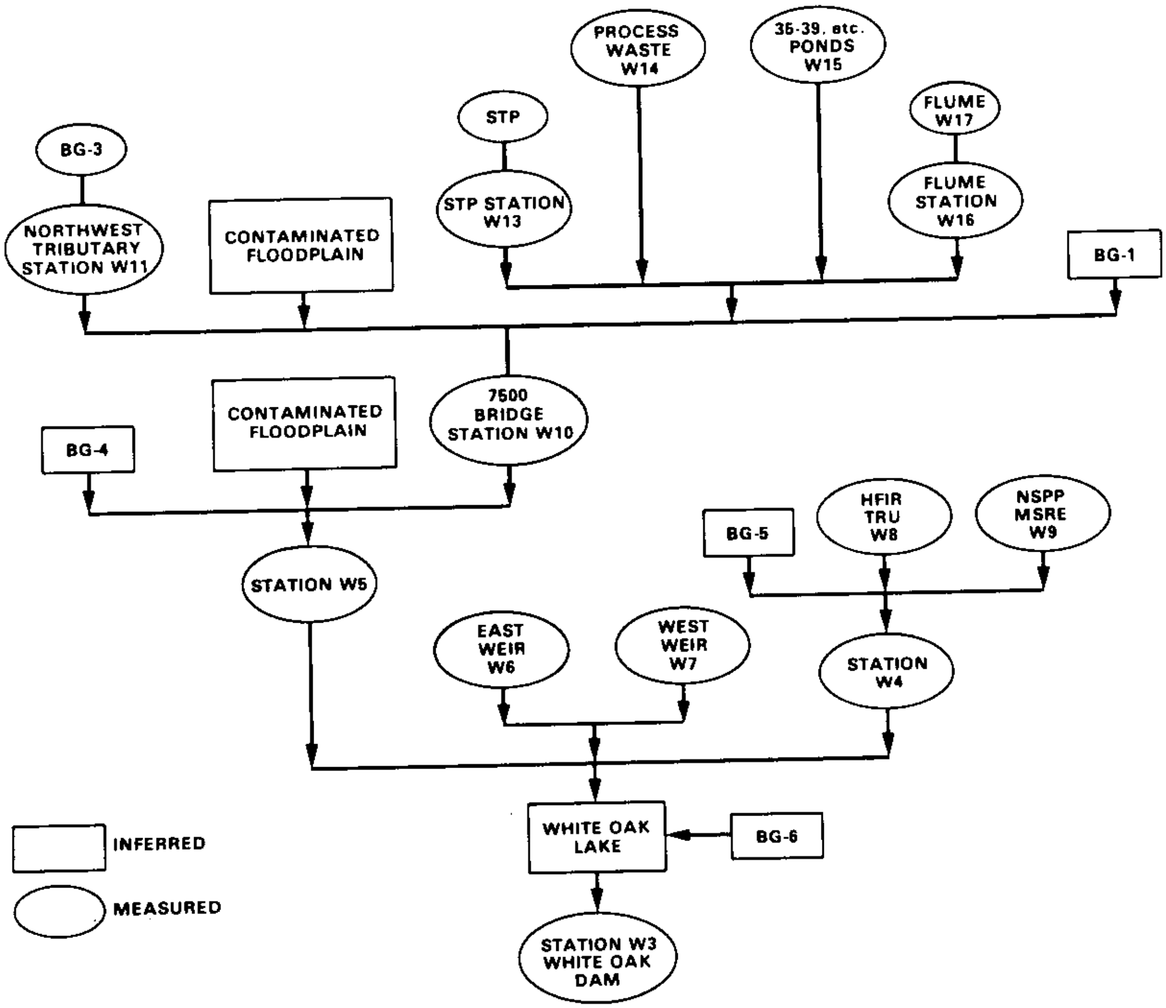

Fig. 5.2.1. Flow diagram of water sampling stations on White Oak Creek and Melton Branch.

In some cases, maximum concentrations recommended by the TDHE and EPA are below the detection limit using the most sensitive EPA-approved method. The practical limit of detection may vary with the matrix and other factors. In 1986 Energy Systems analytical laboratories changed their reportable detection limits on some metals (such as Be and Hg) and some organics (such as herbicides and pesticides), resulting in inconsistencies in the analytical data.

Data for composite samples at Bear Creek outfall 304 are given in Tables 5.2.1 through 5.2.8. Surface water data for upper Bear Creek near the S-3 Pond site by month are given in Tables 5.2.9 through 5.2.14. Radiochemical water quality data for Bear Creek, East Fork Poplar Creek, and New Hope Pond are given in Tables 5.2.15 to 5.2.20.

The Oak Ridge Y-12 Plant discharges sanitary and process water into the City of Oak Ridge sewage system. The 1986 concentrations of parameters in this discharge are given in Tables 5.2.21 through 5.2.23.

Water samples were collected regularly from First Creek, Fifth Creek, 7500 Bridge, Melton Branch 1 (MB1), Melton Branch 2 (MB2),

Table 5.2.1. 1986 Bear Creek Outfall 304[a] weekly composite samples for first and second quarters

Parameter	1st Quarter: Number of samples	1st Quarter Concentration (mg/L): Max	Min	Av	2nd Quarter: Number of samples	2nd Quarter Concentration (mg/L): Max	Min	Av
Hg	8	0.0006	<0.0005	<0.0005	13	<0.0005	<0.0005	<0.0005
Cl	0				13	17	6.4	10
F	8	0.4	0.14	0.24	13	0.23	<0.1	<0.14
MBAS	1	<0.05	<0.05	<0.05	13	<0.05	<0.05	<0.05
SO_4	8	29	11	16	13	19	<10	<12
Ag	8	<0.01	<0.01	<0.01	13	<0.01	<0.01	<0.01
Al	8	5.2	0.14	1.43	13	2.7	0.16	0.57
As	8	<0.06	<0.06	<0.06	13	<0.06	<0.06	<0.06
B	8	0.33	0.08	0.18	13	0.39	0.02	0.19
Ba	8	<0.2	<0.2	<0.2	13	<0.2	<0.2	<0.2
Be	8	0.0010	<0.0005	<0.0006	13	0.0005	<0.0005	<0.0005
Ca	8	49	24	37	13	61	34	43
Cd	8	<0.002	<0.002	<0.002	13	<0.002	<0.002	<0.002
Ce	8	<0.03	<0.03	<0.03	13	<0.03	<0.03	<0.03
Co	8	0.002	<0.002	<0.002	13	<0.002	<0.002	<0.002
Cr	8	<0.01	<0.01	<0.01	13	0.03	<0.01	<0.01
Cu	8	0.004	<0.004	<0.004	13	0.005	<0.004	<0.004
Fe	8	3.8	0.15	1.36	13	1.5	0.12	0.37
Ga	8	<0.04	<0.04	<0.04	13	<0.04	<0.04	<0.04
K	8	2.9	0.9	1.5	13	2.2	0.9	1.3
La	8	<0.01	<0.01	<0.01	13	<0.01	<0.01	<0.01
Li	8	0.12	0.04	0.07	13	0.16	0.01	0.07
Mg	8	9.8	5.6	8.5	13	16	9.9	13
Mn	8	0.12	0.02	0.06	13	0.12	0.02	0.05
Mo	8	<0.1	<0.1	<0.1	13	<0.1	<0.1	<0.1
Na	8	13	2.5	5.0	13	7.7	1.9	4.2
Nb	8	<0.02	<0.02	<0.02	13	<0.02	<0.02	<0.02
Ni	8	<0.01	<0.01	<0.01	13	0.02	<0.01	<0.01
P	8	0.06	<0.03	<0.04	13	0.09	<0.03	<0.03
Pb	8	<0.01	<0.01	<0.01	13	<0.01	<0.01	<0.01
Sc	8	<0.001	<0.001	<0.001	13	<0.001	<0.001	<0.001
Sr	8	0.14	0.053	0.086	13	0.13	0.043	0.081
Th	8	<0.02	<0.02	<0.02	13	<0.02	<0.02	<0.02
Ti	8	0.028	<0.001	<0.014	13	0.029	0.005	0.012
V	8	0.007	<0.003	<0.006	13	0.004	<0.003	<0.003
Y	8	0.002	<0.001	<0.002	13	<0.001	<0.001	<0.001
Zn	8	<0.02	<0.02	<0.02	13	<0.02	<0.02	<0.02
Zr	8	0.004	<0.001	<0.002	13	0.002	<0.001	<0.001

[a]The sample ID for outfall 304 is W46.

Table 5.2.2. 1986 Bear Creek Outfall 304[a] weekly composite samples for third and fourth quarters

Parameter	3rd Quarter: Number of samples	3rd Quarter: Concentration[b] (mg/L) Max	Min	Av	4th Quarter: Number of samples	4th Quarter: Concentration (mg/L) Max	Min	Av
Hg	13	0.0007	0.0002	0.0005	14	0.0005	<0.0002	<0.0002
Cl	13	26	3	12	14	27	3	15
F	13	0.3	<0.1	<0.2	14	0.3	<0.1	<0.18
MBAS	13	<0.05	<0.05	<0.05	14	<0.05	<0.05	<0.05
SO_4	13	55	<10	<20	14	62	15	39
Ag	12	<0.01	<0.004	<0.007	14	<0.004	<0.004	<0.004
Al	12	5.08	0.63	1.87	14	4.27	0.15	1.11
As	12	<0.06	<0.04	<0.05	14	<0.04	<0.04	<0.04
B	12	0.44	<0.02	<0.149	14	0.576	0.090	0.287
Ba	12	<0.2	0.0654	<0.150	14	0.157	0.0587	0.1039
Be	12	<0.0005	<0.0001	<0.0003	14	0.0002	<0.0001	<0.0001
Ca	12	80.4	38	52.7	14	91.9	27.0	64.1
Cd	12	<0.003	<0.002	<0.002	14	<0.003	<0.003	<0.003
Ce	12	<0.03	<0.02	<0.02	14	<0.02	<0.02	<0.02
Co	12	<0.002	<0.002	<0.002	14	<0.002	<0.002	<0.002
Cr	12	<0.01	<0.006	<0.008	14	<0.006	<0.006	<0.006
Cu	12	0.004	<0.002	<0.003	14	0.021	<0.002	<0.004
Fe	12	3.93	0.54	1.40	14	3.44	0.14	0.93
Ga	12	<0.04	<0.01	<0.02	14	<0.01	<0.01	<0.01
K	12	4.5	1.0	2.0	14	3.1	1.1	2.0
La	12	<0.01	<0.003	<0.006	14	<0.003	<0.003	<0.003
Li	12	0.17	0.005	0.061	14	0.195	0.030	0.104
Mg	12	21.2	14	16.2	14	22.7	6.15	15.1
Mn	12	0.16	0.056	0.095	14	0.112	0.016	0.050
Mo	12	<0.1	<0.006	<0.05	14	<0.006	<0.006	<0.006
Na	12	12.2	1.36	5.60	14	11.2	3.39	6.93
Nb	12	<0.02	<0.01	<0.02	14	<0.01	<0.01	<0.01
Ni	12	<0.01	<0.007	<0.008	14	<0.007	<0.007	<0.007
P	12	1.31	<0.03	<0.16	14	0.06	<0.06	<0.06
Pb	12	<0.02	<0.01	<0.02	14	<0.02	<0.02	<0.02
Sc	11	<0.001	<0.0004	<0.0001	14	0.0009	<0.0004	<0.0004
Sr	12	0.202	0.0403	0.097	14	0.244	0.0689	0.1465
Th	12	<0.02	<0.01	<0.02	14	<0.01	<0.01	<0.01
Ti	12	0.019	0.001	<0.006	14	0.036	<0.002	<0.008
V	12	<0.004	<0.003	<0.004	14	<0.004	<0.004	<0.004
Y	8	0.001	<0.001	<0.001	0			
Zn	12	<0.02	0.003	<0.014	14	0.023	0.003	0.009
Zr	12	0.003	<0.001	<0.002	14	<0.002	<0.002	<0.002

[a]The sample ID for outfall 304 is W46.
[b]In 1986, reportable detection limits were changed for Be, Hg, Th, Ti, and U.

Table 5.2.3. 1986 Bear Creek Outfall 304[a] weekly composite samples for February and March[b]

Parameter	Concentration[c] (mg/L)							
	2/5/86	2/12/86	2/19/86	2/26/86	3/5/86	3/12/86	3/19/86	3/27/86
Hg	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cl	ND[d]	ND	ND	ND	ND	12	8.2	7.5
F	0.4	0.2	0.14	0.2	0.2	0.26	0.30	0.22
MBAS	ND	ND	ND	ND	ND	ND	<0.05	ND
SO_4	29	19	13	14	15	15	14	11
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	2.7	0.14	0.32	0.17	0.18	2.6	5.2	0.18
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	0.23	0.18	0.08	0.15	0.19	0.33	0.10	0.14
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	<0.0005
Ca	49	45	24	37	41	42	24	33
Cd	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Co	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.004	<0.004	0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	3.7	0.21	0.49	0.27	0.15	2.1	3.8	0.15
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
K	2.9	1.2	1.1	1.2	0.9	1.4	2.2	1.0
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Li	0.09	0.07	0.04	0.05	0.07	0.12	0.04	0.06
Mg	8.7	9.8	6.4	8.9	9.7	9.4	5.6	9.2
Mn	0.12	0.04	0.05	0.02	0.04	0.08	0.12	0.02
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	13	5.2	2.5	3.9	3.6	4.4	4.4	3.3
Nb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P	0.06	<0.03	<0.03	<0.03	<0.03	<0.03	0.06	<0.03
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	0.14	0.10	0.053	0.078	0.086	0.10	0.064	0.067
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	0.014	0.028	0.026	0.027	<0.001	<0.001	0.009	<0.01
V	0.007	<0.003	<0.003	<0.003	<0.003	0.004	0.004	<0.003
Y	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zr	<0.001	<0.001	0.003	0.004	<0.001	<0.001	0.004	0.001

[a]The sample ID for outfall 304 is W46.
[b]No weekly composites for January.
[c]Detection limits for several parameters were changed in 1986.
[d]ND = no data.

Table 5.2.4. 1986 Bear Creek Outfall 304[a] weekly composite samples for April and May

Parameter	Concentration[b] (mg/L)								
	4/2/86	4/9/86	4/16/86	4/23/86	4/30/86	5/7/86	5/14/86	5/21/86	5/28/86
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cl	7.8	10	11	13	10	7.1	6.4	7	17
F	0.21	0.23	0.17	0.2	0.14	<0.1	<0.1	0.10	0.14
MBAS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SO_4	11	19	14	16	14	<10	<10	<10	18
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	0.18	0.26	0.16	0.17	0.29	0.24	0.26	0.31	2.7
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	0.17	0.25	0.32	0.39	0.28	0.11	0.10	0.21	0.28
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ca	34	45	51	61	46	37	35	41	49
Cd	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	0.13	0.23	0.12	0.12	0.15	0.13	0.14	0.15	1.5
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
K	1.0	1.4	1.5	1.8	1.5	1.0	0.9	1.0	2.2
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Li	0.07	0.09	0.14	0.16	0.13	0.04	0.04	0.06	0.11
Mg	9.9	11	13	14	13	13	13	14	12
Mn	0.02	0.02	0.02	0.02	0.02	0.04	0.07	0.05	0.06
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	3.2	4.6	5.2	6.1	4.8	2.8	2.4	2.6	7.7
Nb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	0.087	0.12	0.11	0.13	0.10	0.056	0.051	0.060	0.11
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	<0.01	<0.01	<0.01	<0.01	0.029	0.018	0.006	0.005	0.021
V	<0.003	<0.003	<0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003
Y	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zr	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.002

[a]The sample ID for outfall 304 is W46.
[b]Detection limits for several parameters were changed in 1986.

Table 5.2.5. 1986 Bear Creek Outfall 304[a] weekly composite samples for June and July

Parameter	Concentration (mg/L)								
	6/3/86	6/10/86	6/19/86	6/26/86	7/3/86	7/10/86	7/17/86	7/24/86	7/31/86
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cl	18	14	8	4.1	6.7	8.1	26	10	5
F	<0.1	0.1	<0.1	<0.1	0.12	0.11	0.3	0.1	<0.1
MBAS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SO_4	<10	<10	<10	<10	<10	<10	30	14	<10
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	ND[b]	<0.01	<0.01	<0.01
Al	0.70	0.98	0.63	0.56	0.63	ND	1.0	1.0	2.4
As	<0.06	<0.06	<0.06	<0.06	<0.06	ND	<0.06	<0.06	<0.06
B	0.08	0.17	0.09	0.02	0.13	ND	0.44	0.16	0.03
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	ND	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.0005	<0.0005	<0.0005
Ca	38	45	45	38	45	ND	68	53	41
Cd	<0.002	<0.002	<0.002	<0.002	<0.002	ND	<0.002	<0.002	<0.002
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	ND	<0.03	<0.03	<0.03
Co	<0.002	<0.002	<0.002	<0.002	<0.002	ND	<0.002	<0.002	<0.002
Cr	<0.01	0.03	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01
Cu	0.005	<0.004	<0.004	<0.004	<0.004	ND	<0.004	<0.004	<0.004
Fe	0.41	0.76	0.47	0.46	0.54	ND	0.77	0.84	1.1
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	ND	<0.04	<0.04	<0.04
K	1.3	1.4	1.2	1.1	1.7	ND	2.5	1.8	1.7
La	<0.01	<0.01	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01
Li	0.02	0.07	0.02	0.01	0.08	ND	0.17	0.07	0.02
Mg	13	15	16	14	15	ND	14	17	15
Mn	0.05	0.05	0.09	0.12	0.16	ND	0.06	0.06	0.11
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<0.1	<0.1	<0.1
Na	4.2	5.8	3.2	1.9	3.5	ND	11	4.8	1.7
Nb	<0.02	<0.02	<0.02	<0.02	<0.02	ND	<0.02	<0.02	<0.02
Ni	<0.01	0.02	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01
P	<0.03	<0.03	<0.03	0.09	<0.03	ND	<0.03	<0.03	<0.03
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	ND	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	ND	<0.001	<0.001	ND
Sr	0.059	0.073	0.057	0.043	0.072	ND	0.18	0.088	0.053
Th	<0.02	<0.02	<0.02	<0.02	<0.02	ND	<0.02	<0.02	<0.02
Ti	0.005	0.008	0.011	0.008	0.003	ND	0.001	0.005	0.019
V	<0.003	<0.003	<0.003	<0.003	<0.003	ND	<0.003	<0.003	<0.003
Y	<0.001	<0.001	<0.001	<0.001	<0.001	ND	<0.001	<0.001	<0.001
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	ND	<0.02	<0.02	<0.02
Zr	0.001	<0.001	<0.001	<0.001	<0.001	ND	<0.001	0.002	0.003

[a]The sample ID for outfall 304 is W46.
[b]ND = no data.

Table 5.2.6. 1986 Bear Creek Outfall 304[a] weekly composite samples for August and September

Parameter	Concentration[b] (mg/L)							
	8/7/86	8/14/86	8/21/86	8/28/86	9/04/86	9/11/86	9/18/86	9/25/86
Hg	<0.0005	<0.0005	<0.0005	0.0006	0.0007	0.0002	0.0003	0.0002
Cl	3	4	3	17	22	25	14	9
F	<0.1	<0.1	<0.1	0.3	0.3	0.12	0.13	0.1
MBAS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SO_4	<10	34	<10	55	28	23	36	20
Ag	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Al	0.99	2.6	1.48	5.08	3.30	1.82	1.30	1.09
As	<0.06	<0.06	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
B	<0.02	<0.02	0.013	0.327	0.198	0.192	0.175	0.082
Ba	<0.2	<0.2	0.0654	0.127	0.108	0.117	0.106	0.0806
Be	<0.0005	<0.0005	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ca	40	38	38.8	80.4	58.3	64.0	58.3	48.1
Cd	<0.002	<0.002	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ce	<0.03	<0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Co	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cu	<0.004	<0.004	<0.002	<0.002	0.003	<0.002	0.003	<0.002
Fe	0.79	1.3	1.18	3.93	2.31	1.50	1.42	1.08
Ga	<0.04	<0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K	1.0	1.5	1.1	4.5	2.8	2.4	1.7	1.3
La	<0.01	<0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Li	<0.01	<0.01	0.005	0.125	0.068	0.081	0.065	0.029
Mg	15	15	15.1	15.0	14.4	21.2	20.4	17.8
Mn	0.09	0.14	0.148	0.091	0.056	0.081	0.083	0.065
Mo	<0.1	<0.1	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	1.5	1.7	1.36	9.70	12.2	10.5	5.84	3.34
Nb	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.01	<0.01	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
P	<0.03	0.07	0.10	0.13	1.31	<0.06	<0.06	<0.06
Pb	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.001	<0.001	<0.0004	0.0008	0.0005	<0.0004	<0.0004	<0.0004
Sr	0.053	0.046	0.0403	0.202	0.134	0.126	0.101	0.0668
Th	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	0.006	0.010	0.009	<0.002	0.012	<0.002	<0.002	<0.002
V	<0.003	<0.003	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Y	<0.001	<0.001	<0.001	0.001				
Zn	<0.02	<0.02	0.005	0.015	0.008	0.003	0.007	0.005
Zr	<0.001	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

[a]The sample ID for outfall 304 is W46.
[b]Detection limits for several parameters were changed in 1986.

Table 5.2.7. 1986 Bear Creek Outfall 304[a] weekly composite samples for October and November

Parameter	Concentration (mg/L)								
	10/2/86	10/9/86	10/16/86	10/23/86	10/30/86	11/06/86	11/13/86	11/20/86	11/25/86
Hg	0.0002	0.0003	0.0002	0.0003	<0.0002	<0.0002	<0.0002	<0.0002	0.0004
Cl	7	13	22	27	27	26	17	15	12
F	0.1	0.12	0.3	0.2	0.23	0.17	0.2	0.14	0.3
MBAS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
SO_4	15	25	62	36	48	31	40	21	61
Ag	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Al	0.76	1.38	1.32	0.90	0.25	0.39	0.62	0.21	4.27
As	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
B	0.090	0.176	0.417	0.506	0.523	0.576	0.271	0.231	0.253
Ba	0.0843	0.106	0.145	0.135	0.127	0.157	0.113	0.0917	0.113
Be	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Ca	49.5	62.8	86.5	91.9	91.1	88.2	74.6	61.8	51.0
Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ce	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cu	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.006
Fe	0.72	1.39	1.45	0.96	0.25	0.46	0.58	0.21	3.44
Ga	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K	1.3	1.9	2.8	2.4	2.3	2.3	2.3	1.3	3.1
La	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Li	0.030	0.070	0.126	0.178	0.191	0.195	0.097	0.081	0.083
Mg	19.3	22.7	17.0	22.0	18.4	20.6	15.3	14.6	9.06
Mn	0.053	0.078	0.052	0.043	0.025	0.100	0.024	0.024	0.112
Mo	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	3.39	5.78	10.3	11.1	11.2	9.40	9.17	6.49	5.98
Nb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
P	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.06
Pb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0009
Sr	0.0689	0.106	0.244	0.219	0.212	0.229	0.176	0.129	0.148
Th	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	<0.002	<0.002	0.004	<0.002	<0.002	0.007	0.005	0.003	0.036
V	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Y	ND[b]	ND	ND	ND	ND	ND	ND	ND	ND
Zn	0.004	0.004	0.006	0.004	0.003	0.007	0.006	0.007	0.023
Zr	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

[a]The sample ID for outfall 304 is W46.
[b]ND = no data.

Table 5.2.8. 1986 Bear Creek Outfall 304[a] weekly composite samples for December

Parameter	Concentration (mg/L)				
	12/4/86	12/11/86	12/18/86	12/23/86	12/31/86
Hg	<0.0002	0.0002	0.0005	0.0002	<0.0002
Cl	12	3	11	10	8
F	0.1	<0.1	0.2	0.2	0.12
MBAS	<0.05	<0.05	<0.05	<0.05	<0.05
SO_4	26	29	37	18	15
Ag	<0.004	<0.004	<0.004	<0.004	<0.004
Al	0.83	0.98	3.23	0.27	0.15
As	<0.04	<0.04	<0.04	<0.04	<0.04
B	0.186	0.109	0.376	0.163	0.143
Ba	0.0833	0.0602	0.112	0.0685	0.0587
Be	<0.0001	<0.0001	0.0002	<0.0001	<0.0001
Ca	57.4	27.0	56.6	53.7	44.7
Cd	<0.003	<0.003	<0.003	<0.003	<0.003
Ce	<0.02	<0.02	<0.02	<0.02	<0.02
Co	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.006	<0.006	<0.006	<0.006	<0.006
Cu	<0.002	0.002	0.021	0.005	0.007
Fe	0.43	0.86	1.97	0.22	0.14
Ga	<0.01	<0.01	<0.01	<0.01	<0.01
K	1.7	1.7	2.3	1.4	1.1
La	<0.003	<0.003	<0.003	<0.003	<0.003
Li	0.073	0.045	0.151	0.070	0.061
Mg	12.7	6.15	10.6	11.1	11.2
Mn	0.018	0.046	0.082	0.029	0.016
Mo	<0.006	<0.006	<0.006	<0.006	<0.006
Na	6.86	3.41	5.43	4.59	3.93
Nb	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.007	<0.007	<0.007	<0.007	<0.007
P	<0.06	<0.06	<0.06	<0.06	<0.06
Pb	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.0004	<0.0004	0.0005	<0.0004	<0.0004
Sr	0.120	0.0730	0.150	0.0951	0.0809
Th	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	0.006	0.009	0.029	<0.002	0.004
V	<0.004	<0.004	<0.004	<0.004	<0.004
Y	ND[b]	ND	ND	ND	ND
Zn	0.021	0.009	0.014	0.005	0.018
Zr	<0.002	<0.002	<0.002	<0.002	<0.002

[a] The sample ID for outfall 304 is W46.
[b] ND = no data.

Table 5.2.9. 1986 surface water concentrations of upper Bear Creek[a] January and February

Parameter	Concentration[b] (mg/L)							
	1/6/86	1/13/86	1/20/86	1/27/86	2/3/86	2/10/86	2/18/86	2/24/86
pH (units)	6.6	6.6	6.8	7.1	6.6	6.8	7.0	[illegible]
Dissolved oxygen	9	7	11	8.4	8.0	7.4	9.0	10.0
Suspended solids	6	<5	6	<5	6	<5	23	200
Total dissolved solids	2700	2600	2400	2100	2600	1900	720	980
Chloroform	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01
Methylene chloride	0.017	<0.01	0.066	0.012	0.015	<0.01	0.022	0.016
Perchloroethylene	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01
Trichloroethylene	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01
Trichloroethane	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01	<0.01
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phenol	<0.001	<0.001	<0.001	0.001	0.008	<0.001	<0.001	0.002
^{241}Am (pCi/L)	0.36	<0.2	<0.2	<0.2	0.21	<0.2	<0.2	<0.2
^{237}Np (pCi/L)	<6.0	9.2	<6.0	<6.0	3.7	<6.0	<6.0	<6.0
^{238}Pu (pCi/L)	<0.2	NS[c]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
^{239}Pu (pCi/L)	<0.2	NS	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
^{240}Pu (pCi/L)	<0.2	NS	<0.2	<0.2	<0.2	<0.02	<0.2	<0.2
^{99}Tc (pCi/mL)	0.78	0.97	0.73	0.55	0.78	0.79	<0.3	<0.3
^{235}U (%)	0.30	0.32	0.32	0.31	0.40	0.30	0.37	0.29
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	0.70	0.16	0.16	0.09	0.13	0.13	0.43	5.8
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	0.11	0.10	0.12	0.11	0.13	0.10	0.04	0.03
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ca	480	430	470	390	490	330	100	88
Cd	0.012	0.011	0.012	0.010	0.014	0.008	<0.002	<0.002
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
CN	<0.002	0.002	<0.002	0.003	0.002	<0.002	0.007	0.022
Co	0.004	0.004	0.004	0.002	0.004	<0.002	<0.002	0.003
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Cu	0.007	<0.004	<0.004	0.005	<0.004	<0.004	<0.004	0.013
F	1.0	0.80	0.80	1.0	0.80	1	0.9	0.6
Fe	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.50	8.5
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Hg	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	0.0005	0.0011
K	14.0	13.0	12.0	11	15.0	9.8	4.1	4.3
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Li	0.03	0.03	0.03	0.03	0.04	0.03	0.01	0.03
Mg	75.0	72.0	78.0	66.0	91	54	15	15
Mn	3.9	3.9	3.5	2.8	4.7	2.5	0.41	0.40
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	100.0	92.0	91.0	75.0	90	75	130	160
Nb	0.05	0.04	0.07	0.06	0.09	0.02	<0.02	<0.02
Ni	0.02	0.01	0.01	0.01	0.02	<0.01	<0.01	0.01
$N\text{-}NO_3$	330	340	340	240	330	190	30	22
P	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.10
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	1.0	0.96	0.98	0.88	1.2	0.73	0.35	0.28
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.027	0.063
U	1.32	1.33	1.40	1.43	1.28	0.882	0.357	0.250
V	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.019
Y	0.005	0.003	0.003	0.001	0.003	0.002	<0.001	0.003
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Zr	<0.001	<0.001	0.002	<0.001	0.003	<0.001	<0.001	0.008

[a]The sample ID for upper Bear Creek is W42.
[b]Detection limits for several parameters were changed in 1986.
[c]NS = No sample.

Table 5.2.10. 1986 surface water concentrations of upper Bear Creek[a]
March and April

Parameter	Concentration[b] (mg/L)								
	3/3/86	3/10/86	3/17/86	3/24/86	3/31/86	4/7/86	4/14/86	4/21/86	4/28/86
pH (units)	6.8	6.3	6.9	6.8	6.8	7.0	6.7	6.8	6.8
Dissolved oxygen	7.9	7.4	7.8	8.8	8.1	8.4	7.1	6.4	6.2
Suspended solids	<5	<5	<5	<5	7.5	<5	<5	6	<5
Total dissolved solids	2300	2700	2000	1900	2400	2500	2600	2500	3300
Chloroform	ND[c]	<0.01	<0.01	<0.01	<0.01	<0.01	NS	<0.01	<0.01
Methylene chloride	ND	<0.01	<0.01	NS[c]	<0.01	<0.01	NS	<0.01	<0.01
Perchloroethylene	<0.01	<0.01	<0.01	NS	<0.01	<0.01	NS	<0.01	<0.01
Trichloroethylene	ND	<0.01	<0.01	NS	<0.01	<0.01	NS	<0.01	<0.01
Trichloroethane	ND	<0.01	<0.01	NS	<0.01	<0.01	NS	<0.01	<0.01
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phenol	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
^{241}Am (pCi/L)	<0.9	<0.9	<0.5	<0.5	<0.4	<0.5	<0.6	<0.7	<1.0
^{237}Np (pCi/L)	2.70	3.10	1.1	2.4	2.8	<5.0	3.4	1.9	2.6
^{238}Pu (pCi/L)	<0.2	<0.3	<0.3	<0.4	<0.4	<0.4	<0.4	<0.3	<0.2
^{239}Pu (pCi/L)	<0.2	<0.3	<0.3	<0.4	<0.4	<0.4	<0.4	<0.3	<0.2
^{240}Pu (pCi/L)	<0.2	<0.3	<0.1	<0.2	<0.1	<0.4	<0.15	<0.1	<0.1
^{99}Tc (pCi/mL)	0.91	0.75	0.91	0.59	0.77	1.79	1.75	0.69	1.5
^{235}U (%)	0.32	0.32	0.32	0.31	0.35	0.33	0.33	0.31	0.32
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	0.17	0.13	0.21	0.26	0.23	0.26	0.20	0.56	0.13
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	0.08	0.09	0.08	0.09	0.08	0.09	0.10	0.09	0.13
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ca	350	390	310	340	320	370	380	440	630
Cd	0.008	0.010	0.007	0.008	0.008	0.007	0.009	0.008	0.009
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
CN	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Co	<0.002	0.002	<0.002	0.002	0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
F	1.3	1.0	1.2	1.2	1.2	1.0	0.9	0.8	0.8
Fe	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.20	<0.06

Table 5.2.10 (continued)

Parameter	Concentration[b] (mg/L)								
	3/3/86	3/10/86	3/17/86	3/24/86	3/31/86	4/7/86	4/14/86	4/21/86	4/28/86
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
K	8.0	7.9	7.9	9.2	8.5	9.9	11	12	16
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Li	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Mg	59	70	50	55	56	64	66	75	110
Mn	2.6	3.2	2.1	2.5	2.5	2.7	2.7	2.6	3.4
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	100	93	84	91	88	98	87	110	120
Nb	0.05	0.02	0.02	0.02	<0.02	0.03	0.03	0.04	0.03
Ni	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
N-NO_3	110	340	190	180	280	290	320	270	420
P	0.05	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	0.78	0.90	0.68	0.74	0.72	0.86	0.92	0.92	1.3
Th	<0.02	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01
U	1.15	1.33	0.097	0.875	1.42	1.21	1.23	1.15	1.52
V	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Y	0.002	0.002	0.001	0.002	0.002	0.001	0.001	0.001	<0.001
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zr	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[a]The sample ID for upper Bear Creek is W42.
[b]Detection limits for several parameters were changed in 1986.
[c]ND = no data; NS = no sample.

Table 5.2.11. 1986 surface water concentrations of upper Bear Creek[a]
May and June

Parameter	Concentration (mg/L)								
	5/5/86	5/12/86	5/19/86	5/27/86	6/2/86	6/9/86	6/16/86	6/23/86	6/30/86
pH (units)	7.0	7.6	7.0	7.0	7.0	6.9	6.6	6.8	7.0
Dissolved oxygen	6.4	4.6	4.2	4.5	10.0	4.8	4.0	5	5.5
Suspended solids	<5	<5	7.5	<5	<5	<5	<5	10	14
Total dissolved solids	3400	3600	4000	840	2900	2800	4000	4600	5000
Chloroform	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	<0.01	<0.01	0.026	<0.01	<0.010	<0.010	<0.010	<0.010	0.010
Perchloroethylene	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethane	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phenol	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
^{241}Am (pCi/L)	<0.8	<0.6	<0.55	<0.7	<0.58	<0.5	<0.8	<0.6	<0.5
^{237}Np (pCi/L)	2.0	1.6	<0.5	1.5	2.4	3.0	2.7	1.8	1.2
^{238}Pu (pCi/L)	<0.3	<0.3	<0.4	<0.2	<0.3	<0.3	<0.4	<0.3	<0.3
^{239}Pu (pCi/L)	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
^{240}Pu (pCi/L)	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
^{99}Tc (pCi/mL)	<0.08	1.3	1.4	0.80	0.87	0.14	<0.05	1.6	1.7
^{235}U (%)	0.34	0.32	0.30	0.33	0.31	0.33	0.31	0.29	0.31
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	0.11	0.12	0.31	0.95	0.23	0.19	0.31	0.13	0.48
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	0.11	0.12	0.12	0.05	0.08	0.10	0.11	0.16	0.14
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ca	610	630	690	170	390	490	530	850	910
Cd	0.008	0.007	0.022	0.002	0.007	0.008	0.011	0.011	0.007
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
CN	<0.002	<0.002	<0.002	0.028	0.006	<0.002	0.013	<0.002	<0.002
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.004	<0.004	<0.004	0.005	0.006	<0.004	<0.004	<0.004	<0.004
F	0.8	0.8	0.8	0.70	1.0	0.95	0.77	0.67	0.8
Fe	<0.06	<0.06	0.07	0.39	0.07	<0.06	0.13	<0.06	0.12

Table 5.2.11 (continued)

Parameter	Concentration (mg/L)								
	5/5/86	5/12/86	5/19/86	5/27/86	6/2/86	6/9/86	6/16/86	6/23/86	6/30/86
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Hg	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<0.0005
K	15	18	17	6.7	13	12	16	23	24
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Li	0.03	0.03	0.03	0.01	0.02	0.02	0.03	0.03	0.05
Mg	96	110	120	23	83	88	100	160	170
Mn	3.4	3.9	6.1	0.69	2.9	3.7	5.0	6.3	5.2
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	130	120	120	42	110	100	160	140	170
Nb	0.05	0.04	0.04	<0.02	0.04	0.04	0.05	0.05	0.03
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N-NO_3	440	510	590	80	340	330	520	660	740
P	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	1.2	1.3	1.4	0.43	0.93	0.99	1.3	1.9	1.8
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	0.003	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
U	1.42	1.66	1.76	0.56	1.34	1.36	1.11	1.74	1.66
V	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Y	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Zr	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[a]The sample ID for upper Bear Creek is W42.

**Table 5.2.12. 1986 surface water concentrations of upper Bear Creek[a]
July and August**

Parameter	Concentration[b] (mg/L)							
	7/8/86	7/14/86	7/21/86	7/28/86	8/3/86	8/11/86	8/18/86	8/25/86
pH (units)	6.9	7.2	6.9	6.8	7.2	7.3	7.1	7.3
Dissolved oxygen	5.7	7.2	5.2	4.0	6.3	6.2	5.8	5.8
Suspended solids	11	6.5	7	<5	17	18	7	7.5
Total dissolved solids	3300	1500	3100	3700	4200	1100	3800	4000
Chloroform	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Perchloroethylene	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethylene	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<0.0005	<0.0005
Phenol	<0.001	0.002	<0.001	<0.001	<0.001	0.001	0.002	<0.001
^{241}Am (pCi/L)	<0.24	<0.7	<0.7	<0.2	<0.2	<0.3	<0.85	<0.67
^{237}Np (pCi/L)	7.9	<6.0	2.4	<6.0	<6.0	<0.7	1.8	<1.5
^{238}Pu (pCi/L)	<0.3	<0.3	<0.3	<0.4	<0.2	<0.3	<0.2	<0.2
^{239}Pu (pCi/L)	<0.3	<0.3	<0.3	<0.4	<0.2	<0.3	<0.2	<0.2
^{240}Pu (pCi/L)	<0.3	<0.3	<0.1	<0.1	<0.2	<0.1	<0.2	<0.2
^{99}Tc (pCi/mL)	1.5	0.3	0.98	1.3	1.4	<0.3	1.5	1.6
^{235}U (%)	0.29	0.39	0.32	0.33	0.33	0.34	0.30	0.30
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004
Al	0.21	0.71	0.34	0.33	0.30	3.4	0.16	0.07
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.04
B	0.14	0.09	0.14	0.17	0.15	0.06	0.16	0.137
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.0595
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001
Ca	720	290	530	540	700	160	660	601
Cd	0.009	0.003	0.013	0.014	0.009	0.002	0.007	0.006
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.02
CN	0.005	0.018	0.010	0.010	0.002	<0.002	0.04	0.02
Co	0.003	<0.002	0.004	0.004	0.003	<0.002	0.003	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006
Cu	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002
F	0.7	0.9	0.9	0.7	0.5	0.4	0.46	0.44
Fe	0.09	0.39	0.16	0.08	0.10	1.3	0.07	0.05

Table 5.2.12 (continued)

Parameter	Concentration[b] (mg/L)							
	7/8/86	7/14/86	7/21/86	7/28/86	8/3/86	8/11/86	8/18/86	8/25/86
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	0.0002
K	20	8.8	17	20	18	7.7	21	17.9
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.003
Li	0.04	0.02	0.03	0.16	0.03	0.01	0.03	0.027
Mg	130	43	94	100	130	24	120	121
Mn	4.9	1.1	4.9	6.2	5.9	1.0	4.1	2.61
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.006
Na	140	72	100	100	120	45	120	100
Nb	0.04	0.02	0.04	0.05	0.03	<0.02	0.03	<0.01
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.007
$N\text{-}NO_3$	630	90	380	490	480	82	530	560
P	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.40
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Sc	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.0004
Sr	1.6	0.69	1.3	1.6	1.6	0.54	1.5	1.27
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Ti	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	<0.001	<0.002
U	1.66	0.903	1.30	1.30	1.42	0.346	1.44	1.46
V	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.004
Y	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.001
Zr	0.002	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.002

[a]The sample ID for upper Bear Creek is W42.
[b]Detection limits for some parameters were changed in 1986.

Table 5.2.13. 1986 surface water concentrations of upper Bear Creek[a]
September and October

Parameter	Concentration (mg/L)								
	9/2/86	9/8/86	9/15/86	9/22/86	9/29/86	10/6/86	10/13/86	10/20/86	10/27/86
pH (units)	7.0	7.1	7.0	6.9	6.7	6.9	7.2	7.1	7.2
Dissolved oxygen	5.2	7.4	4.5	4.4	3.4	3.5	8.0	6.1	7.3
Suspended solids	<5	6	8	16	12	5	12	<5	<5
Total dissolved solids	2600	2100	2800	3300	3600	2700	340	2000	1400
Chloroform	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Perchloroethylene	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethylene	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB	<0.0005	<0.0005	<0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phenol	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
^{241}Am (pCi/L)	<0.97	<0.64	<0.94	<0.36	<1.0	<1.6	<0.59	<1.7	<0.69
^{237}Np (pCi/L)	<2.1	<1.0	3.2	5.0	4.2	2.0	<1.1	2.4	2.3
^{238}Pu (pCi/L)	<0.73	<0.17	<0.43	<0.41	<0.32	<0.41	<0.32	1.0	<0.70
^{239}Pu (pCi/L)	<0.16	<0.07	<0.10	<0.13	<0.12	<0.16	<0.13	0.11	<0.27
^{240}Pu (pCi/L)	<0.16	<0.07	<0.10	<0.13	<0.12	<0.16	<0.13	0.11	<0.27
^{99}Tc (pCi/mL)	0.58	0.61	0.75	0.82	0.94	0.83	0.07	0.97	0.61
^{235}U (%)	0.34	0.35	0.33	0.56	0.46	0.31	1.28	0.34	0.933
Ag	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Al	0.12	0.32	0.35	11.9	0.08	<0.01	0.80	0.17	1.23
As	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
B	0.139	0.138	0.152	0.175	0.170	0.168	0.068	0.151	0.135
Ba	0.0815	0.0712	0.0804	0.175	0.0786	0.0718	0.0375	0.0639	0.0834
Be	0.0001	0.0002	0.0002	0.0007	0.0002	0.0001	<0.0001	0.0002	0.0002
Ca	399	359	415	617	769	428	62.6	315	300
Cd	0.011	0.008	0.010	0.018	0.011	0.008	<0.003	0.007	0.006
Ce	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
CN	0.006	0.005	0.008	0.012	0.01	0.009	0.014	<0.002	<0.002
Co	<0.002	<0.002	<0.002	0.008	0.002	<0.002	<0.002	0.002	<0.002
Cr	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cu	0.003	<0.002	<0.002	0.016	0.002	<0.002	0.005	<0.002	0.003
F	1.0	1.1	0.9	0.9	0.7	0.9	0.6	1.0	1.3
Fe	0.09	0.18	0.22	10.2	0.13	0.04	0.65	<0.06	1.13

Table 5.2.13 (continued)

Parameter	Concentration (mg/L)								
	9/2/86	9/8/86	9/15/86	9/22/86	9/29/86	10/6/86	10/13/86	10/20/86	10/27/86
Ga	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hg	<0.0002	0.0004	0.0002	0.0002	0.0002	0.0003	0.0006	<0.0002	0.0002
K	13.2	12.3	12	17.5	15	12	3.7	10.8	8.7
La	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Li	0.024	0.023	0.024	0.055	0.034	0.025	0.011	0.022	0.027
Mg	68.8	61.7	81.3	113	142	81.9	8.87	54.0	54.2
Mn	3.56	3.18	4.56	7.2	5.29	4.54	0.172	3.08	2.07
Mo	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	95.4	86.8	83.2	96.8	88.5	79.6	23.1	70.7	55.5
Nb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	0.007	<0.007	0.008	0.022	0.010	0.010	<0.007	0.008	<0.007
N-NO_3	220	210	320	330	340	240	18	180	0.7
P	0.34	0.30	0.37	0.61	0.72	0.38	0.12	<0.06	<0.06
Pb	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.0004	<0.0004	<0.0004	0.0023	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Sr	1.01	0.902	1.07	1.35	1.24	1.12	0.201	0.924	0.743
Th	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	<0.002	<0.002	<0.002	0.046	0.022	<0.002	0.003	0.002	0.008
U	1.22	1.22	1.36	1.38	1.29	1.52	0.196	1.24	0.38
V	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Y	ND[b]	ND	ND	ND	ND	ND	ND	ND	ND
Zn	0.015	0.015	0.005	0.065	0.008	0.001	0.018	0.012	0.030
Zr	<0.002	<0.002	<0.002	0.006	<0.002	<0.002	<0.002	<0.002	<0.002

[a]The sample ID for upper Bear Creek is W42.
[b]ND = no data.

Table 5.2.14. 1986 surface water concentrations of upper Bear Creek[a] November and December

Parameter	Concentration[b] (mg/L)								
	11/3/86	11/10/86	11/17/86	11/24/86	12/1/86	12/8/86	12/15/86	12/22/86	12/29/86
pH (units)	7.0	7.2	7.1	7.3	7.1	7.5	7.2	7.1	7.0
Dissolved oxygen	5.7	8.6	5.2	8.7	6.6	11	9.4	9.2	12
Suspended solids	<5	<5	<5	10	<5	55	<5	<5	17
Total dissolved solids	2200	1400	1500	450	1300	370	1300	1300	1400
Chloroform	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Perchloroethylene	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethane	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Phenol	<0.001	<0.001	<0.001	0.002	0.004	0.003	<0.001	<0.001	<0.001
^{241}Am (pCi/L)	<1.2	0.63	<1.3	<0.71	<0.98	<1.5	<0.28	<0.21	<0.27
^{237}Np (pCi/L)	2.3	<1.0	10.0	1.1	2.6	1.3	1.4	1.9	1.4
^{238}Pu (pCi/L)	<0.41	<0.31	<0.65	0.21	<0.22	<0.13	<0.13	<0.19	<0.14
^{239}Pu (pCi/L)	<0.16	<0.10	<0.26	<0.05	<0.07	<0.13	<0.05	<0.07	<0.05
^{240}Pu (pCi/L)	<0.16	<0.10	<0.26	<0.05	<0.07	<0.13	<0.05	<0.07	<0.05
^{99}Tc (pCi/mL)	1.0	0.60	0.55	0.07	0.38	0.04	0.58	0.67	0.30
^{235}U (%)	0.44	0.34	0.32	0.36	0.32	0.56	0.32	0.47	0.32
Ag	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Al	0.02	0.03	0.05	3.39	0.02	4.69	0.06	0.05	0.06
As	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
B	0.153	0.127	0.129	0.046	0.125	0.055	0.113	0.115	0.110
Ba	0.0660	0.0697	0.0555	0.0516	0.0523	0.0578	0.0559	0.0566	0.0565
Be	<0.0001	<0.0002	0.0002	0.0001	<0.0001	0.0002	0.0001	0.0001	0.0001
Ca	345	250	253	88.7	248	68	263	249	260
Cd	0.006	0.004	0.006	<0.003	0.005	<0.003	0.004	0.004	0.005
Ce	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
CN	0.016	0.012	0.006	0.017	0.004	0.020	0.004	0.006	0.12
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Cu	<0.002	0.002	<0.002	0.005	0.002	0.009	<0.002	0.003	<0.002
F	1.1	1.4	0.12	0.6	1.0	0.5	1.2	1.3	1.2
Fe	<0.02	0.03	0.03	2.25	0.03	3.27	0.03	0.03	0.04

Table 5.2.14 (continued)

Parameter	Concentration[b] (mg/L)								
	11/3/86	11/10/86	11/17/86	11/24/86	12/1/86	12/8/86	12/15/86	12/22/86	12/29/86
Ga	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hg	0.0002	0.0002	<0.0002	0.0014	0.0002	0.0009	<0.0002	0.0002	0.0004
K	8.7	9.3	8.1	4.3	7.0	4.2	7.0	6.5	8.3
La	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Li	0.020	0.017	0.017	0.039	0.018	0.031	0.014	0.017	0.019
Mg	59.9	48.6	49.4	13.8	45.9	11.3	41.0	40.3	46.1
Mn	2.52	1.54	2.04	0.220	1.49	0.173	1.31	1.31	1.40
Mo	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	58.9	58.6	58.7	27.6	47.8	29.2	44.6	43.4	54.4
Nb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	0.012	<0.007	0.009	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
N-NO_3	140	92	0.51	10	100	5.2	92	20	110
P	<0.06	<0.06	<0.06	0.35	<0.06	0.11	<0.06	<0.06	<0.06
Pb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.0004	<0.0004	<0.0004	<0.0006	<0.0004	<0.0008	<0.0004	<0.0004	<0.0004
Sr	0.890	0.713	0.695	0.270	0.611	0.232	0.596	0.620	0.643
Th	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	<0.002	<0.002	<0.002	0.015	<0.002	0.014	<0.002	<0.002	<0.002
U	1.10	0.993	1.10	0.288	1.04	0.088	1.10	1.04	1.10
V	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Y	ND[c]	ND	ND	ND	ND	ND	ND	ND	ND
Zn	0.005	0.008	0.006	0.018	0.004	0.047	<0.001	0.012	0.003
Zr	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

[a]The sample ID for upper Bear Creek is W42.
[b]Detection limits for some parameters were changed in 1986.
[c]ND = no data.

Table 5.2.15. 1986 radiochemical water quality for Bear Creek outfall 304[a]

Parameter	No. of samples[b]	Concentration[c] (pCi/L)		
		Max	Min	Av
^{234}U	11	22	6.0	13
^{235}U	11	17	<0.3	<2.1
^{238}U	11	43	1.2	<20
^{228}Th	11	15	0.13	3.8
^{230}Th	11	0.7	<0.10	<0.33
^{232}Th	11	4.3	<0.08	<0.57
^{3}H	11	<2200	<600	<1140
^{241}Am	11	<1.1	<0.1	<0.39
^{60}Co	11	<17	<10	<11
^{137}Cs	11	<15	<9.0	<10
^{237}Np	12	<6.0	<0.46	<1.6
^{99}Tc	12	<300	<20	<80
^{90}Sr	11	<8.0	<3.0	<5.7
^{238}Pu	11	<0.14	<0.1	<0.2
$^{239/240}Pu$	12	<0.1	<0.05	<0.08
^{226}Ra	10	2.3	<1.0	<1.6
^{95}Nb	11	<13	<8.0	<8.9
^{106}Ru	11	<125	<75	<84
^{95}Zr	11	<23	<14	<15
U-total (mg/L)	12	1.04	0.030	0.129
^{235}U (%)	12	0.54	0.32	0.45
Th-total (mg/L)	11	0.015	<0.003	<0.005

[a]The sample ID for outfall 304 is W46.
[b]Monthly composites.
[c]Detection limits for radionuclides may vary with sample size, counting time, and other factors.

Table 5.2.16. 1986 radiochemical water quality for Bear Creek outfall 304:[a] monthly composites

Parameter	Concentration[b] (pCi/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
^{234}U	NS[c]	18	6.7	8.0	16	6.0	9.6	7.6	17	18	22	22
^{235}U	NS	17	<0.3	<0.3	<0.4	<0.5	1.5	<0.31	0.52	1.0	0.80	0.97
^{238}U	NS	<1.2	14	15	15	13	19	11	20	30	39	43
^{228}Th	NS	<0.3	<0.4	<0.4	3.7	0.13	<0.6	<1.4	<3.3	15	14	2.8
^{230}Th	NS	0.14	<0.4	<0.4	0.7	<0.10	<0.2	<0.14	<0.32	<0.39	<0.34	0.56
^{232}Th	NS	<0.1	<0.3	<0.1	4.3	<0.10	<0.2	<0.08	<0.32	<0.34	<0.34	<0.11
^{3}H	NS	<2200	<2200	<2200	610	1200	<600	<670	<730	<600	<600	930
^{241}Am	NS	<0.2	<0.2	<0.3	<0.3	<0.3	<0.1	<0.43	<0.33	<0.48	<0.46	<1.1
^{60}Co	NS	<10	<10	<17	<10	<10	<10	<10	<17	<10	<10	<10
^{137}Cs	NS	<9	<9	<15	<9	<9	<9	<9	<15	<9	<9	<9
^{237}Np	<6.0	<6.0	<0.6	0.54	<0.6	<0.6	<1.6	<0.68	<1.1	<0.66	0.49	<0.46
^{99}Tc	<300	<300	<310	<300	<30	<300	<300	<20	50	100	100	<30
^{90}Sr	NS	<3.0	<3.0	<3.0	<7.0	<6.3	<4.0	<7.3	<8.0	<6.9	<6.0	<7.8
^{238}Pu	NS	<0.2	<0.4	<0.1	<0.2	<0.2	<0.1	<0.15	<0.20	<0.18	<0.18	<0.23
$^{239/240}Pu$	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.06	<0.08	<0.07	<0.07	<0.09
^{226}Ra	NS	NS	<1.1	<1.8	<1.9	1.1	<1.7	<1.8	2.3	<1.9	<1.2	<1.0
^{95}Nb	NS	<8	<8	<13	<8	<8	<8	<8	<13	<8	<8	<8
^{106}Ru	NS	<75	<75	<125	<75	<75	<75	<75	<125	<75	<75	<75
^{95}Zr	NS	<14	<14	<23	<14	<14	<14	<14	<23	<14	<14	<14
U-total (mg/L)	0.058	0.052	0.043	0.040	0.041	0.035	0.053	0.030	0.042	0.074	1.04	0.080
^{235}U (%)	0.39	0.32	0.40	0.40	0.54	0.40	0.41	0.41	0.53	0.42	0.40	0.40
Th-total (mg/L)	NS	<0.003	<0.003	<0.003	0.015	<0.003	<0.003	0.007	<0.003	<0.003	<0.003	0.005

[a] The sample ID for outfall 304 is W46.
[b] Detection limits for radionuclides may vary with sample size, counting time, and other factors.
[c] NS = no sample.

Table 5.2.17. 1986 radionuclide concentrations in East Fork Poplar Creek outfall 303 (New Hope Pond outlet)[a]

	No. of samples[b]	Concentration (pCi/L)		
		Annual Max	Annual Min	Annual Av
^{234}U	11	27	7.5	13.2
^{235}U	11	53	<0.33	<2.1
^{238}U	11	44	<4.8	<12.9
^{228}Th	11	17	<0.2	<4.4
^{230}Th	11	0.9	0.14	<0.37
^{232}Th	11	4.1	<0.04	<0.59
^{3}H	11	<2200	<600	<1000
^{241}Am	11	<0.94	<0.1	<0.35
^{60}Co	11	<17	<10	<13.2
^{137}Cs	11	<15	<9	<12
^{237}Np	11	7.7	<0.4	<1.9
^{99}Tc	11	8900	<20	<960
^{90}Sr	11	<8.7	<3.0	<5.7
^{238}Pu	11	<0.28	<0.1	<0.20
$^{239/240}Pu$	11	<0.22	<0.05	<0.09
^{226}Ra	10	<2.0	<0.98	<1.0
^{95}Nb	11	<13	<8.0	<10.3
^{106}Ru	11	<130	<80	<109
^{95}Zr	11	<23	<14	<18
U-total (mg/L)	12	0.125	0.011	0.037
^{235}U (%)	12	1.60	0.41	0.694
Th-total (mg/L)	12	0.014	<0.003	<0.007

[a] The sample ID for outfall 303 is W45.
[b] Monthly composites.

Table 5.2.18. 1986 radiochemical water quality for New Hope Pond outlet:[a] monthly composites

Parameter	Concentration (pCi/L)[b]											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
^{234}U	NS[c]	11	8.2	13	7.5	8.2	9.6	14	27	12	11	18
^{235}U	NS	<1.2	53	0.63	<0.4	0.33	<1.2	0.42	0.98	1.0	0.53	0.41
^{238}U	NS	9.6	7.6	16	14	4.8	6.2	5.2	44	12	8.4	16
^{228}Th	NS	<0.4	<0.4	<0.5	4.8	<0.1	<0.6	<3.1	<3.2	16	17	2.7
^{230}Th	NS	<0.4	<0.3	<0.2	0.9	0.21	<0.3	<0.40	<0.42	<0.31	<0.32	<0.51
^{232}Th	NS	<0.3	<0.1	<0.2	4.1	0.04	<0.2	<0.35	<0.36	<0.31	<0.10	<0.43
^{3}H	NS	<2200	<2200	<2200	770	1300	1100	<670	<730	<630	<600	<760
^{241}Am	NS	<0.2	<0.3	<0.3	<0.4	0.15	<0.1	<0.94	<0.28	<0.62	<0.40	<0.25
^{60}Co	NS	<10	<10	<17	<17	<10	<10	<17	<17	<17	<10	<10
^{137}Cs	NS	<9	<9	<15	<15	9	<9	<15	<15	<15	<9.0	<9.0
^{237}Np	NS	<6.0	<0.4	<0.6	<0.6	<0.5	<1.6	1.5	<1.2	7.7	0.41	<0.47
^{99}Tc	NS	<300	<300	<300	<30	<300	<300	<20	8900	40	30	50
^{90}Sr	NS	<3.0	<3.0	<3.0	<6.3	<6.9	<4.0	7.3	<8.7	<6.8	<6.1	<7.6
^{238}Pu	NS	<0.2	<0.3	<0.2	<0.2	<0.15	<0.1	<0.19	<0.28	<0.17	<0.22	<0.15
$^{239/240}Pu$	NS	<0.2	<0.1	0.1	<0.1	<0.1	<0.1	<0.06	<0.09	<0.05	<0.22	<0.06
^{226}Ra	NS	NS	<1.8	<1.1	<1.0	<1.0	<1.0	<1.0	<1.1	<1.1	<2.0	<0.98
^{95}Nb	NS	<8	<8	<13	<13	<8	<8	<13	<13	<13	<8.0	<8.0
^{106}Ru	NS	<75	<75	<125	<125	<75	<75	<125	<125	<125	<75	<75
^{95}Zr	NS	<14	<14	<23	<23	<14	<14	<23	<23	<23	<14	<14
U-total (mg/L)	0.013	0.028	0.023	0.040	0.042	0.011	0.020	0.014	0.125	0.032	0.024	0.031
^{235}U (%)	0.87	0.52	0.58	0.57	0.41	0.86	0.81	1.06	0.49	0.50	1.60	0.440
Th-total (mg/L)	<0.02	<0.003	<0.003	<0.003	0.014	<0.003	<0.003	0.005	<0.003	0.014	0.007	0.008

[a] The sample ID for outfall 303 is W45.
[b] Detection limits vary with sample size, counting time, and other factors.
[c] NS = no sample.

Table 5.2.19. 1986 radiochemical water quality for New Hope Pond inlet[a]

Parameter	No. of samples[b]	Concentration (pCi/L)		
		Max	Min	Av
^{234}U	11	25	7.1	13
^{235}U	11	1.4	<0.3	<1.7
^{238}U	11	42	<4.9	14
^{228}Th	11	17	<0.3	<2.8
^{230}Th	11	0.81	0.09	<0.39
^{232}Th	11	<0.44	<0.10	<0.25
^{3}H	11	<2200	570	<1214
^{241}Am	11	<1.2	<0.11	<0.44
^{60}Co	11	<17	<10	<12
^{137}Cs	11	<15	<9.0	<11
^{237}Np	11	1.6	<0.42	<0.89
^{99}Tc	11	1100	<30	<280
^{90}Sr	11	<7.9	<3.0	<5.6
^{238}Pu	11	<0.24	<0.1	<0.17
$^{239/240}Pu$	11	<0.1	<0.05	<0.07
^{226}Ra	10	<1.9	<1.0	<1.3
^{95}Nb	11	<13	<8.0	<9.8
^{106}Ru	11	<125	<75	<89
^{95}Zr	11	<23	<14	<15
U-total (mg/L)	11	0.120	0.013	0.038
^{235}U (%)	11	1.20	0.40	0.65
Th-total (mg/L)	11	0.014	<0.003	<0.005

[a]The sample ID is W56.
[b]Monthly composites.

Table 5.2.20. 1986 radiochemical water quality for New Hope Pond inlet:[a] monthly composites

Parameter	Concentration[b] (pCi/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
^{234}U	NS[c]	7.1	8.5	11	13	8.8	9.7	8.9	25	24	15	12
^{235}U	NS	<1.2	<0.3	0.53	<0.4	<0.4	<2.2	<0.48	1.4	1.3	<0.54	<0.52
^{238}U	NS	11	8.7	13	12	5.2	6.5	4.9	42	35	8.5	17
^{228}Th	NS	<0.3	<0.6	<0.4	0.47	<0.5	<0.6	<1.9	<3.2	17	3.0	2.3
^{230}Th	NS	<0.1	<0.6	<0.4	0.09	<0.4	0.4	<0.24	0.81	<0.32	<0.51	0.40
^{232}Th	NS	<0.1	<0.2	<0.1	0.42	<0.4	<0.2	<0.14	<0.37	<0.32	<0.44	<0.10
^{3}H	NS	<2200	<2200	<2200	570	2100	660	<680	<750	<600	<600	<800
^{241}Am	NS	<0.2	<0.2	<0.3	<0.4	<0.11	<0.3	<0.45	<0.31	<0.64	<1.2	<0.69
^{60}Co	NS	<10	<10	<17	<17	<17	<17	<10	<10	<10	<10	<10
^{137}Cs	NS	<9	<9	<15	<15	<15	<15	<9	10	<9	<9	<9
^{237}Np	NS	<0.6	1.6	0.79	<0.6	<0.5	<1.6	<0.80	<1.2	<1.1	<0.42	0.56
^{99}Tc	NS	<300	<300	<300	<300	<300	<300	30	<30	40	50	1100
^{90}Sr	NS	<3.0	<3.0	<3.0	<6.1	<6.2	<4.4	<7.3	<7.9	<7	<6	<7.6
^{238}Pu	NS	<0.2	<0.2	<0.1	<0.1	<0.2	<0.1	<0.15	<0.14	<0.23	<0.19	<0.24
$^{239/240}Pu$	NS	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.06	<0.05	<0.05	<0.06	<0.05
^{226}Ra	NS	NS	<1.1	<1.7	<1.2	<1.9	<1.0	<1.1	<1.3	<1.2	<1.9	<1.0
^{95}Nb	NS	<8	<8	<13	<13	<13	<13	<8	<8	<8	<8	<8
^{106}Ru	NS	<75	<75	<125	<125	<125	<75	<75	<75	<75	<75	<75
^{95}Zr	NS	<14	<14	<23	<23	<23	<14	<14	<14	<14	<14	<14
U-total (mg/L)	NS	0.021	0.031	0.034	0.032	0.014	0.015	0.013	0.120	0.085	0.024	0.032
^{235}U (%)	NS	0.48	0.67	0.55	0.55	0.81	0.80	1.20	0.40	0.44	0.80	0.48
Th-total (mg/L)	NS	<0.003	<0.003	<0.003	0.014	<0.003	<0.003	0.004	<0.003	<0.003	<0.003	0.012

[a]The sample ID is W56.
[b]Detection limits vary with sample size, counting time, and other factors.
[c]NS = no sample.

Table 5.2.21. 1986 concentrations in east sanitary sewer discharge from Y-12 Plant to Oak Ridge sewage system, January–May

Parameter	Concentration (mg/L)				
	Jan.	Feb.	March	April	May
Hg	0.0530	0.0053	0.0180	0.0320	0.0016
Oil and grease	ND[a]	ND	8	9	7
TSS	ND	ND	110	150	48
CN	ND	ND	<0.002	0.009	<0.002
KJL	ND	ND	15	8	13
$N\text{-}NO_3$	ND	ND	0.8	2	0.7
N-TOT	ND	ND	16	10	14
BOD	ND	ND	51	29	23
PCB	<0.0005	0.0014	<0.0005	0.0010	<0.0005
pH (units)	7.8	7.7	7.9	7.8	7.6
Alpha (pCi/L)	8.9	82	1	15	27
Beta (pCi/L)	17	46	37	4	57
U (pCi/L)	0.004	0.017	0.004	0.016	0.075
^{235}U (%)	2.18	2.2	1.9	7.22	0.33
^{235}U (pCi/L)	ND	ND	0.4	1.8	0.77
^{234}U (pCi/L)	7.5	32	7.5	50	11
^{238}U (pCi/L)	1.5	6.7	2	6.7	27
^{60}Co (pCi/L)	9	10	10	10	10
^{137}Cs (pCi/L)	10	9	9	9	9
^{237}Np (pCi/L)	3	3	0.5	0.7	0.6
^{238}Pu (pCi/L)	0.2	0.1	0.2	0.2	0.8
$^{239/240}Pu$ (pCi/L)	ND	ND	ND	<0.1	ND
Ag	0.04	<0.01	0.05	0.02	0.01
Al	0.16	0.06	0.26	0.9	0.4
As	0.06	0.06	0.06	0.06	0.06
B	0.02	0.03	0.03	0.02	0.03
Ba	0.2	0.2	0.2	0.2	0.2
Be	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ca	35	51	35	35	33
Cd	<0.002	<0.002	<0.002	<0.002	<0.002
Ce	<0.03	<0.03	<0.03	<0.03	<0.03
Co	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	0.03
Cu	0.028	0.010	0.044	0.048	0.038
Fe	0.66	0.14	0.58	0.79	0.38
Ga	<0.04	<0.04	<0.04	<0.04	<0.04
K	5.6	5	5.2	5.4	4.6
La	<0.01	<0.01	<0.01	<0.01	<0.01
Li	<0.01	<0.01	<0.01	<0.01	0.03
Mg	9.4	11	9.1	8.9	9
Mn	0.05	0.18	0.05	0.09	0.04
Mo	<0.1	<0.1	<0.1	<0.1	<0.1
Na	14	18	12	15	1
Nb	<0.02	<0.02	<0.02	<0.02	<0.02
Ni	<0.01	<0.01	<0.01	<0.01	<0.01
P	2.5	1.3	2.5	3	3
Pb	<0.01	<0.01	<0.01	<0.01	<0.01
Sc	<0.001	<0.001	<0.001	<0.001	<0.001
Sr	0.110	0.170	0.110	0.100	0.096
Th	<0.02	<0.02	<0.02	<0.02	<0.02
Ti	<0.001	0.025	<0.001	<0.001	<0.006
V	<0.003	<0.003	<0.003	<0.003	<0.003
Y	<0.001	<0.001	<0.001	0.002	<0.001
Zn	0.20	0.10	0.18	0.23	0.17

Table 5.2.21 (continued)

Parameter	Concentration (mg/L)				
	Jan.	Feb.	March	April	May
Zr	<0.001	<0.001	<0.001	<0.001	0.001
Benzene	ND	ND	ND	<0.010	<0.010
Bromodichloromethane	ND	ND	ND	<0.010	<0.010
Bromoform	ND	ND	ND	<0.010	<0.010
Bromomethane	ND	ND	ND	<0.010	<0.010
CCl_4	ND	ND	ND	<0.010	<0.010
Chlorobenzene	ND	ND	ND	<0.010	<0.010
Chloroethane	ND	ND	ND	<0.010	<0.010
Chloroethylvinyl ether	ND	ND	ND	<0.010	<0.010
Chloroform	ND	ND	ND	0.014	0.011
Chloromethane	ND	ND	ND	<0.010	<0.010
Dibromochloromethane	ND	ND	ND	<0.010	<0.010
1,2-Dichlorobenzene	ND	ND	ND	ND	<0.010
1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	<0.010	<0.010
1,2-Dichloroethane	ND	ND	ND	<0.010	<0.010
1,1-Dichloroethene	ND	ND	ND	<0.010	<0.010
Trans-1,2-Dichloroethene	ND	ND	ND	<0.010	<0.010
cis-1,3-Dichloropropene	ND	ND	ND	<0.010	<0.010
Ethyl benzene	ND	ND	ND	<0.010	<0.010
Methylene chloride	ND	ND	0.013	<0.010	<0.010
1,1,2,2-Tetrachloroethane	ND	ND	ND	<0.010	<0.010
Tetrachloroethene	ND	ND	0.012	<0.010	<0.010
Toluene	ND	ND	ND	<0.010	<0.010
1,1,1-Trichloroethane	ND	ND	ND	<0.010	<0.010
1,1,2-Trichloroethane	ND	ND	ND	<0.010	<0.010
Trichloroethene	ND	ND	ND	<0.010	<0.010
Trichlorofluoromethane	ND	ND	ND	<0.010	<0.010
Vinyl chloride	ND	ND	ND	<0.010	<0.010
Acetone	ND	ND	ND	ND	0.084

[a]ND = no data.

Table 5.2.22. Concentrations in east sanitary sewer discharge from Y-12 Plant to Oak Ridge sewage system, June–December

Parameter	Concentration (mg/L)						
	June	July	August	September	October	November	December
Hg	0.0018	0.0070	0.0054	0.0022	0.0019	0.0018	0.0015
Oil and grease	8	25	7	3	12	<2	8
TSS	7.5	230	100	77	110	66	98
CN	<0.002	<0.002	<0.002	0.003	0.004	<0.002	<0.002
KJL	7.4	22	10	18	19	28	9.4
N-NO_3	0.5	0.7	0.6	0.5	0.4	0.27	0.8
N-TOT	7.9	23	11	19	19	28	10.2
BOD	21	9	70	55	37	52	5
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
pH (units)	7.8	7.9	7.4	7.8	7.9	8.0	7.8
Alpha (pCi/L)	<1	12	270	<1	8.1	14	57
Beta (pCi/L)	8	22	280	15	<4	28	3.8
U (mg/L)	0.034	0.002	0.945	0.036	0.248	0.050	0.003
^{235}U (%)	1.05	1.69	0.22	4.19	0.49	1.24	1.47
^{235}U (pCi/L)	<0.3	0.9	6	2	<0.16	<0.44	<0.35
^{234}U (pCi/L)	2.1	9.1	92	60	4.4	3.1	3.6
^{238}U (pCi/L)	0.5	68	360	11	4.7	1.2	0.68
^{60}Co (pCi/L)	<10	<10	<17	<10	<10	<10	<10
^{137}Cs (pCi/L)	<9	<9	<15	<9	<9	<9	<9
^{237}Np (pCi/L)	<0.6	<0.5	4.6	<0.55	<0.54	1.1	<0.86
^{238}Pu (pCi/L)	<0.2	<0.3	<0.1	<0.18	<0.22	<0.16	<0.14
$^{239/240}$Pu (pCi/L)	ND[a]	ND	ND	<0.07	ND	ND	<0.14
Ag	0.01	<0.01	<0.01	0.007	0.01	0.012	0.026
Al	<0.05	0.16	0.46	0.17	0.38	0.26	0.56
As	<0.06	<0.06	<0.06	<0.04	<0.04	<0.04	<0.04
B	0.03	<0.02	0.06	0.019	0.015	0.04	0.033
Ba	<0.2	<0.2	<0.2	0.0583	0.0393	0.0444	0.0461
Be	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001
Ca	42	29	38	37.1	38.5	37	38.6
Cd	<0.002	<0.002	<0.002	<0.003	<0.003	<0.003	<0.003
Ce	<0.03	<0.03	<0.03	<0.02	<0.02	<0.02	<0.02
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	0.12	<0.006	0.017	<0.006	<0.006
Cu	0.010	0.024	0.048	0.037	0.161	0.027	0.046
Fe	0.13	0.36	0.41	0.29	0.72	0.4	0.49
Ga	<0.04	<0.04	<0.04	<0.01	<0.01	<0.01	<0.01
K	5.1	5.5	5.4	8.3	7.8	9.5	7.8
La	<0.01	<0.01	<0.01	<0.003	<0.003	<0.003	<0.003
Li	<0.01	<0.01	0.17	0.006	0.01	0.008	0.013
Mg	11	7.6	8.8	9.4	10.4	10.6	10.5
Mn	0.04	0.04	0.05	0.041	0.037	0.048	0.057
Mo	<0.1	<0.1	<0.1	0.039	0.055	0.027	0.046
Na	13	11	12	16	15.5	17.4	21.2
Nb	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01
Ni	<0.01	<0.01	<0.01	<0.007	<0.007	<0.007	<0.007
P	1.5	2	2.1	2.76	2.93	4.65	2.86
Pb	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02
Sc	<0.001	<0.001	<0.001	<0.0004	<0.0004	<0.0004	<0.0004
Sr	0.120	0.093	0.120	0.107	0.108	0.124	0.121
Th	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01
Ti	0.008	<0.001	0.004	<0.002	<0.002	0.002	0.002
V	<0.003	<0.003	<0.003	<0.004	<0.004	<0.004	<0.004
Y	<0.001	<0.001	<0.001	ND	ND	ND	ND
Zn	0.13	0.22	0.14	0.19	0.199	0.179	0.206

Table 5.2.22 (continued)

Parameter	Concentration (mg/L)						
	June	July	August	September	October	November	December
Zr	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002	<0.002
Benzene	<0.010	<0.010	ND	ND	<0.010	ND	ND
Bromodichloromethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bromoform	<0.010	ND	ND	ND	ND	ND	<0.010
Bromomethane	ND	ND	ND	ND	ND	ND	<0.010
CCl_4	ND	<0.010	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	<0.010
Chloroethane	ND	ND	ND	ND	ND	ND	ND
Chloroethylvinyl ether	ND	0.010	ND	ND	0.010	0.010	ND
Chloroform	<0.010	<0.010	0.010	<0.010	ND	ND	<0.010
Chloromethane	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	<0.010	<0.010	ND	ND	<0.010	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	<0.010	ND	ND	ND	ND	<0.010
Ethyl benzene	<0.010	<0.010	ND	ND	ND	<0.010	<0.010
Methylene chloride	ND	<0.010	ND	ND	ND	<0.010	<0.010
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	<0.010	ND	ND
Tetrachloroethene	<0.010	ND	ND	<0.010	<0.010	<0.010	ND
Toluene	ND	ND	<0.010	<0.010	<0.010	ND	ND
1,1,1-Trichloroethane	<0.010	<0.010	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	<0.010	ND	ND	ND	ND	ND
Trichloroethene	<0.010	<0.010	<0.010	<0.010	<0.010	ND	<0.010
Trichlorofluoro-methane	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	<0.010	ND	<0.010
Acetone	ND	ND	ND	ND	>0.060	ND	ND

[a]ND = no data.

Table 5.2.23. 1986 concentration in West Sanitary Sewer discharge from Y-12 Plant to Oak Ridge Sewage Treatment Plant

Parameter	Concentration[b] (mg/L)											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hg	<0.0005	<0.0005	0.0036	<0.0005	<0.0005	0.0016	0.0007	<0.0005	0.0003	0.0009	0.0022	0.0014
Oil	ND[b]	ND	9	<2	5	7	10	2	5	6	3	7
TSS	ND	ND	96	<5	<5	42	49	20	20	91	10	36
CN	ND	ND	0.021	<0.002	<0.002	<0.002	<0.002	<0.002	0.006	0.02	0.031	0.027
KJL	ND	ND	19	0.6	<0.2	14	13	14	18	23	11	31
N-NO_3	ND	ND	5.3	1	0.8	0.2	0.4	0.1	0.4	3.0	5.8	6.8
N-TOT	ND	ND	24	1.6	1	14	13	14	19	24	17	38
BOD	ND	ND	57	<5	<5	30	29	27	32	38	35	54
PCB	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.005	<0.0005
pH (units)	7.9	7.1	7.5	7.7	7.1	7.3	7.3	7.4	7.7	7.9	7.7	8.1
Alpha (pCi/L)	<1.0	5.8	120	15	9.6	42	26	3.9	56	67	11	54
Beta (pCi/L)	7.2	6.9	130	17	<4	230	5.4	42	50	51	56	140
U (mg//L)	0.002	0.002	0.045	0.003	0.003	0.390	0.010	0.016	0.030	0.023	0.021	0.014
^{235}U (%)	2.08	2.29	2.3	2.12	2.1	2.88	2.86	3.14	2.41	2.35	1.84	1.56
^{235}U (pCi/L)	<2.2	ND	4.9	<0.8	<0.3	1.5	0.9	1.7	2.3	1.1	0.77	<0.33
^{234}U (pCi/L)	4.5	3.4	81	18	4.9	59	26	43	60	42	27	22
^{238}U (pCi/L)	ND	<1.2	13	4	1.3	7.7	3.3	6	11	8.2	7.2	5
^{60}Co (pCi/L)	<9	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
^{137}Cs (pCi/L)	<10	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9
^{237}Np (pCi/L)	<6	<3	2.2	6.2	<0.5	<0.5	<0.5	<0.6	<0.4	2.8	0.96	<0.6
^{238}Pu (pCi/L)	<0.2	<0.1	<0.2	<0.2	<0.1	<0.2	<0.2	<0.6	<0.17	<0.16	<0.39	<0.23
^{239,240}Pu (pCi/L)	ND	ND	ND	ND	ND	ND	ND	<0.6	ND	ND	ND	ND
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	<0.004
Al	<0.05	<0.05	0.47	<0.05	<0.05	0.12	0.17	0.09	0.11	0.43	0.07	0.39
As	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.04	<0.04	<0.04	<0.04	<0.04
B	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.017	0.024	0.028	0.032	0.037
Ba	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.0339	0.0423	0.0832	0.0573	0.0771
Be	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	0.0001	<0.0001	0.0001
Ca	36	62	45	37	35	38	34	37.4	44.1	50.5	58.2	47.9
Cd	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.003	<0.003	<0.003	<0.003	<0.003
Ce	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Co	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006	0.055	0.009	<0.006	<0.006
Cu	0.005	0.005	0.032	0.004	<0.004	0.012	0.013	0.011	0.015	0.032	0.006	<0.002
Fe	0.14	<0.06	0.81	<0.06	<0.06	0.39	0.44	0.36	0.4	0.83	0.17	0.24
Ga	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01	<0.01	<0.01	<0.01	<0.01
K	2.0	2.2	5.5	1.9	1.8	6.7	5.6	5.9	8.1	9.1	6	13.2
La	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Li	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.006	0.037	0.006	0.007	0.013
Mg	6.8	11	10	6.4	7.5	10	8.2	9.67	10.9	12.5	13.5	10.9
Mn	0.08	0.05	0.19	0.08	0.03	0.06	0.07	0.042	0.071	0.176	0.254	0.262
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.006	<0.006	0.014	<0.006	<0.006
Na	9	35.0	17.0	10	9.2	18	14	13.9	18.9	18.8	15.7	25.4

Table 5.2.23 (continued)

Parameter	Concentration (mg/L)											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Nb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.007	0.007	0.009	0.009	0.009
P	0.16	0.04	2.9	0.1	0.06	2.3	1.8	1.97	3.19	3.83	2.67	4.02
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Sr	0.081	0.130	0.120	0.088	0.081	0.110	0.097	0.103	0.127	0.147	0.178	0.134
Th	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Ti	<0.001	0.003	0.001	<0.010	0.015	0.005	0.003	0.006	<0.002	<0.002	<0.002	<0.002
V	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.004	<0.004	<0.004	<0.004	<0.004
Y	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	ND	ND	ND	ND
Zn	<0.02	0.07	0.18	<0.02	0.02	0.12	0.09	0.088	0.095	0.225	0.092	0.113
Zr	<0.001	0.002	<0.001	<0.001	0.002	<0.001	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002
Benzene	ND	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bromodichloromethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	<0.010	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Bromomethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	ND	ND	ND	ND
2-Chloroethylenevinyl ether	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chloroform	ND	ND	<0.010	0.107	<0.010	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	0.020
Chloromethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.010	<0.010	<0.010
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.010	<0.010	<0.010
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.010	<0.010	<0.010
1,1-Dichloroethane	ND	ND	ND	ND	<0.010	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,2-Dichloroethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,1-Dichloroethene	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Trans-1,2 Dichloroethene	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,2 Dichloropropane	ND	ND	ND	ND	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cis-1,3-Dichloropropene	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Ethyl benzene	ND	ND	ND	ND	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methylene chloride	ND	ND	<0.010	<0.010	<0.010	<0.010	ND	<0.010	<0.010	<0.010	<0.010	438
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Tetrachloroethene	ND	ND	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	0.014	0.010	<0.010
Toluene	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,1,1-Trichloroethane	ND	ND	ND	<0.010	<0.010	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010
1,1,2-Trichloroethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Trichloroethene	ND	ND	ND	ND	<0.010	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Trichlorofluoromethane	ND	ND	ND	ND	<0.010	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010
Vinyl chloride	ND	ND	ND	ND	<0.010	0.014	ND	<0.010	<0.010	<0.010	<0.010	<0.010

[a] Detection limits for several parameters changed in 1986.
[b] ND = no data.

Melton Hill Dam, Northwest Tributary (NMT), Raccoon Creek, Sewage Treatment Plant (STP), White Oak Creek (WOC), White Oak Creek headwaters, and White Oak Dam (WOD), and analyzed for radionuclides. The flow and concentration data from ORNL streams were recorded to determine the concentrations of radionuclides discharged from ORNL processes. In addition, process water samples were collected from the sanitary waste treatment plants at ORGDP and at Kingston. Samples from Melton Hill Dam, WOC headwaters, and ORNL tap water were considered as background. In addition, real-time monitoring is performed at WOD, MB, and WOC. The parameters monitored are given in Tables 5.2.24 and 5.2.25.

Flow proportional samples at 7500 Bridge were collected and analyzed daily as an early warning of discharges of radioactivity from ORNL processes. Samples were collected weekly and analyzed monthly for additional parameters. Flow proportional samples from WOD were collected and analyzed weekly while those from WOC, MB1, STP, and Melton Hill Dam were collected weekly, composited, and analyzed monthly. The time proportional samples from ORGDP and grab samples from Kingston and ORNL tap water were composited and analyzed quarterly. Summaries of radionuclide concentrations are presented in Tables 5.2.26 and 5.2.27. Samples were analyzed for total Pu, ^{239}Pu, and ^{240}Pu. Initially, samples were analyzed for ^{90}Sr. To comply with the method recommended by the EPA, during the third quarter, the Analytical Chemistry Division instituted a change in the procedure so that analyses are performed for total radioactive Sr.

Concentrations of ^{60}Co during the first three quarters were higher at Melton Branch than at other stations. Concentrations observed at Melton Branch during the first quarter were significantly higher than those observed during the other quarters. During the fourth quarter, concentrations of ^{60}Co at 7500 Bridge, WOC, and WOD were significantly higher than during previous quarters (Table 5.2.26). The increase was caused by a higher-than-usual level of ^{60}Co released from the WC-10 Tank Farm storage area into WOC via the Process Waste Treatment Plant. Overall, the concentrations of ^{60}Co were higher at Melton Branch. The concentrations of ^{137}Cs were higher at 7500 Bridge, WOC, and WOD than at the other stations (Table 5.2.26). Most of the ^{3}H was derived from SWSA 5 near the MB1 station. The highest concentrations were observed at this station (Table 5.2.26). The high concentrations of total Sr found at the First Creek station were probably due to leakage from burst pipes. Suspected pipe breaks in this area are being addressed in the short term by placing a liner inside the pipes. There is a long-term project to replace selected piping in the ORNL complex.

Flows in the Clinch River at Melton Hill Dam and WOC at WOD, and the ratio of these flows are presented in Table 5.2.28. Total flow per day at MB1, WOC, and WOD were calculated by subtracting consecutive daily flow recorder readings and multiplying by a factor for conversion to liters. Clinch River flow was recorded daily by TVA personnel and forwarded monthly to ORNL. Low flow and high flow readings were recorded for WOC and MB1 and were summed to estimate total flow. Three flows (low, medium, and high) were recorded at WOD and summed to give total flow. Average contributors of ^{90}Sr from various ORNL areas are given in Table 5.2.29.

Tritium and ^{90}Sr are the radionuclides of greatest concern in terms of radiation doses to the public from drinking water. Approximately 90% of the ^{3}H discharges over WOD could be accounted for by the discharges of ^{3}H over the MB1 weir. Tritium values measured at MB1 weir, which is below the area where SWSA 5 discharges to Melton Branch, are generally more than an order of magnitude higher than values measured at the MB2 weir above the SWSA 5 area (Table 5.2.26). Characterization of SWSA 5, particularly the ^{3}H problem in SWSA 5, will be a high priority of the Remedial Investigation Feasibility Study subcontract. This characterization, scheduled for April 1987, is necessary to comply with RCRA requirements and to determine the measures necessary to reduce the flow of ^{3}H and/or other contaminants from SWSA 5 effectively.

Table 5.2.24. Environmental parameters monitored at White Oak Dam

Signal	Output	Range	Unit
		Monitors	
pH	4–20 mA	0–12	
Dissolved oxygen	4–20 mA	0–24	mg/L
Turbidity	4–20 mA	0–240	Jackson turbidity units
Conductivity	4–20 mA	0–2400	μmhos
Temperature	4–20 mA	0–120	°F
Low flow	4–20 mA	0–7000	gal/min
Medium flow	4–20 mA	0–89772	gal/min
High flow	4–20 mA	0–9.439 × 10^5	gal/min
Tailwater level	4–20 mA	0–12	in.
Beta	Pulse	10–1 × 10^6 (note[a])	counts/min
Gamma	Pulse	10–1 × 10^6 (note[a])	counts/min
Gamma spectrum	Pulse		spectrum
		Alarms	
Sample bottle full		Contact	
Sampler inoperative		Contact	
Floor drain overflow		Contact	
Low sample flow		Contact	
Low water quality flow		Contact	
Low gamma flow		Contact	
Low beta flow		Contact	
Shelter door open		Contact	
Shelter abnormal temperature		Contact	

[a]Count rate must be determined from pulse output.

Table 5.2.25. Environmental parameters monitored at White Oak Creek and Melton Branch

Signal	Output	Range	Unit
Monitors			
pH	4–20 mA	0–12	
Dissolved oxygen	4–20 mA	0–24	mg/L
Turbidity	4–20 mA	0–240	Jackson turbidity units
Conductivity	4–20 mA	0–2400	μmhos
Temperature	4–20 mA	0–120	°F
Low flow	4–20 mA	0–7000	gal/min
High flow	4–20 mA	0–5.529 × 10^5	gal/min
Tailwater level	4–20 mA	0–12	inches
Beta	Pulse	10–1 × 10^6 (note[a])	counts/min
Gamma	Pulse	10–1 × 10^6 (note[a])	counts/min
Gamma spectrum	Pulse		spectrum
Alarms			
Sample bottle full		Contact	
Sampler inoperative		Contact	
Floor drain overflow		Contact	
Low sample flow		Contact	
Low water quality flow		Contact	
Low gamma flow		Contact	
Low beta flow		Contact	
Shelter door open		Contact	
Shelter abnormal temperature		Contact	

[a]Count rate must be determined from pulse output.

Table 5.2.26. 1986 radionuclide concentrations in ORNL surface streams

Radionuclides	Number of samples	Concentration (pCi/L) Max	Min	Av	95% CC[a]
		First Creek			
^{60}Co	12	13	<2.7	<6.3	1.9
^{137}Cs	12	<27	<2.4	<7.4	4.0
Total Sr[b]	12	1,000	250	590	140
		Fifth Creek			
^{60}Co	12	<11	<1.6	<5.2	1.8
^{137}Cs	12	<8.1	<1.3	<4.8	1.6
Total Sr[b]	12	54	25	39	5.1
		7500 Bridge			
^{60}Co	12	140	4.9	24	24
^{137}Cs	12	230	59	160	30
^{3}H	12	8,200	<3,200	<5,900	1,100
Total Sr[b]	12	150	68	104	17
		Melton Branch 1			
^{60}Co	12	1600	68	330	230
^{137}Cs	12	<11	<2.7	<6.4	2.2
^{3}H	12	3,200,000	520,000	1,700,000	420,000
Total Sr[b]	12	300	62	205	35
		Melton Branch 2			
^{60}Co	12	1800	30	300	280
^{137}Cs	12	<11	<1.6	<5.6	<2.2
^{3}H	12	170,000	5,100	91,000	36,000
Total Sr[b]	12	19	0.81	5.9	3.4
		Melton Hill Dam			
^{60}Co	12	<8.1	<1.6	<4.2	1.4
^{137}Cs	12	<8.1	<1.4	<3.4	1.4
^{3}H	12	7,200	3,200	3,900	740
Pu	12	0.032	0.013	0.027	0.0044
Total Sr[b]	12	7.8	1.1	3.8	1.3
^{228}Th	11	1.4	<0.0054	<0.29	0.28
^{230}Th	11	<0.54	<0.0054	<0.10	0.10
^{232}Th	12	<0.54	<0.0054	<0.098	0.10
TransPu	12	0.22	0.013	0.052	0.032
^{234}U	12	0.84	0.0054	0.35	0.13
^{235}U	12	0.27	0.0019	0.072	0.050
^{238}U	12	3.2	0.011	0.70	0.60
		Northwest Tributary			
^{60}Co	12	<11	<1.6	<4.3	1.6
^{137}Cs	12	<11	<1.4	<4.6	1.7
Total Sr[b]	12	68	2.7	34	12
		Raccoon Creek			
^{60}Co	12	<11	<1.9	<4.6	1.6
^{137}Cs	12	<11	<1.4	<4.5	1.6
Total Sr[b]	12	180	25	91	31

Table 5.2.26 (continued)

Radionuclides	Number of samples	Concentration (pCi/L)			
		Max	Min	Av	95% CC[a]
Sewage Treatment Plant					
^{60}Co	12	<14	<2.0	<5.9	1.8
^{137}Cs	12	30	<5.4	<11	3.9
Total Sr[b]	12	380	100	180	51
White Oak Creek					
^{60}Co	12	150	<2.0	<26	27
^{137}Cs	12	220	62	140	31
^{3}H	12	59,000	3,500	27,000	12,000
Total Sr[b]	12	190	92	150	20
White Oak Creek Headwaters					
^{60}Co	12	<8.1	<2.2	<4.2	1.3
^{137}Cs	12	<8.1	<1.6	<4.1	1.3
^{3}H	12	70,000	3,200	9,300	11,000
Pu	12	0.032	<0.011	<0.028	0.0044
Total Sr[b]	12	9.2	0.27	3.2	1.7
^{228}Th	11	1.4	<0.0054	<0.30	0.27
^{230}Th	11	0.54	0.014	0.13	0.12
^{232}Th	12	0.54	<0.0027	<0.13	0.12
Trans Pu	12	0.11	0.027	0.049	0.014
^{234}U	12	0.81	0.0081	0.31	0.14
^{235}U	12	0.14	0.0014	0.049	0.021
^{238}U	12	3.2	0.014	0.61	0.60
White Oak Dam					
^{60}Co	52	250	7.8	40	15
^{137}Cs	52	460	17	100	25
Gross alpha	52	360	11	79	17
Gross beta	52	2,300	270	630	95
^{3}H	50	540,000	39,000	240,000	41,000
Pu	50	6.5	0.043	0.53	0.26
Total Sr[b]	52	320	4.1	170	15
TransPu	49	17	0.19	1.8	0.71

[a]95% confidence coefficient about the average.
[b]Samples were analyzed for ^{90}Sr or total radioactive Sr.

Table 5.2.27. 1986 radionuclide concentrations in water at 7500 Bridge

Radionuclides	No.of samples	Concentration (pCi/L)			
		Max	Min	Av	95% CC[a]
^{60}Co	152	760	2.7	26	12
^{137}Cs	184	2200	27	240	32
^{152}Eu	9	1400	21	360	340
^{154}Eu	4	410	16	230	170
^{155}Eu	3	110	22	65	51
^{156}Eu	3	1200	540	920	400
Gross alpha	28	1400	27	310	93
Gross beta	35	3500	220	840	190
^{131}I	3	14	5.4	10	5.3
^{24}Na	10	86	13	42	13
Total Sr[b]	267	840	40	110	8.9

[a]95% confidence coefficient about the average.
[b]Samples were analyzed for ^{90}Sr or total radioactive Sr.

Table 5.2.28. 1986 flow for Clinch River and White Oak Creek

Month	Flow (10^9 L)		Average ratio[b]
	Clinch River[a]	White Oak Creek[a]	
January	300	0.83	360
February	200	1.5	130
March	200	1.2	170
April	90	0.71	130
May	180	0.54	330
June	180	0.55	330
July	250	0.72	350
August	170	0.56	300
September	240	0.57	420
October	310	0.77	400
November	200	0.88	230
December	290	1.5	190

[a]Ratio of Clinch River to White Oak Creek flow is calculated weekly and averaged for the month.
[b]Average Clinch River ÷ average WOC.

Table 5.2.29. Average contribution of ^{90}Sr from various ORNL areas

Area	1979		1980		1981		1982	
	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]
Measured contributors								
Measured flume (W16)	15	6.3	10	6.1	13	10.6	13	5.4
Measured 3539 & 3540 ponds (W15)	1.0	0.40	2.4	1.4	0.40	0.3	0.20	0.1
Measured Process Waste Treatment Plant (PWTP) (W14)	2.9	1.2	1.9	1.1	2.7	2.2	0.50	0.2
Measured Sewage Treatment Plant (STP) (W13)	11	4.8	15	9.1	18	14.8	36	15.7
(Sum) ORNL operations	30	12.7	30	17.7	34	27.9	50	21.4
Measured station 2A (W10)	70	30	77	46.4	72	58.9	120	49.8
Measured station 3 (W5)	170	71.5	110	65.1	100	84.4	180	77.1
Measured HFIR/TRU (W8)	0.20	0.10	0.20	0.10	0.30	0.30	0.90	0.4
Measured NSPP/MSRE (W9)	6.6	2.8	4.8	2.9	3.3	2.7	9.0	3.9
(Sum) Melton Branch	6.8	2.9	5.0	3.0	3.6	3.0	9.9	4.3
Measured station 4 (W4)	67	28.5	52	31.2	17	14.1	50	21.5
Measured east weir (W6)	NA		0.30	0.20	1.0	0.80	0.10	0.10
Measured west weir (W7)	NA		5.9	3.6	1.0	0.8	3.1	1.3
(Sum) total pits			6.2	3.8	2.0	1.6	3.2	1.4
Total effluents (sum of Station W5, Station W4, and pits)	240		170		120		230	
Measured White Oak Dam station (W3)	200		125		123		225	

Table 5.2.29 (continued)

Area	1979		1980		1981		1982	
	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]
Inferred contributors								
Burial grounds 1, 3 and floodplain (station W10, minus ORNL operation)	40	17	48	30	38	31	66	29
Burial ground 4 (W5 minus W10)	99	42	31	20	31	26	63	28
Burial ground 5 (W4 minus Melton Branch)	60	26	47	29	14	11	40	18
Total	200	85	130	79	80	68	170	75

[a]To convert from 10^9 pCi/mo to 10^7 Bq/mo, multiply by 3.7.
[b]Percent of total effluents.
Source: Developed from J. H. Coobs, ORNL, personal communications, November 14, 1983, and January 5 and February 8, 1984.

Radioactive strontium discharges from ORNL, unlike ^{3}H, which comes primarily from SWSA 5, are much more diffuse primarily resulting from discharges from the main ORNL area burial grounds and floodplains, with lesser amounts also being contributed by process discharges. Most of the strontium measured can be attributed to discharges into WOC above the monitoring station. Strontium concentrations below the range of 160 to 190 pCi/L measured in 1985 can be attributed to low levels of precipitation during 1986. It is believed that a significant portion (>50%) of the strontium discharges at ORNL during normal rainfall are the result of runoff. Concentrations of radionuclides in surface streams and tap water are given in Table 5.2.30.

At WOD, WOC, MB1, and the STP ^{90}Sr discharges are calculated by multiplying the concentration (in Ci/L) by the flow (in liters per second). Those data are given in Table 5.2.31. At WOC, MB1, and the STP, a single flow proportional sample was analyzed monthly to estimate radionuclide concentrations. At WOD, weekly flow proportional samples were analyzed. Radionuclide discharges at WOC, MB1, and the STP were calculated by dividing the concentration in the monthly composite sample by the total flow for the month at each station. However, at WOD, weekly radionuclide discharges are calculated by dividing the weekly composited sample concentration by the total weekly flow. A flow weighted concentration at WOD for the year was calculated by dividing the total radionuclide discharge by the total flow.

Surface water concentrations in West Fork Poplar Creek, ORGDP sanitary water, Poplar Creek near the Clinch River, Clinch River near ORGDP, K-901, and Poplar Creek above Blair Bridge are given in Tables 5.2.32 through 5.2.37. Concentrations of uranium in surface water are given in Table 5.2.38. Concentrations in the K-1515 sanitary water plant are given in Table 5.2.39.

5.3 WATER DISCHARGES AND NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

5.3.1 Oak Ridge Y-12 Plant Water Discharges

Discharges from the Oak Ridge Y-12 Plant area affect water quality and flow in Kerr Hollow Quarry, Rogers Quarry, East Fork Poplar Creek, or Bear Creek before entering the Clinch River. Regulators have directed the Oak Ridge Y-12 Plant to provide treatment for a variety of liquid wastes discharged to East Fork Poplar Creek. Until all of the new wastewater treatment facilities are constructed and ready for operation, steam plant and plating shop rinse waters are being discharged to East Fork Poplar Creek. Discharges allowed under permits include storm drainage, cooling water, water from firefighter training, cooling tower blowdown, and process wastewaters including effluents from pollution control treatment facilities. Sumps that collect groundwater in building basements also discharge to the stream. Major point discharges and treatment facility discharges are categorized according to their NPDES outfalls in Table 5.3.1 (NPDES, 1984).

The sanitary sewage effluent from the Oak Ridge Y-12 Plant site flows to the City of Oak Ridge West End Treatment Plant. The average daily flow is approximately 2 to 2.7 million liters per day and is independent of storm drainage and industrial waste systems (Daugherty, 1984).

A network of storm drains covers the entire area of the Oak Ridge Y-12 Plant that discharges into East Fork Poplar Creek. The system gathers rainfall from the adjacent hillsides, the parking areas north of the developed portion of the plant, the roof drains, and fire water flow from the testing of the fire protection system. In the past, interconnecting with the storm drainage system were numerous process discharges and laboratory

Table 5.2.30. 1986 concentrations of radionuclides in surface streams and tap water[a]

Location	Number of samples	Value	Concentration (pCi/L)										
			^{60}Co	^{137}Cs	Gross alpha	Gross beta	^{3}H	Total Pu	Total Sr[b]	^{234}U	^{235}U	^{236}U	^{238}U
Melton Hill Dam	4	Max	<0.54	<0.54	4.1	7.3		<0.0030	0.81	0.15	0.0044	0.00030	0.090
		Min	<0.13	<0.11	1.0	2.7		<0.0030	0.30	0.087	0.0022	<0.00016	0.045
		Av	<0.30	<0.30	2.2	4.8		<0.0030	0.53	0.12	0.0036	0.00022	0.073
ORGDP sanitary water intake	4	Max	<0.92	<0.54	5.1	15	2200	<0.0030	3.8	0.14	0.0042	0.00057	0.087
		Min	<0.16	<0.14	1.1	6.2	270	<0.0030	0.84	0.11	0.0032	<0.00013	0.068
		Av	<0.47	<0.28	3.2	9.9	1200	<0.0030	1.9	0.13	0.0037	0.00025	0.076
Kingston	4	Max	<0.27	<0.54	3.0	6.5	580	<0.0030	1.1	0.14	0.0046	0.0018	0.084
		Min	<0.081	<0.081	0.54	3.2	150	<0.0030	0.19	0.071	0.0021	0.00024	0.042
		Av	<0.20	<0.26	1.7	4.9	320	<0.0030	0.60	0.11	0.0036	0.0010	0.068
ORNL tap water	4	Max	<0.54	<0.54	5.4	5.9		<0.0030	1.1	0.16	0.0044	0.00017	0.090
		Min	<0.14	<0.11	0.54	3.2		<0.0030	0.19	0.010	0.00039	0.000037	0.0077
		Av	<0.30	<0.30	2.2	4.7		<0.0030	0.61	0.077	0.0022	0.000097	0.044

[a]1 pCi/L = 0.037 Bq/L.

[b]Samples (2 each) were analyzed for ^{90}Sr and total radioactive Sr.

Table 5.2.31. Average contribution of ^{90}Sr from various ORNL areas

Area	1983		1984		1985		1986	
	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]
Measured contributors								
Measured flume (W17)	10	4.0	7.8	4.9	20	8.3	12.4	9.5
Measured 3539 & 3540 ponds (W15)	0.20	0.10	0.40	0.25	7.2	3.0	2.6	2.0
Measured Process Waste Treatment Plant (PWTP) (W14)	0.30	0.10	0.40	0.25	33	14	6	4.6
Measured Sewage Treatment Plant (STP) (W13)	20	7.9	12	7.5	33	14	4	3.1
(Sum) ORNL operations	31	12	21	13	93	39	25	19
Measured station 2A (W10)	85	33	72	45	160	67	75	58
Measured station 3 (W5)	170	66	110	69	200	83	100	77
Measured HFIR/TRU (W8)	6.1	2.4	0.49	0.31	0.24	0.1	0.3	0.2
Measured NSPP/MSRE (W9)	4.9	1.9	5.2	3.3	4.8	2.0	4.4	3.4
(Sum) Melton Branch	11	4.3	5.7	3.6	5.0	2.1	4.7	3.6
Measured station 4 (W4)	82	33	44	28	32		28	19
Measured east weir (W6)	0.10	0.10	0.14	0.088	0.093	0.03	1.23	0.95
Measured west weir (W7)	3.6	1.4	5.1	3.2	2.4	1.0	4.0	3.1
(Sum) total pits	3.7	1.5	5.2	3.3	2.5	1.0	5.2	4.0
Total effluents (sum of Station W5, Station W4, and pits)	260		160		240		130	
Measured White Oak Dam station (W3)	208		216		250		150	

Table 5.2.31 (continued)

Area	1983		1984		1985		1986	
	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]	10^9 pCi/mo[a]	Percent[b]
Inferred contributors								
Burial grounds 1, 3 and floodplain (station W10, minus ORNL operation)	54	22	51	32	71	30	49	38
Burial ground 4 (W5 minus W10)	85	33	38	24	40	17	25	19
Burial ground 5 (W4 minus Melton Branch)	71	29	38	24	27	11	19	15
Total	210	84	130	79	140	58	93	72

[a]To convert from 10^9 pCi/mo to 10^7 Bq/mo, multiply by 3.7.
[b]Percent of total effluents.
Source: Personal communication from L. Lasher (March 1986).

Table 5.2.32. 1986 concentration at West Fork Poplar Creek (W33)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	0.0002	<0.0002	<0.0002
COD	41	<5	<11
Suspended solids	82	5	<21
Dissolved solids	320	118	179
pH	7.9	7.3	7.6
Cyanide	0.004	<0.002	<0.002
Ammonia nitrogen	0.5	<0.2	<0.23
Fluoride	0.18	<0.1	<0.11
Nitrate nitrogen	0.56	<0.11	<0.33
Sulfate	60	30	45
Chromium	0.03	<0.01	<0.01
Copper	0.094	<0.004	<0.012
Manganese	0.44	0.01	<0.15
Nickel	<0.05	<0.05	<0.05
Sodium	8.1	3.4	5.3
Zinc	0.04	<0.02	<0.02
Cadmium	0.002	<0.002	<0.002
Lead	0.013	<0.004	<0.005

Table 5.2.33. 1986 concentration in ORGDP Sanitary Water (W30)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	0.0002	<0.0002	<0.0002
COD	44	<5	<9.2
Suspended solids	47	<1	<8.0
Dissolved solids	202	94	161
pH	8.3	7.5	7.9
Cyanide	0.006	<0.002	<0.002
Ammonia nitrogen	4.2	<0.2	<0.6
Fluoride	0.11	<0.1	<0.1
Nitrate nitrogen	0.54	<0.17	<0.39
Sulfate	29	23	24
Chromium	0.014	<0.01	<0.01
Copper	0.036	<0.004	<0.014
Manganese	1.0	<0.01	<0.102
Nickel	<0.05	<0.05	<0.05
Sodium	<6.3	4.9	5.6
Zinc	0.068	<0.02	<0.028
Cadmium	<0.002	<0.002	<0.002
Lead	0.009	<0.004	<0.005

Table 5.2.34. 1986 concentration at Poplar Creek near Clinch River (W32)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	0.0004	<0.0002	<0.0002
COD	44	<5	<13.0
Suspended solids	41	8	19.8
Dissolved solids	260	155	191
pH	8.3	7.1	7.9
Cyanide	0.008	<0.002	<0.003
Ammonia nitrogen	0.5	<0.2	<0.22
Fluoride	0.33	<0.1	<0.19
Nitrate nitrogen	1.98	0.16	0.81
Sulfate	44	29	37
Chromium	0.02	<0.01	<0.011
Copper	0.034	<0.004	<0.008
Manganese	0.17	<0.01	<0.09
Nickel	<0.05	<0.05	<0.05
Sodium	10.0	4.9	7.6
Zinc	<0.02	<0.02	<0.02
Cadmium	0.005	<0.002	<0.002
Lead	<0.012	<0.004	<0.007

Table 5.2.35. 1986 concentration in Clinch River near ORGDP (W55)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	<0.0002	<0.0002	<0.0002
COD	41	<5	<8.8
Suspended solids	27	3	11.9
Dissolved solids	186	17	147
pH	8.5	7.6	8.0
Cyanide	0.003	<0.002	<0.002
Ammonia nitrogen	0.4	<0.2	<0.2
Fluoride	0.19	<0.1	<0.11
Nitrate nitrogen	0.48	<0.11	<0.35
Sulfate	28	21	24
Chromium	0.02	<0.01	<0.011
Copper	0.061	<0.004	<0.009
Manganese	0.13	0.011	0.043
Nickel	<0.05	<0.05	<0.05
Sodium	6.2	4.9	5.6
Zinc	0.06	<0.02	<0.023
Cadmium	<0.002	<0.002	<0.002
Lead	0.006	<0.004	<0.004

Table 5.2.36. 1986 concentration at intake to K-901 @ 892 (W29)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	<0.0002	<0.0002	<0.0002
COD	41	<5	<9.1
Suspended solids	19	<1	<5.2
Dissolved solids	216	114	162
pH	8.2	7.3	7.7
Cyanide	0.003	<0.002	<0.002
Ammonia nitrogen	0.8	<0.2	<0.28
Fluoride	0.18	<0.1	<0.11
Nitrate nitrogen	0.59	0.18	0.41
Sulfate	31	1.1	22.4
Chromium	0.014	<0.01	<0.01
Copper	0.042	<0.004	<0.010
Manganese	0.58	<0.01<	0.033
Nickel	<0.05	<0.05	<0.05
Sodium	11.0	5.1	6.4
Zinc	0.071	<0.02	<0.041
Cadmium	0.004	<0.002	<0.002
Lead	0.028	<0.004	<0.008

Table 5.2.37. 1986 concentration at Poplar Creek above Blair Bridge (W31)

Parameter	Concentration (mg/L)		
	Max	Min	Ave
Arsenic	<0.005	<0.005	<0.005
Mercury	0.0003	<0.0002	<0.0002
COD	31	<5	<9.5
Suspended solids	50	5	18
Dissolved solids	440	114	205
pH	8.4	7.4	7.7
Cyanide	0.001	<0.002	<0.004
Ammonia nitrogen	0.7	<0.2	<0.27
Fluoride	0.7	<0.1	<0.30
Nitrate nitrogen	2.1	0.44	1.30
Sulfate	60	34	42
Chromium	0.016	<0.01	<0.01
Copper	0.038	<0.004	<0.009
Manganese	0.19	0.01<	0.094
Nickel	<0.05	<0.05	<0.05
Sodium	16.0	4.2	9.9
Zinc	0.02	<0.02	<0.02
Cadmium	0.002	<0.002	<0.002
Lead	0.013	<0.004	<0.006

Table 5.2.38. 1986 uranium in surface water[a]

Location	ID	Concentration (mg/L)			(Concentration (pCi/L)		
		Max	Min	Av	Max	Min	Av
K901 @ 892	W29	0.005	<0.001	<0.002	3.9	<0.7	1.6
Clinch River	W55	0.011	<0.001	<0.004	8.7	<0.7	<3.2
West Fork	W33	0.007	<0.001	<0.003	5.5	<0.7	<2.4
K716	W32	0.017	<0.001	<0.005	13.4	<0.7	<3.9
K1513	W30	0.005	<0.001	<0.003	3.9	<0.7	<2.4
K1710	W31	0.03	<0.001	<0.009	23.6	<0.7	<7.1

[a]Assume assay of 1.0% conversion factor 1.27 (10^6) g/Ci or 787.4 pCi/mg.

Table 5.2.39. 1986 drinking water parameters for the K-1515 sanitary water plant

Parameter	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Sample date	Results (pCi/L)	Sample date	Results (pCi/L)	Sample date	Results (pCi/L)	Sample date	Results (pCi/L)
^{131}I	2/3	<135.2	4/7	<5.2	7/14	13.1	10/6	<24.1
	2/4	16.1	4/8	<5.2	7/15	16.1	10/7	<22.1
	2/5	<135.2	4/9	<5.2	7/16	24.1	10/8	<22.1
	2/6	<135.2	4/10	<8.2	7/17	13.1	10/9	<22.1
	2/7	<135.2	4/11	<4.2	7/18	13.1	10/10	<22.1
^{60}Co	1/29	4.3	4/16	<24.2	7/17	16.2	10/7	<5.1
Gross alpha	3/3	32.1	6/2	18.1	7/1	5.1	12/1	8.1
Gross alpha, 2 sigma	3/3	40.0	6/2	12.1	7/1	8.1	12/1	11.1
Gross beta	3/3	57.1	6/2	38.1	7/1	59.1	12/1	81.1
Gross beta, 2 sigma	3/3	43.1	6/2	13.1	7/1	16.1	12/1	27.1
^{3}H			4/16	1161.0	7/17	1431.0	10/7	270.0
^{90}Sr	4/16	16.1	7/17	38.1	10/7	8.1		
^{90}Sr, 2 sigma			4/16	5.1	7/17	16.1	10/7	8.1
^{137}Cs			4/16	<2.1				
^{134}Cs					7/17	14.2	10/7	<5.1

Table 5.3.1. Y-12 Plant NPDES discharges[a]

Serial # discharge	Effluent discharges	Average flow (L × 10^6/d)	Receiving stream
	Point discharges		
301	Kerr Hollow Quarry (disposal of reactive metals)	0–0.02	Scarboro Creek to Clinch River
302	Rogers Quarry (fly ash sluice water & nonreactive metal parts disposal)	1.70–7.57	McCoy Branch to Clinch River
303	New Hope Pond (treated industrial wastewater, cooling tower blowdown, once-through cooling water, storm, and surface runoff)	30.28	EFPC
304	Bear Creek (surface runoff)	15.90	Bear Creek
305	Oil pond No. 1 (leaking burial ground and wet weather springs)	0.05	Bear Creek
306	Oil pond No. 2 (seepage from burial pit and surface water runoff)	Infreqent	Bear Creek
Serial # discharge	**Treatment facility**	**Average flow (L × 10^6/d)**	**Receiving stream**
	Treatment facility discharges		
501	Central Pollution Control Facility (CPCF-I)	3.79	EFPC
502	Central Pollution Control Facility Phase II (CPCF-II) (until WETF comes on line)	9.46	EFPC
503	Steam plant wastewater treatment facility	178.0	EFPC
504	Plating rinse water treatment facility (PRWTF)	3.79	EFPC
505	ORNL Biology Division wastewater treatment facility	299.0	EFPC
506	Sump pump oil separator (9204-3)	5.68	EFPC
508	Experimental mobile wastewater treatment facility	1.2	EFPC

[a]*Source*: J. L. Kasten, *Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation*, ORNL/ESH-1/V21, November, 1986.

drains within the buildings, building floor drains, and drains from accumulation tanks outside the buildings. Efforts outlets that gather the seepages of groundwater at basement levels. Efforts to improve the water quality of streams receiving Oak Ridge Y-12 Plant discharges are ongoing and have resulted in eliminating over 160 process discharges to East Fork Poplar Creek. The NPDES permits have been established using best available technology as a basis for discharge. Environmental monitoring stations are planned to characterize area source contamination.

There are 21 major cooling tower systems and 6 small air conditioning towers in operation at the Oak Ridge Y-12 Plant. Approximately 1380 million liters per year are required as makeup for the 21 major cooling tower systems. About 550 million liters per year are discharged as blowdown into East Fork Poplar Creek, and 830 million liters are lost as evaporation. The blowdown consists of hard water containing nontoxic chemical treatment (a corrosion inhibitor and a microbiocide). The cooling tower system is being upgraded by replacement of old and leaky towers and a the chemical treatment to meet NPDES permit requirements. These changes are helping to reduce the total amount of water consumption.

5.3.2 ORNL Water Discharges

All discharges from ORNL are received by the White Oak Creek drainage basin. Discharges include sanitary wastewaters, coal yard runoff and ash washwater, storm drainage, process wastewaters, cooling water, and cooling tower blowdown. Process wastewaters are generated by operation of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities. The discharges are categorized according to their NPDES outfalls in Table 5.3.2 (NPDES, 1986).

The ORNL sewage system includes the main system, the 7900 area system, and other minor systems. The main ORNL sewage treatment plant, which discharges treated effluent to White Oak Creek at an average flow of approximately 1.1 million liters per day, had been unable to provide adequate treatment of sanitary waste because of design limitations and periodic hydraulic overloading resulting from excessive inflow and groundwater infiltration. A sewer system evaluation survey, completed in 1980, found that approximately 190,000 liters per day of infiltration were entering the sewer system through defective line sections. To reduce the inflow and infiltration problem, selected sanitary sewer pipes have been lined by a process called Insituform. A new, extended aeration-activated sludge plant became operational in August 1985.

Storm water has been identified as a major transporter of contaminants from the ORNL site. Sampling programs for characterization of contaminants in storm water are being initiated. Storm water runoff is either collected by a formal system of catch basins and constructed waterways or carried by natural drainage ways. A preliminary evaluation revealed that in many cases storm drainage from an entire area of ORNL empties into one or two major drainage pipes before it is discharged into streams. Capital projects have been implemented to segregate contaminated process wastewater from the storm drain system.

In the past, effluent from the process waste (PW) treatment system was discharged into White Oak Creek. Changes to the PW system are required to ensure compliance with regulations imposed by the Clean Water Act (CWA) and DOE Order 5480.1. The Nonradiological Waste Treatment Plant (NRWTP) will provide the treatment needed to obtain compliance.

The NRWTP will treat all nonradiological wastes, including heavy metals and organics, previously discharged into White Oak Creek. Tankage will be provided as part of the NRWTP to replace ponds that have the potential of leaking and contaminating groundwater and surface water. The NRWTP will provide additional treatment of ORNL process wastewaters, which should improve the water quality of White Oak Creek.

There are 26 cooling towers at ORNL that discharge to area streams and storm sewers. Of the total amount used for makeup water (7.2 million liters), approximately 20% (1.35 million

Table 5.3.2. ORNL NPDES discharges [a]

Serial # discharge	Effluent discharges	Flow (L × 10^6/d)		Receiving stream
X01	Sewage treatment plant	Av Max	0.87 2.84	WOC
X02	Coal yard runoff treatment facility	Av Max	0.09 0.83	WOC
X03	1500 area	Av	0.028	Northwest tributary of WOC
X04	2000 area	Av	0.05	WOC
X06	3539 and 3540 ponds	Av	0.51	WOC
X06A	X03, X04, X06, X07	Av	0.98	NRWTP to WOC
X07[b]	3544 Process Waste Treatment Plant	Av Max	0.68 1.63	WOC
X08	TRU process waste basin	Av	0.19	Melton Branch
X09	HFIR process waste basin	Av	0.61	Melton Branch
X09	X08, X09	Av	0.79	NRWTP to WOC
X10	ORR resin regneration (as part of NRWTP)	Av	0.03	Fifth Creek (vendor contract)
X11	3518 acid neutralization (in the future)	Av	0.15	WOC (NRWTP or CYRTF)
X12	Nonradiological Wastewater Treatment Project	Av Max	1.89 3.03	WOC
X13	Melton Branch X08, X09, HFIR cooling tower blowdown, and area runoff	Av	7.57	Melton Branch to WOC
X14	WOC and area runoff	Av	26.50	White Oak Lake
X15	White Oak Lake dam and WOC drainage basin	Av	37.90	Clinch River

[a]*Source*: J. L. Kasten, *Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation*, ORNL/ESH-1/V21, November 1986.

liters per day) of the total makeup water for all the cooling towers is lost as blowdown, and 80% (5.85 million liters per day) is lost to the atmosphere as evaporation. Effluent from these towers contains chemicals to retard algae growth that can be toxic to marine and aquatic life. Plans are being developed to characterize the extent and impact of the effluents and to determine appropriate corrective action.

5.3.3 ORGDP Water Discharges

The NPDES permit for ORGDP has six authorized discharge points. Samples are collected at five of the six outfalls and at three internal wastewater discharges. The sixth outfall has been shut down because of insufficient loading and therefore is not monitored. All process water discharges from the plant pass through an NPDES monitoring point. However, many storm drains, some with noncontact cooling water discharges, are not monitored at an NPDES sampling point. Since ORGDP has been in standby mode the major liquid discharge decreases have been the elimination of blowdown from the RCW system and the centrifuge development cooling towers and a decrease in sewage effluent. The discharges are categorized according to their NPDES outfalls in Table 5.3.3 (ORGDP, 1986).

The ORGDP operates two sanitary sewage systems. The main site has an extended aeration treatment plant with a rated capacity of 2.3 million liters per day and a current use of approximately 1.1 million liters per day. Improvements have been made to the collection lines to reduce inflow and infiltration. During periods of heavy rain, raw sewage is partially diverted into a 1-million-liter tank to reduce the heavy loading on the treatment facility. Treated effluent from the main plant is discharged into Poplar Creek (ORGDP, 1986).

Because of their remoteness and low volume of use, outlying facilities such as the power house area, rifle range, and water treatment plant use septic tanks with drain fields. The power house area has a packaged treatment plant with a rated capacity of 0.076 million liters per day that is not now in use (ORGDP, 1986).

Surface runoff within the ORGDP site is drained by Poplar Creek to the Clinch River. Improvements to the surface runoff system include drainage channeled by swales, where appropriate, rather than by piped drain systems. This technique is used to moderate stream flows by enhancing percolation to groundwater systems and reducing runoff quantity and rate. A storm sewer survey is being undertaken to characterize water quality.

The ORGDP was the only ORR facility that recycled its cooling tower blowdown. Because the plant has been placed in standby operation, the treatment facility of the RCW system is no longer used. When in operation, of the 42 million liters per day to the RCW system, 39 million liters per day were lost due to evaporation. The blowdown, 2.7 million liters per day, was treated and recycled. This system is elaborated on in Carmichael et al., 1981. Small once-through cooling systems are now in operation and only one cooling tower, the barrier production plant cooling tower, is currently operated (but is scheduled for shutdown). The cooling tower requires 800,000 liters per day of makeup water; 600,000 liters per day are evaporated to the atmosphere, and 200,000 liters per day are discharged as blowdown.

5.3.4 NPDES

The 1986 National Pollutant Discharge Elimination System (NPDES) compliances and noncompliances are given in Tables 5.3.4 through 5.3.7.

Oak Ridge Y-12 Plant. NPDES compliances at Kerr Hollow Quarry for lithium, pH, and zirconium are given in Figs. 5.3.1 through 5.3.3. All of these parameters have been in compliance 100% of the time over the past five years. Total suspended solids and temperature were added to the new permit at discharge point 301 in 1985; compliance is shown in Figs. 5.3.4 and 5.3.5. Both parameters have been in compliance 100% of the time.

NPDES compliances at discharge point 302, Rogers Quarry, for pH, total suspended solids, and settleable solids are given in Figs. 5.3.6

Table 5.3.3. ORGDP NPDES permit discharges[a]

Serial discharges	Effluent discharges	Average flow ($L \times 10^6$/d) Full-scale operation	Average flow ($L \times 10^6$/d) Standby mode	Receiving stream
K-1700	Steam plant and coal yard Metals cleaning facility Uranium recovery Chemical Process Development Facility Y-12 Plant treated wastewaters Surface runoff	15.5	12.1	
K-901-A	Treated blowdown from plant RCW system (deleted due to standby operation) Lime softening sludges from RCW makeup treatment (deleted due to standby operation) Surface runoff	4.16	3.03	Clinch River
K-1203	Sanitary wastewaters Y-12 Plant treated wastewaters Organic industrial wastewaters Surface runoff	2.46	1.32	Poplar Creek
K-1007-B	Potable water from once-through cooling systems Fire water from once-through systems Surface runoff	7.42	4.73	Poplar Creek
K-1515	Water from sludge and backwash systems associated with the potable water plant Surface runoff	1.44	1.44	Clinch River

[a]*Source*: J. L. Kasten, *Resource Management Plan for the Oak Ridge Reservation, Volume 21: Water Conservation Plan for the Oak Ridge Reservation*, ORNL/ESH-1/V21, November 1986.

Table 5.3.4. 1986 NPDES compliance at the Y-12 Plant

Discharge point	Effluent parameter	Effluent limits				Percent of compliance
		Daily av (kg/d)	Daily max (kg/d)	Daily av (mg/L)	Daily max (mg/L)	
301 (Kerr Hollow Quarry)	Lithium				5.0	100
	pH units			>6.5	<8.5	100
	Total suspended solids			30.0	50.0	100
	Temperature, °C				30.5	100
	Zirconium				3.0	100
302 (Rogers Quarry)	Oil and grease			10.0	15.0	71
	pH units			>6.5	<8.5	100
	Settleable solids, mL/L				0.5	100
	Total suspended solids			30.0	50.0[a]	100
	Temperature, °C				30.5	100
303 (New Hope Pond)	Ammonia (as N)				1.6	99
	Cadmium, total			0.0025	0.0035	96
	Chromium, total			0.05	0.08	100
	Copper, total			0.015	0.022	98
	Dissolved oxygen			5.0[b]		100
	Dissolved solids				2000	100
	Fluoride			1.5	2.0	100
	Lead, total			0.012	0.17	100
	Lithium, total				5.0	100
	Mercury, total			0.0035	0.0080	90
	Nitrogen, total (as N)				20.0	97
	Oil and greast			10.0	15.0	100
	pH units			>6.5	<10.0	100
	Settleable solids (mL/L)				0.50	100
	Surfactants (as MBAS)			5.0	8.0	100
	Total suspended solids				20.0[c]	99
	Temperabure,°C				30.5	100
	Zinc, total			0.20	0.30	100
304 (Bear Creek)	Oil and grease			10.0	15.0	100
	pH units			>6.5	<8.5	100
305 (leaking burial grounds and wet weather springs—Oil Pond #1)	Oil and grease			10.0	15.0	100
	pH units			>6.5	<8.5	92
	Total suspended solids			30.0	50.0	100
306 (seepage from burial pit and surface water runoff—Oil Pond #2)	Oil and grease			10.0	15.0	100
	pH units			>6.5	<8.5	100
	Total suspended solids			30.0	50.0	92
501 Central Pollution Control Facility (CPCF-I)	Cadmium, total	0.07	0.19	0.26	0.69	100
	Chromium, total	0.5	0.25	1.7	2.77	100
	Copper, total	0.6	0.9	2.07	3.38	100
	Cyanide, total	0.2	0.33	0.65	1.20	100
	Lead, total	0.12	0.19	0.43	0.69	100
	Nickel, total	0.65	1.1	2.38	3.98	100
	Oil and grease	7.1	14.2	26.0	52.0	100
	pH units			76.0	<9.0	100
	Silver, total	0.07	0.12	0.24	0.43	100
	Temperature, °C				30.5	100
	Total suspended solids	8.5	16.4	31.0	60.0	98
	Total toxic organics			0.6		89
	Zinc, total	0.4	0.7	1.48	2.61	100

Table 5.3.4 (continued)

Discharge point	Effluent parameter	Effluent limits: Daily av (kg/d)	Daily max (kg/d)	Daily av (mg/L)	Daily max (mg/L)	Percent of compliance
502 Central Pollution Control Facility (CFCF-II) and West End Treatment Facility (WETF)	Cadmium, total	0.07	0.019	0.26	0.69	100
	Chromium, total	0.50	0.75	1.7	2.77	100
	Copper, total	0.60	0.9	2.07	3.38	100
	Cyanide, total	0.2	0.33	0.65	1.20	100
	Lead, total	0.12	0.19	0.43	0.69	100
	Nickel, total	0.65	1.10	2.38	3.98	100
	Oil and grease	7.1	14.2	26.0	52.0	100
	pH units			>0.6	<9.0	100
	Silver, total	0.07	0.12	0.24	0.43	100
	Temperature, °C				30.5	100
	Total suspended solids	8.5	16.4	31.0	60.0	100
	Total toxic organics		0.6		2.13	100
	Zinc, total	0.4	0.7	1.48	2.61	100
Category I Outfalls (precipitation runoff and small amounts of groundwater)	pH units			>6.5	<8.5	98
Category II Outfalls (cooling waters, condensate, precipitation runoff, and building, roof, and foundation drains)	pH units			>6.5	<8.5	100
	Temperature[d]					100
Category III Outfalls (process wastewaters)	pH units			>6.5	<8.5	84
Category IV Outfalls (untreated process wastewaters)	pH units			>6.5	<8.5	99
623 (Steam Plant Fly Ash Sluice Water	pH units			>6.5	<8.5	98
507 (S-3 Ponds Liquid Treatment Facility)	Cadmium, total	0.14	0.38	0.26	0.69	100
	Chromium, total	0.93	1.5	1.7	2.77	100
	Copper, total	1.13	1.84	2.07	3.38	100
	Cyanide, total	0.35	0.65	0.65	1.20	100
	Lead, total	0.23	0.38	0.43	0.69	100
	Nickel, total	1.30	2.17	2.38	3.98	100
	Oil and grease	14.2	28.4	26.0	52.0	100
	pH units			>6.0	<9.0	100
	Silver, total	0.13	0.23	0.24	0.43	100
	Temperature, °C				30.5	100
	Total suspended solids	16.9	32.7	31.0	60.0	100
	Total toxic organics		1.16		2.13	100
	Zinc, total	0.81	1.42	1.48	2.61	100
508 (Experimental Mobile Wastewater Treatment Facility)	Mercury, total			0.002	0.004	50
	pH units			>6.5	<9.0	100
	Total suspended solids			30.0	45.0	100
510 (Waste Coolant Processing Facility)	Biochemical oxygen demand	1.33	2.65			No discharge
	Oil and grease			15.0	20.0	No discharge
	pH units			>6.5	<9.0	No discharge
	Temperature, °C				30.5	No discharge

Table 5.3.4 (continued)

Discharge point	Effluent parameter	Effluent limits				Percent of compliance
		Daily av (kg/d)	Daily max (kg/d)	Daily av (mg/L)	Daily max (mg/L)	
	Total suspended solids				100.0	No discharge
Miscellaneous discharges (cooling tower blowdown)	Chromium, total				1.0	100
	Copper, total			0.5	1.0	100
	Free available chlorine			0.2	0.5	89
	pH units			>6.5	<8.5	45
	Temperature, °C			35	38	96
	Zinc, total			0.5	1.0	100
Miscellaneous discharges (demineralizers)	pH units			>6.5	<8.5	50
	Total suspended solids			30	50	50

[a]Limit not applicable during periods of increased surface runoff resulting from precipitation.
[b]Daily minimum.
[c]If discharge volume exceeds 8.0×10^6 gal/d as a result of precipitation, daily maximum is 100 mg/L.
[d]Temperature shall be controlled such that the stream temperature standards delineated in the General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee, as amended, are not violated as a result of this discharge.

Table 5.3.5. 1986 NPDES compliance at ORNL

Discharge point	Effluent parameters	Discharge limitations				Percentage of measurements in compliance
		Monthly Av (kg/d)	Daily Max (kg/d)	Monthly Av (mg/L)	Daily Max (mg/L)	
X01 (Sewage Treatment Plant)	Biochemical oxygen demand (summer)	8.7	13.1	10	15	100
	Biochemical oxygen demand (winter)	17.4	26.2	20	30	100
	Total suspended solids	26.2	39.2	30	45	99.4
	Ammonia (N) (summer)	3.5	5.2	4	6	100
	Ammonia (N) (winter)	7.8	11.8	9	13.5	100
	Oil and grease	8.7	13.1	10	15	98.3
	Dissolved oxygen			6.0[a]		95.3
	Residual chlorine				0.5	99.2
	Fecal coliform, geometric mean			200[b]	400[b]	96.2
X02 (Coal Yard Runoff Treatment Facility)	Temperature				30.5	100
	Total suspended solids				50	97.5
	Oil and grease			15.0	20.0	100
	Chromium, total			0.2	0.2	100
	Copper, total			1.0	1.0	100
	Iron, total			1.0	1.0	96.3
	Zinc, total			1.0	1.0	100

[a]Minimum.

[b]Colonies per 100 mL.

Note: The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units. It shall be monitored once per week by a grab sample taken at the effluent for the following discharge points: X01, X02, X03, X06, X07, X08, X09, X10, and X11. The percentage of pH measurements in compliance at X07 were 97.5%, 95.7%, and 95.0%, respectively. At all other locations 100% of the measurements were in compliance.

Table 5.3.6. 1986 NPDES compliance at ORGDP

Discharge point	Effluent parameters	Effluent limits: Monthly av (mg/L)	Daily max (mg/L)	Monthly av (kg/d)	Daily max (kg/d)	Percentage of measurements in compliance
001						
(K-1700 discharge)	Aluminum		1.0		16	87
	Chromium	0.050	0.080	0.80	1.2	100
	Nitrate—N		20		310	100
	Suspended solids[a]	30	50	470	780	99
	Oil and grease	10[b]	15	160	230	100
	pH, units		6.0–9.0			100
	Perchloroethylene	0.12	0.21	1.9	3.3	100
	Triochloroethane	0.11		1.7		100
	Methylene chloride	0.035		0.54		100
	Trichloroethylene	0.41	0.61	6.4	9.5	100
	Lead	0.0080	0.93	0.12	14	99
	Zinc	0.12	1.5	1.86	246	100
	Total halomethanes	1.2	2.1	19	32	100
	Beryllium	0.0010	0.0020	0.016	0.032	100
	Cadmium	0.0040	0.010	0.060	0.16	100
	Mercury	0.0013	0.011	0.021	0.17	100
	Selenium	0.12	0.31	1.9	4.8	100
	Silver	0.014	0.027	0.22	0.42	100
003						
K1407B[c]	Cadmium	0.26	0.69			100
	Chromium	1.71	2.77			100
	Copper	2.07	3.38			100
	Lead	0.43	0.69			100
	Silver	0.24	0.43			100
	Zinc	1.48	2.61			100
	Cyanide	0.65	1.20			100
	TTO		2.13			100
	Oil and grease	26	52			100
	Nickel	2.38	3.98			100
	TSS	31	60			98
	PCB, μg/L		0.014			100
005						
(K-1203 Sanitary Treatment Facility)[d]	Ammonia nitrogen	5.0	7.0	12	17.3	100
	BOD	15	20	37	49.5	100
	Chlorine residual		0.24			100
	Dissolved oxygen	5.0[b]				100
	Fecal coliform, No./100 mL	200	400			97
	pH, units		6.09.0			100
	Suspended solids	30	45	74	110	99
	Settleable solids, mL/L		0.50			99
	Beryllium	0.0010	0.0020	0.0020	0.0050	100

Table 5.3.6 (continued)

Discharge point	Effluent parameters	Effluent limits: Monthly av (mg/L)	Daily max (mg/L)	Monthly av (kg/d)	Daily max (kg/d)	Percentage of measurements in compliance
	Cadmium	0.0040	0.010	0.010	0.025	100
	Mercury	0.0013	0.011	0.0030	0.027	100
	Selenium	0.12	0.31	0.30	0.77	100
	Silver	0.014	0.027	0.035	0.067	100
	Lead	0.008	0.93	0.02	2.30	96
	Zinc	0.12	1.52	0.30	3.76	100
	Perchloroethylene	0.12	0.21	0.30	0.52	100
	Trichloroethane	0.11		0.27		100
	Methylene chloride	0.035		0.087		100
	Trichloroethylene	0.41	0.61	1.01	1.51	100
	Total halomethanes	1.23	2.05	3.04	5.07	100
(K-1007-B Holding Pond)	COD	20	25	120	150	79
	Chromium (total)		0.050		0.30	98
	Dissolved oxygen	5.0[b]				100
	Fluoride	1.0	1.5	6.1	9.1	100
	Oil and greas	10	15	61	91	100
	pH, units		6.0–9.0			100
	Suspended solids[a]	30	50	182	304	100
007 (K-901-A Holding Pond)	Chromium (total)		0.05		0.68	94
	Fluoride	1.0	1.5	4.2	6.3	100
	Oil and grease	10	15	42	63	100
	pH, units		6.0–10			100
	Suspended solids[a]	30	50	125	210	100
009 (Sanitary Water Plant)	Suspended solids[a]	30	50	34	51	100
	Aluminum	5.0	10	5.7	11	100
	Sulphate		1400		1600	100
	pH, units		6.0–9.0			100

[a]Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface run-off resulting from precipitation.

[b]Daily minimum.

[c]During the characterization of this effluent point more data are obtained and reported but are not subject to limits at this time.

[d]Because of the small flow rates at the K-710 sanitary treatment facility, (discharge point W27), a rapid sand filter was installed May 1, 1978, eliminating the surface discharge and the need for monitoring.

Table 5.3.7. 1986 Oak Ridge installations NPDES compliance experience

Month	Installation	Noncompliance parameters	Number of noncompliances	Percentage total compliance
January	Y-12 Plant	Suspended solids, Hg, pH	8	98
	ORNL	None	0	100
	ORGDP	Suspended solids[a]	2	99.8
February	Y-12 Plant	pH, TTO[b]	2	99
	ORNL	None	0	100
	ORGDP	Fecal coliform, suspended solids, COD, Al	11	98.8
March	Y-12 Plant	pH, suspended solids, TTO, total nitrogen	17	98
	ORNL	None	0	100
	ORGDP	Fecal coliform	3	99.8
April	Y-12 Plant	pH	10	98
	ORNL	pH	1	99
	ORGDP	Fecal coliform	1	99.9
May	Y-12 Plant	pH and Cl	7	98.6
	ORNL	Oil and grease, suspended solids	5	96
	ORGDP	Al, Cr	3	99.8
June	Y-12 Plant	pH, total nitrogen	12	98
	ORNL	Cl	1	99
	ORGDP	Al	2	99.9
July	Y-12 Plant	pH, TTO, Cl, Cu	13	98
	ORNL	DO, Zn, TSS, fecal coliform	6	98.6
	ORGDP	Al, COD, Cr	5	99.4
August	Y-12 Plant	pH, suspended solids	6	99
	ORNL	pH, TSS, oil and grease	11	96
	ORGDP	COD, Cr	4	99.6
September	Y-12 Plant	pH	7	98.6
	ORNL	TSS, fecal coliform	3	99.0
	ORGDP	COD, Al	2	99.8
October	Y-12 Plant	pH, visible foam	14	98
	ORNL	Fecal coliform, oil and grease, TSS, suspended solids, Cl	7	98.7
	ORGDP	COD, Pb	4	99.6
November	Y-12 Plant	Cl, Hg, upper pH	14	98.0
	ORNL	TSS	5	99.0
	ORGDP	Visible foam, Pb 72-h monthly composite sample, COD	6	99.7
December	Y-12 Plant	Visible foam, ammonia, copper, mercury, pH, free chlorine	14	98.8
	ORNL	Not available	2	99.99
	ORGDP	Not available	12	98.6

[a]Unpermitted discharge.
[b]Sample not analyzed within required holding time.

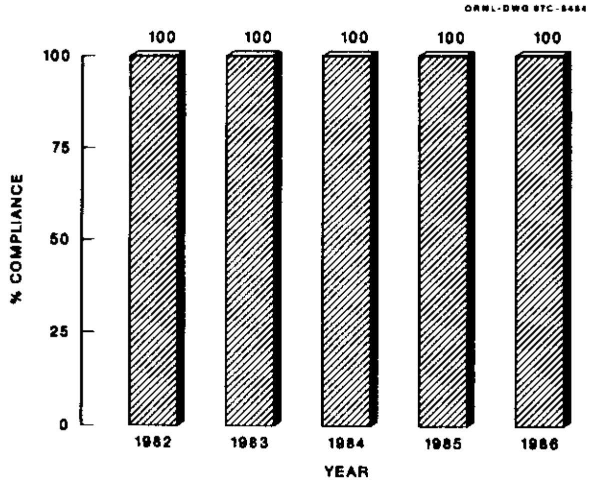

Fig. 5.3.1. NPDES compliance for lithium at Kerr Hollow Quarry (301).

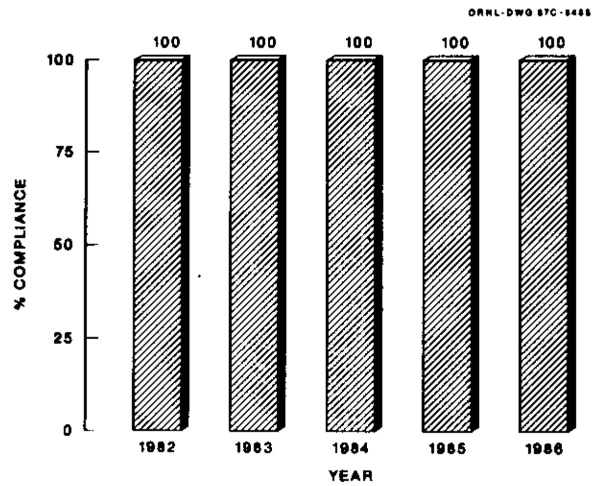

Fig. 5.3.2. NPDES compliance for pH at Kerr Hollow Quarry (301).

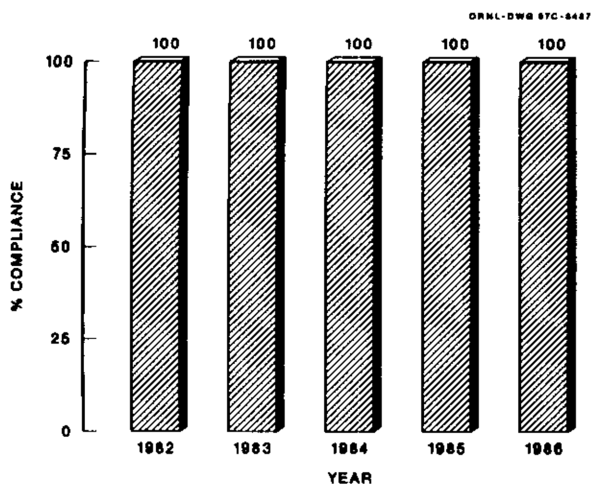

Fig. 5.3.3. NPDES compliance for zirconium at Kerr Hollow Quarry (301).

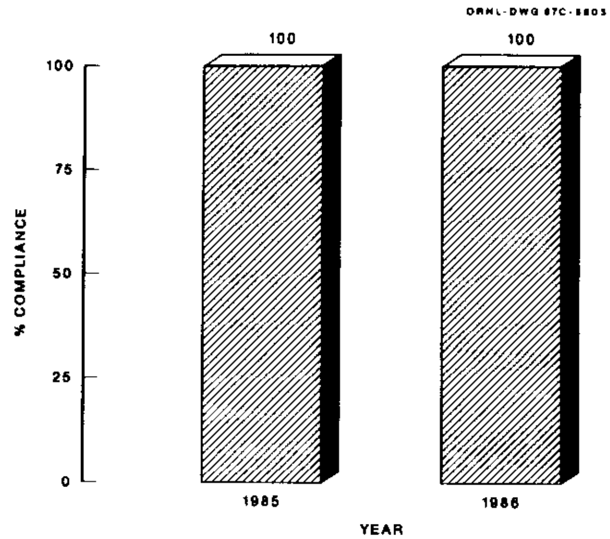

Fig. 5.3.4. NPDES compliance for temperature at Kerr Hollow Quarry (301).

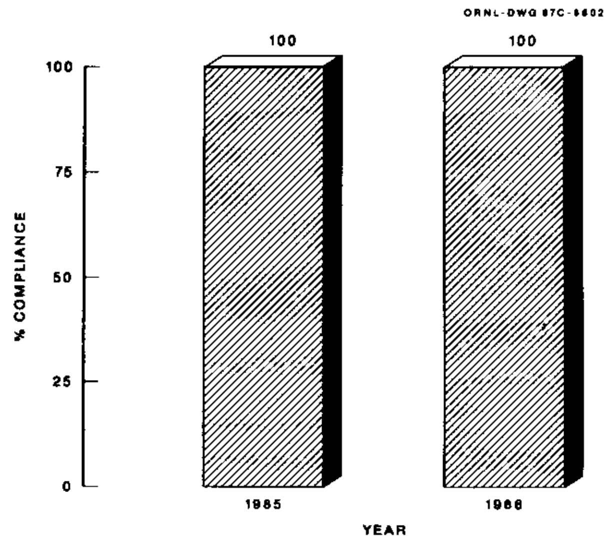

Fig. 5.3.5. NPDES compliance for total suspended solids at Kerr Hollow Quarry (301).

through 5.3.8. The pH ranges from 100% (1982, 1983) to 71% (1986) with settleable solids (as total suspended solids) being 100% each year except 1985. The drop in percentage of compliance for pH (Fig. 5.3.6) could be attributed to a change in sampling location from downstream of the weir to upstream and to increased sampling frequency during out-of-compliance episodes. Section 12.1.4 (Vol. 1) explains changes in the facility that can account

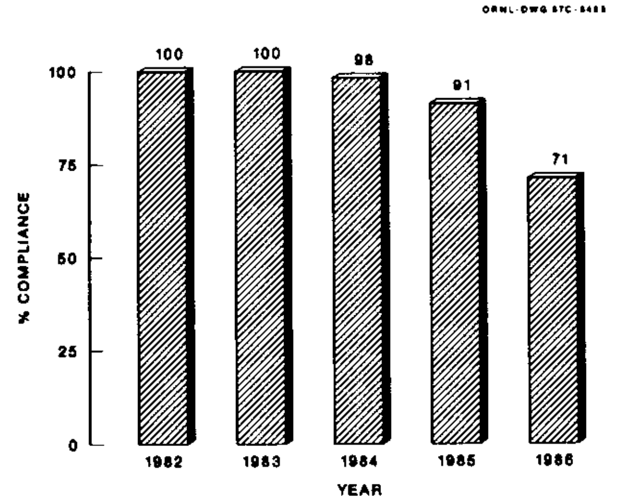

Fig. 5.3.6. NPDES compliance for pH at Rogers Quarry (302).

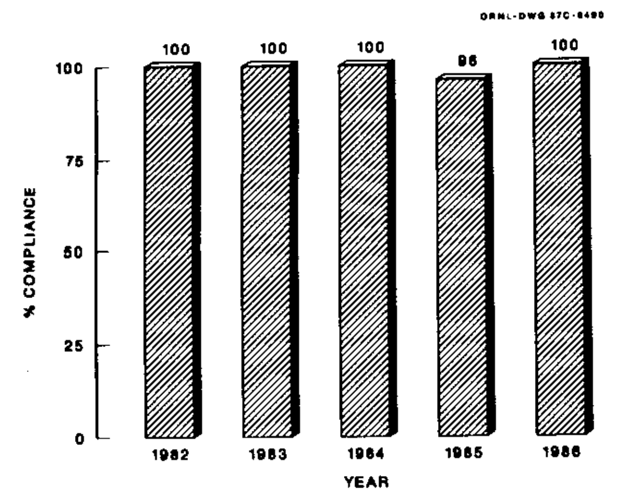

Fig. 5.3.7. NPDES compliance for settleable solids at Rogers Quarry (302).

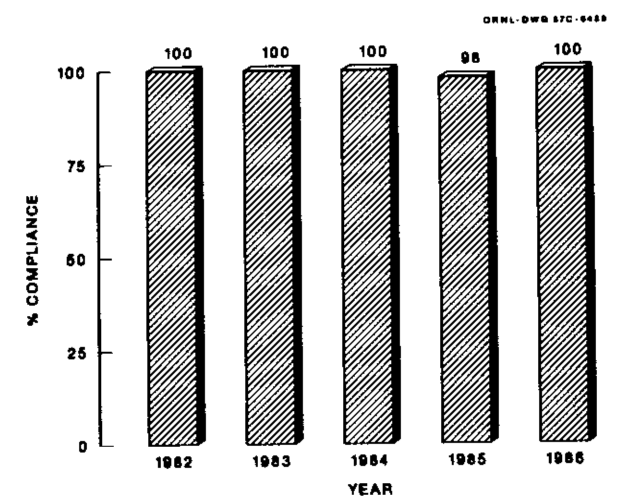

Fig. 5.3.8. NPDES compliance for total suspended solids at Rogers Quarry (302).

for the trend. Temperature and oil and grease were added to the new permit at outfall 302 in 1985; compliances are given in Figs. 5.3.9 and 5.3.10.

NPDES compliances at discharge point 303, New Hope Pond, for zinc, settleable solids, pH, oil and grease, ammonia as N, chromium, dissolved oxygen, dissolved solids, fluoride, and lithium are given in Figs. 5.3.11 through 5.3.20. The increase in percentage of compliance for zinc (Fig. 5.3.11) is attributed to a decrease in the use of treated water. Oil and grease show better compliance in 1986 than in 1985 (Fig. 5.3.14) because of an increased emphasis on spill control.

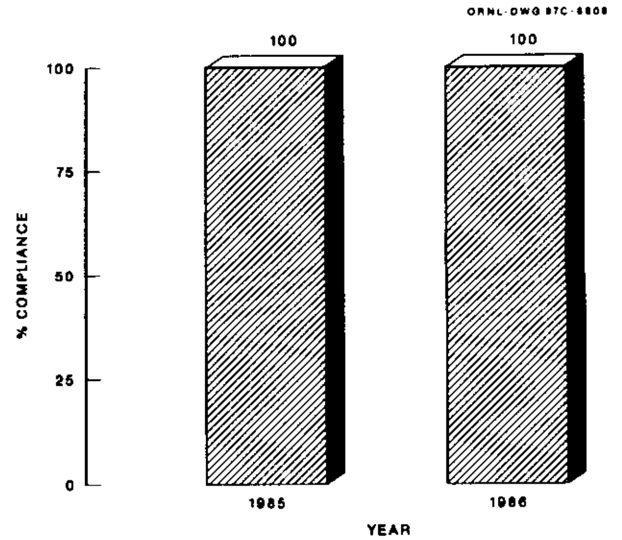

Fig. 5.3.9. NPDES compliance for temperature at Rogers Quarry (302).

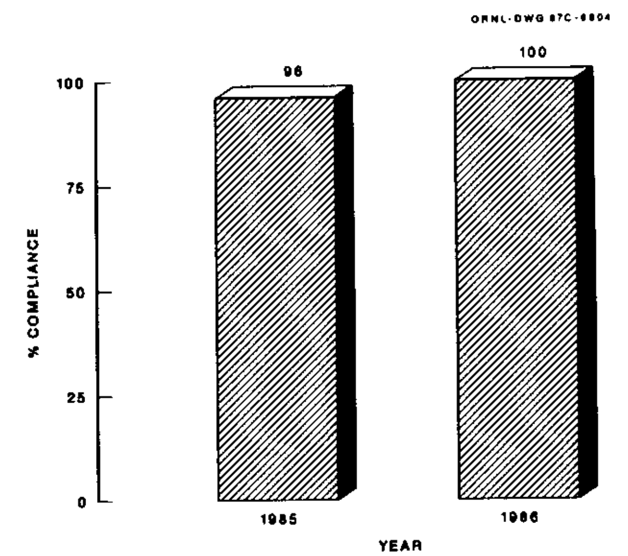

Fig. 5.3.10. NPDES compliance for oil and grease at Rogers Quarry (302).

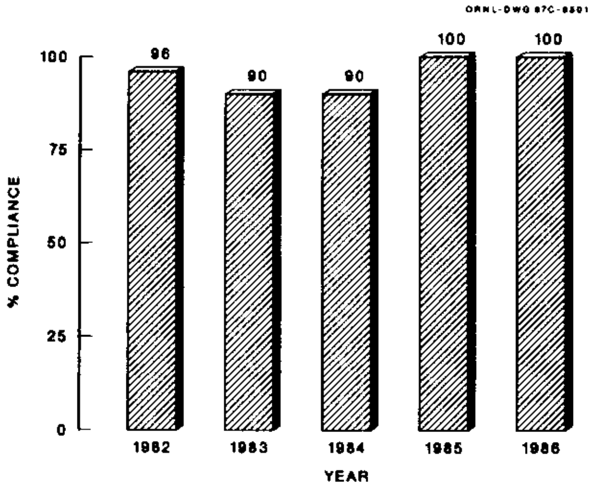

Fig. 5.3.11. NPDES compliance for zinc at New Hope Pond (303).

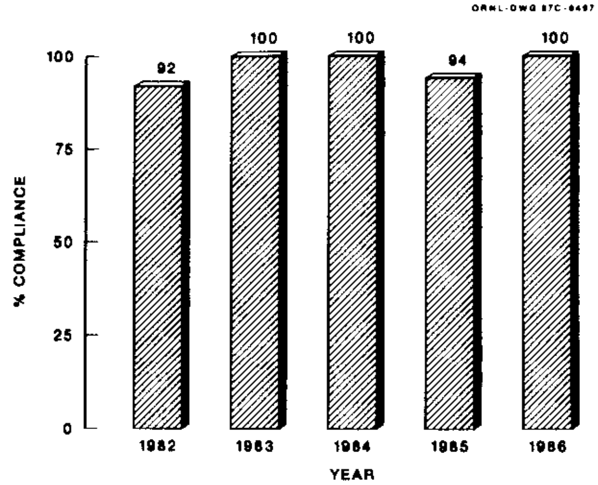

Fig. 5.3.14. NPDES compliance for oil and grease at New Hope Pond (303).

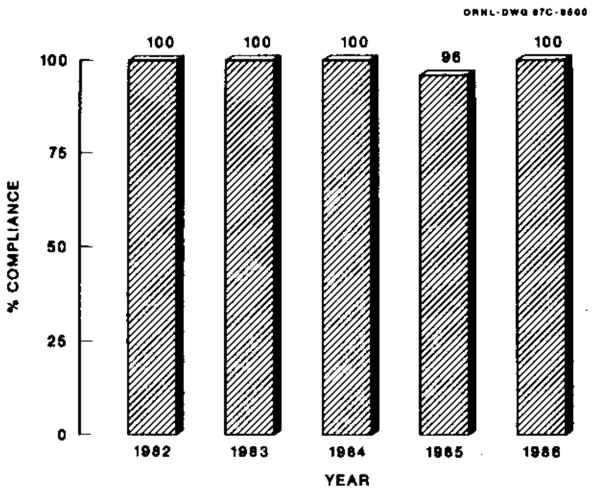

Fig. 5.3.12. NPDES compliance for settleable solids at New Hope Pond (303).

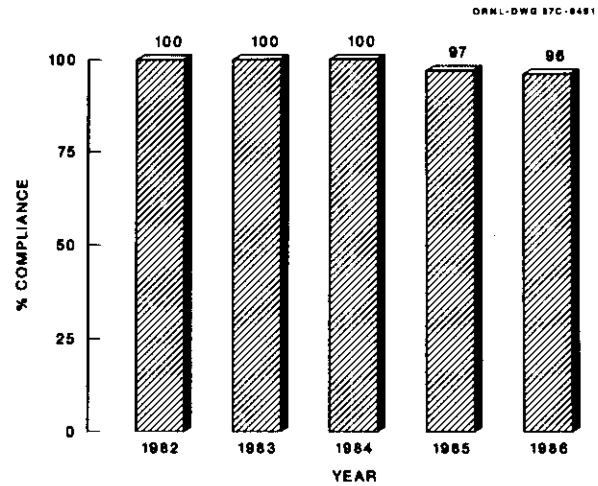

Fig. 5.3.15. NPDES compliance for ammonia at New Hope Pond (303).

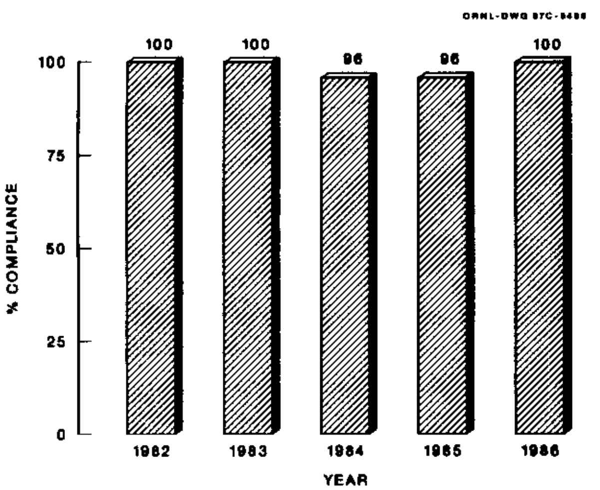

Fig. 5.3.13. NPDES compliance for pH at New Hope Pond (303).

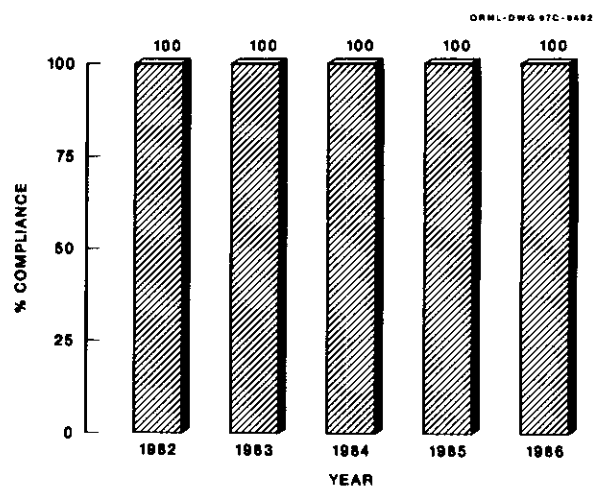

Fig. 5.3.16. NPDES compliance for chromium at New Hope Pond (303).

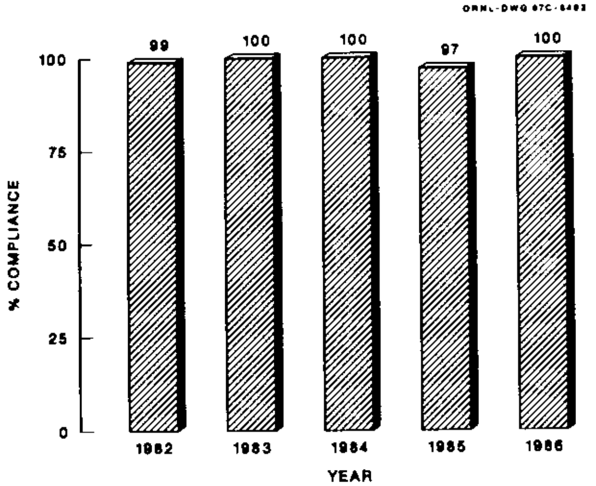

Fig. 5.3.17. NPDES compliance for dissolved oxygen at New Hope Pond (303).

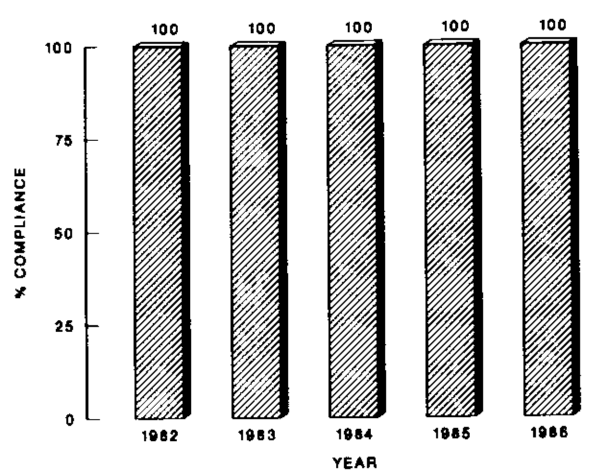

Fig. 5.3.20. NPDES compliance for lithium at New Hope Pond (303).

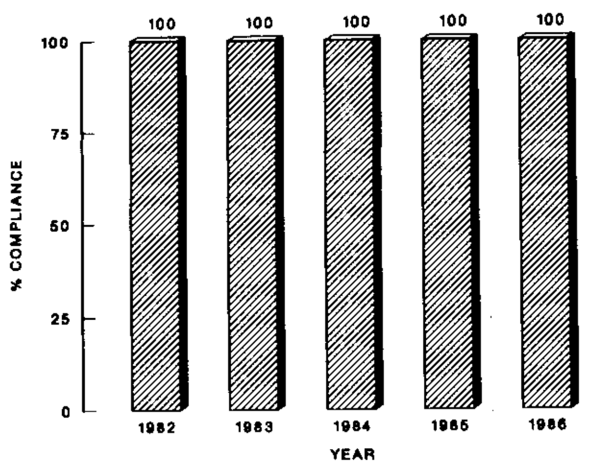

Fig. 5.3.18. NPDES compliance for dissolved solids at New Hope Pond (303).

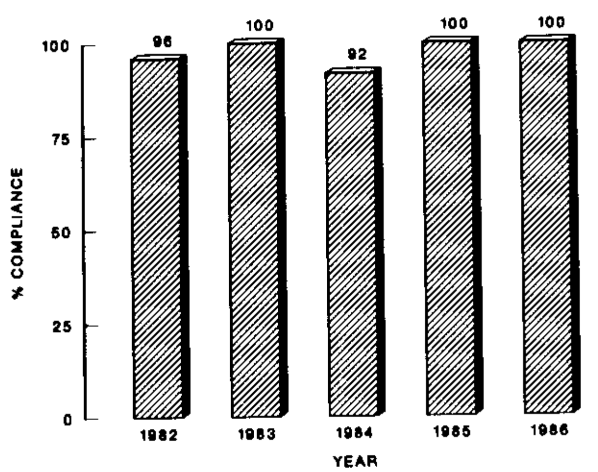

Fig. 5.3.19. NPDES compliance for fluoride at New Hope Pond (303).

The increased percentage of compliance for fluoride shown in Fig. 5.3.19 is the result of better control at the water treatment plant. NPDES compliances for total suspended solids are shown in Fig. 5.3.21, for surfactants as MBAS in 5.3.22, and for total nitrogen in 5.3.23. The less-than-100% compliance for total nitrogen shown in Fig. 5.3.23 is a result of the use of urea for ice control during inclement weather. Compliances for temperature, mercury, lead, copper, and cadmium were added in 1985, and percentages of compliance are shown in Figs. 5.3.24 through 5.3.28. The decrease in compliance for mercury (Fig. 5.3.25) is attributed to cleaning and lining of Hg-contaminated pipes and increased monitoring during out-of-compliance episodes. Increased compliance for copper (Fig. 5.3.27) resulted from stopping the use of Cu-containing algaecides.

NPDES compliance at discharge point 304, Bear Creek No. 1, for oil and grease and pH are shown in Figs. 5.3.29 and 5.3.30.

NPDES compliance at discharge point 305 for oil and grease, pH, and total suspended solids are shown in Figs. 5.3.31 through 5.3.33. Achievement of 100% compliance for pH (Fig. 5.3.32) was a result of replacement of rusty discharge pipes. Compliances at discharge point 306 for oil and grease, pH, and total suspended solids are given in Figs. 5.3.34 through 5.3.36.

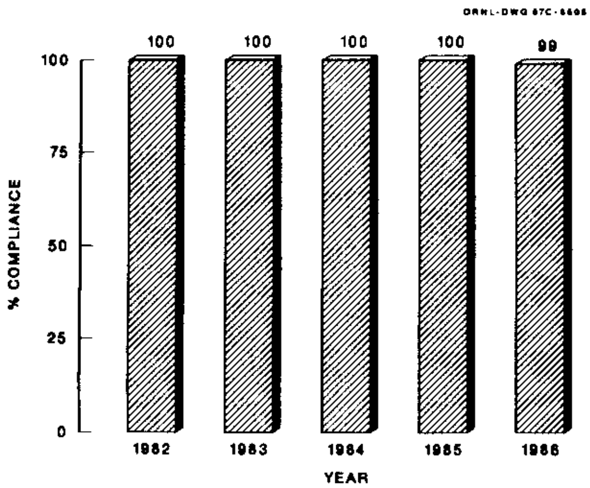

Fig. 5.3.21. NPDES compliance for total suspended solids at New Hope Pond (303).

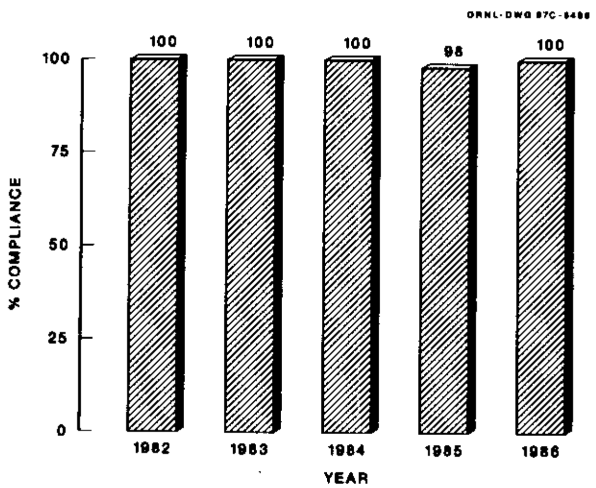

Fig. 5.3.22. NPDES compliance for surfactants (as MBAS) at New Hope Pond (303).

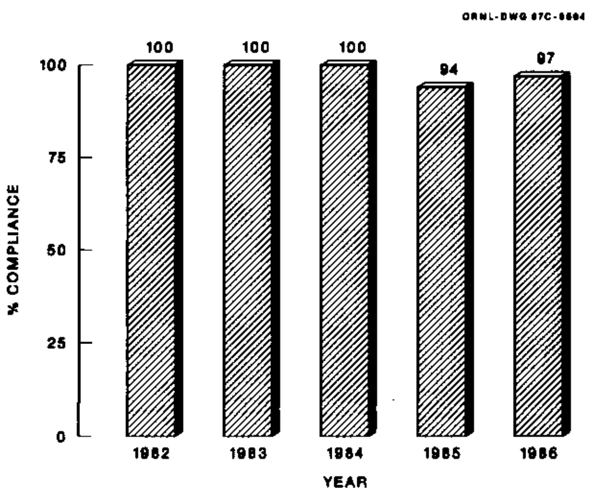

Fig. 5.3.23. NPDES compliance for total nitrogen at New Hope Pond (303).

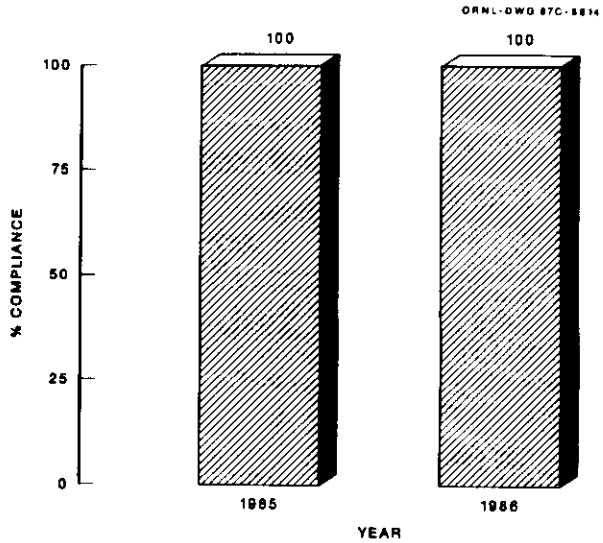

Fig. 5.3.24. NPDES compliance for temperature at New Hope Pond (303).

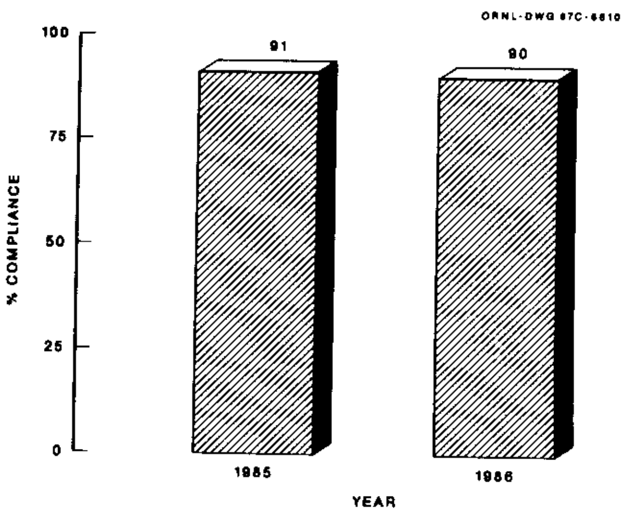

Fig. 5.3.25. NPDES compliance for mercury at New Hope Pond (303).

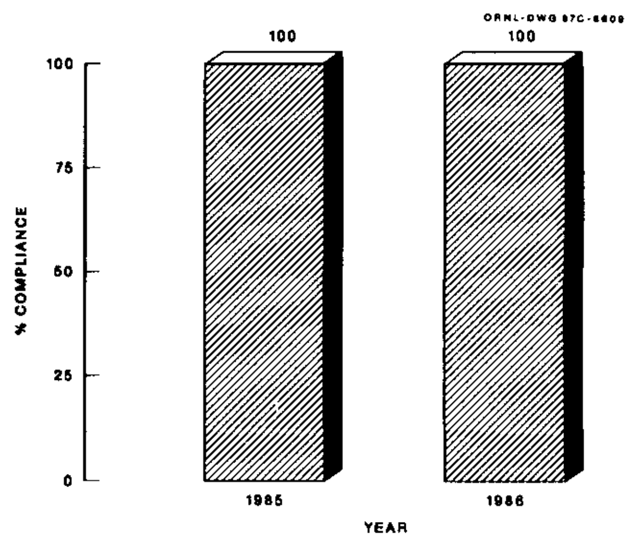

Fig. 5.3.26. NPDES compliance for lead at New Hope Pond (303).

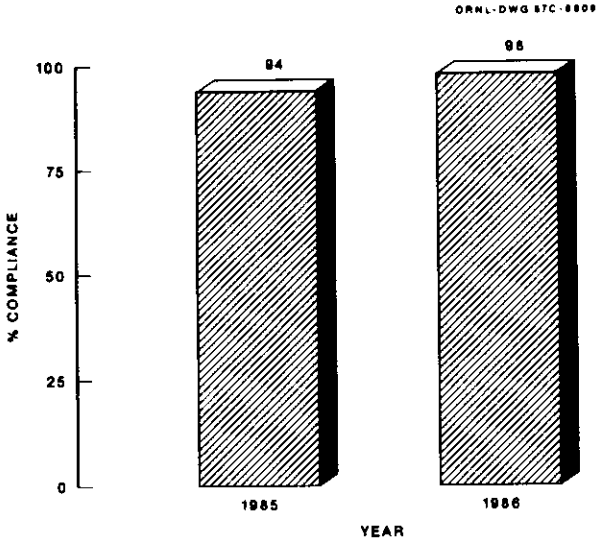

Fig. 5.3.27. NPDES compliance for copper at New Hope Pond (303).

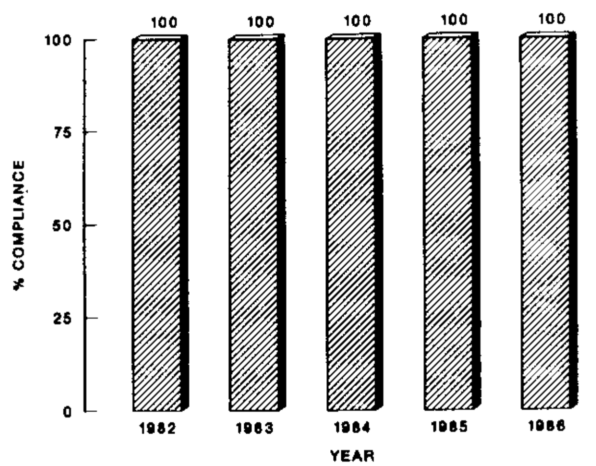

Fig. 5.3.29. NPDES compliance for oil and grease at Bear Creek (304).

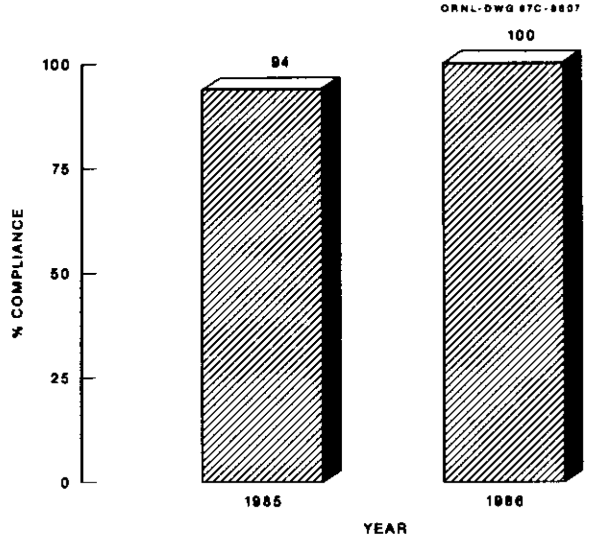

Fig. 5.3.28. NPDES compliance for cadmium at New Hope Pond (303).

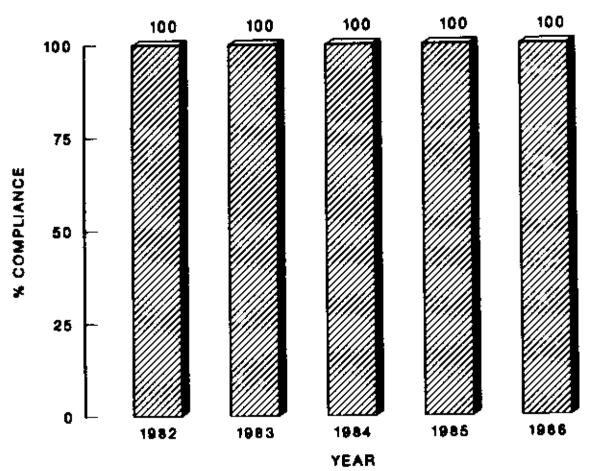

Fig. 5.3.30. NPDES compliance for pH at Bear Creek (304).

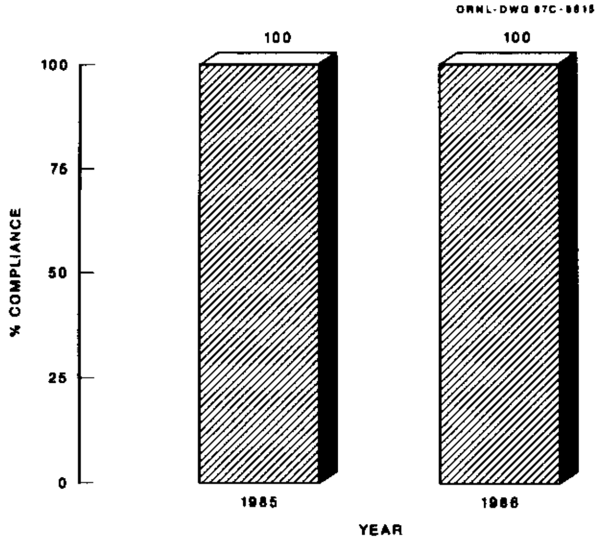

Fig. 5.3.31. NPDES compliance for oil and grease at leaking burial grounds (305).

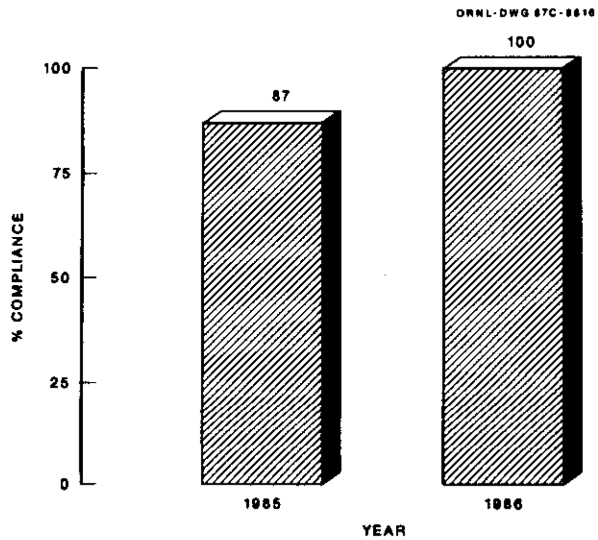

Fig. 5.3.32. NPDES compliance for pH at leaking burial grounds (305).

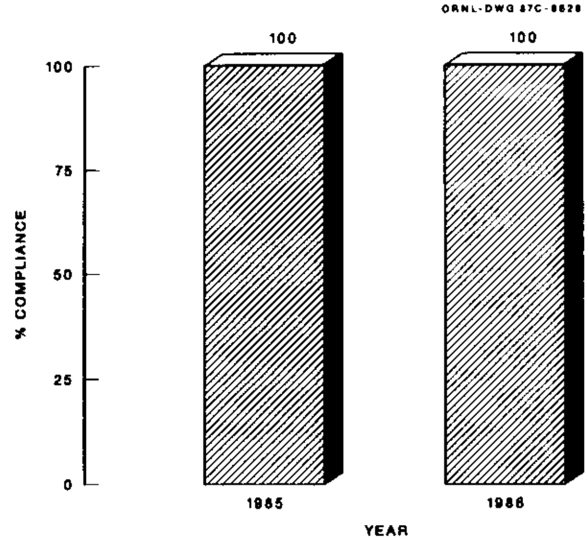

Fig. 5.3.33. NPDES compliance for total suspended solids at leaking burial grounds (305).

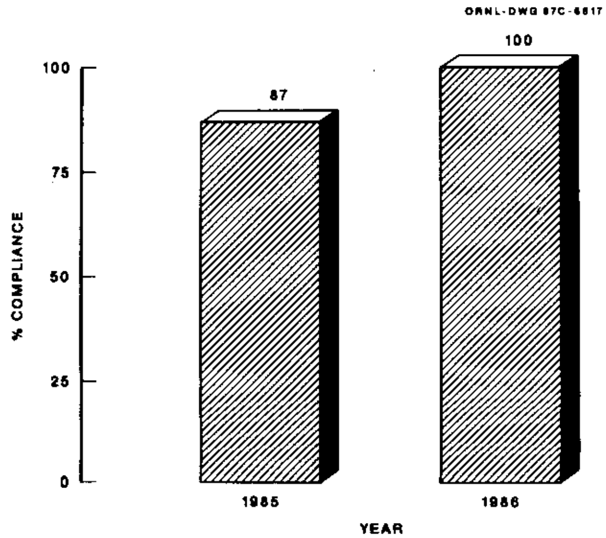

Fig. 5.3.34. NPDES compliance for oil and grease at seeps from burial pit (306).

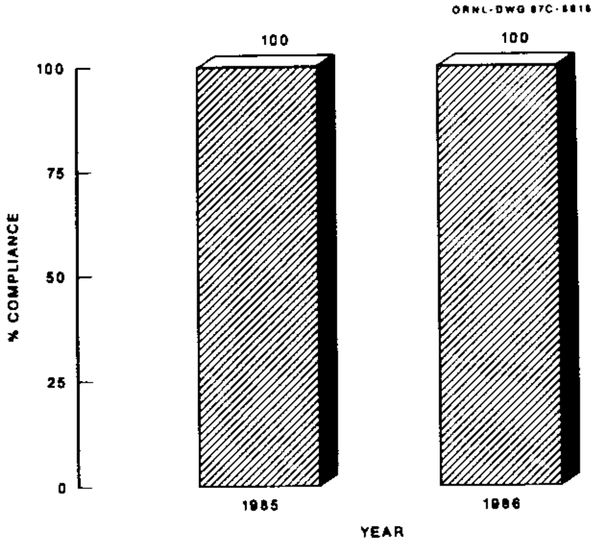

Fig. 5.3.35. NPDES compliance for pH at seeps from burial pit (306).

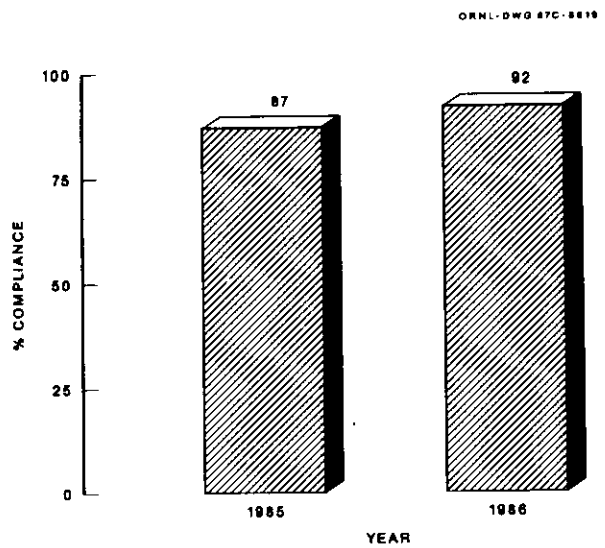

Fig. 5.3.36. NPDES compliance for total suspended solids at seeps from burial pit (306).

Increased compliance for oil and grease and total suspended solids resulted from replacement of rusty discharge pipes.

NPDES pH compliances at the Oak Ridge Y-12 Plant Category I, II, III, and IV outfalls are given in Figs. 5.3.37 through 5.3.41. NPDES pH compliance at discharge point 623 is given in Fig. 5.3.42.

Compliances at discharge point 507 for cadmium, chromium, copper, cyanide, lead, nickel, oil and grease, pH, silver, temperature, total suspended solids, total toxic organics, and zinc are given in Figs. 5.3.43 through 5.3.55. Cadmium, chromium, copper, lead, nickel, oil and grease, pH, silver, temperature, total toxic organics, and zinc were all 100% in compliance. Total suspended solids and cyanide were 99% in 1985 and 100% in 1986.

Percentages of NPDES compliance at discharge point 508 for mercury, pH, and total suspended solids are given in Figs. 5.3.56 through 5.3.58.

The compliances at cooling tower discharges for chromium, copper, free available chlorine, pH, temperature, and zinc are given in Figs. 5.3.59 through 5.3.64. Compliances for determineralizer discharges for pH and total suspended solids are given in Figs. 5.3.65 and 5.3.66. Central Pollution Control Facility compliances for all parameters are given in Figs. 5.3.67 and 5.3.68. The low compliance for TTO shown in Fig. 5.3.67 is a result of operational problems with phenols.

Concentrations for Oak Ridge Y-12 Plant discharge points are given in Tables 5.3.8 through 5.3.29.

ORNL. NPDES compliances at ORNL discharge point X01 for ammonia (as N), biochemical oxygen demand, residual chlorine, fecal coliform, pH, settleable solids, and suspended solids are given in Figs. 5.3.69 through 5.3.75. The 1986 improvement in compliance rates for all parameters except fecal coliform is a result of the new Sewage Treatment Plant. Some problems with fecal coliform levels have occurred because of reductions in chlorine levels.

Concentrations for ORNL discharge points are given in Tables 5.3.30 through 5.3.42.

ORGDP. Compliances at ORGDP discharge point 001, K-1700 discharge, for aluminum, chromium, nitrate, suspended solids, and pH are given in Figs. 5.3.76 through 5.3.80. Compliances for lead are given in Fig. 5.3.81. Compliances for oil and grease, perchloroethylene, trichloroethane, methylene chloride, trichloroethylene, zinc, total halomethanes, beryllium, cadmium, mercury, selenium, and silver are given in Figs. 5.3.82 through 5.3.93.

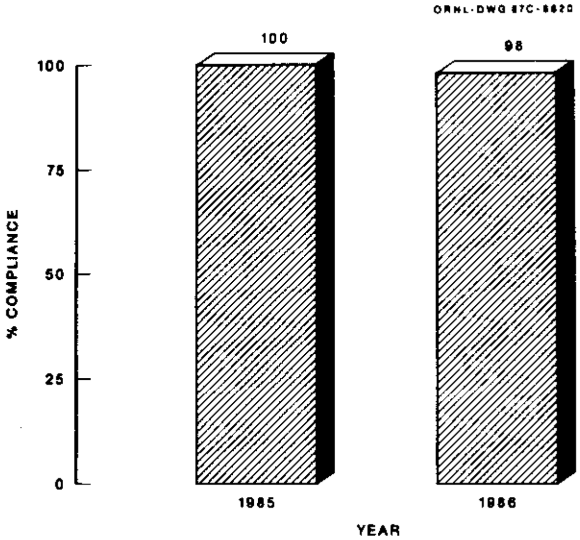

Fig. 5.3.37. NPDES compliance for pH at Category I outfalls.

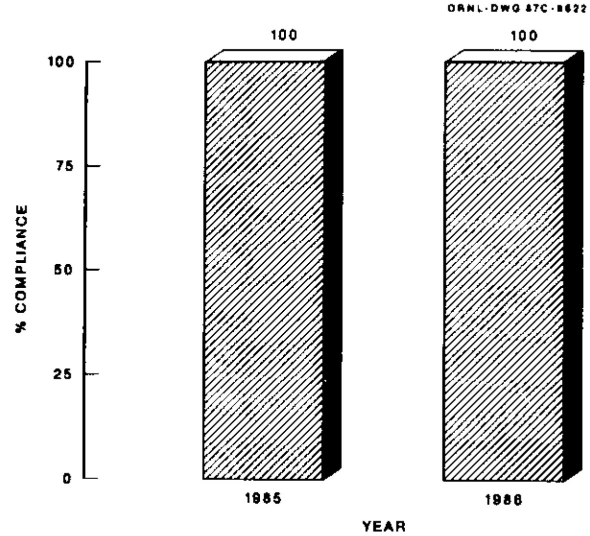

Fig. 5.3.39. NPDES compliance for temperature at Category II outfalls.

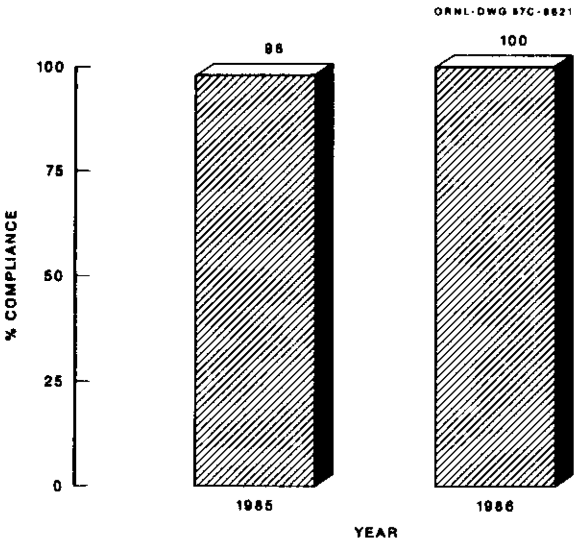

Fig. 5.3.38. NPDES compliance for pH at Category II outfalls.

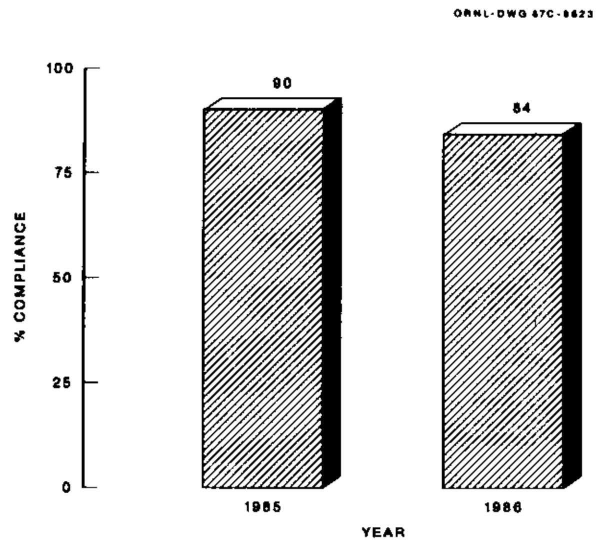

Fig. 5.3.40. NPDES compliance for pH at Category III outfalls.

Compliances at discharge point 005, K-1203 Sanitary Treatment Facility, for ammonia, BOD, residual chlorine, dissolved oxygen, fecal coliform, pH, suspended solids, and settleable solids are given in Figs. 5.3.94 through 5.3.101. Compliances during 1985 and 1986 for beryllium, cadmium, mercury, selenium, silver, lead, zinc, perchloroethylene, trichloroethane, methylene chloride, trichloroethylene, and total halomethanes are given in Figs. 5.3.102 through 5.3.113.

Compliances at discharge point 006, K-1007-B Holding Pond, for COD, chromium, dissolved oxygen, fluoride, oil and grease, pH, and and suspended solids are given in Figs. 5.3.114 through 5.3.120.

The NPDES compliances at discharge point 007, K-901-A Holding Pond, for chromium, fluoride, oil and grease, pH, and suspended solids are given in Figs. 5.3.121 through 5.3.125. Compliances at discharge point 009, K-1515, Sanitary Water Plant, for suspended solids, aluminum, sulphate, and pH are given in Figs. 5.3.126 through 5.3.129.

Concentrations for ORGDP discharge points are given in Tables 5.3.43 through 5.3.57.

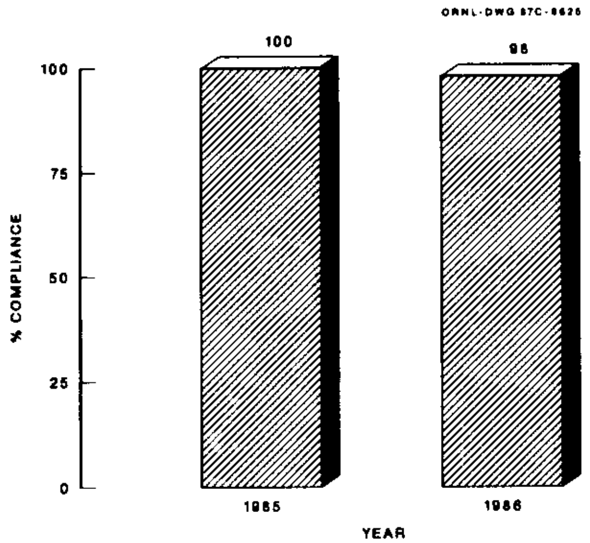

Fig. 5.3.41. NPDES compliance for pH at Category IV outfalls.

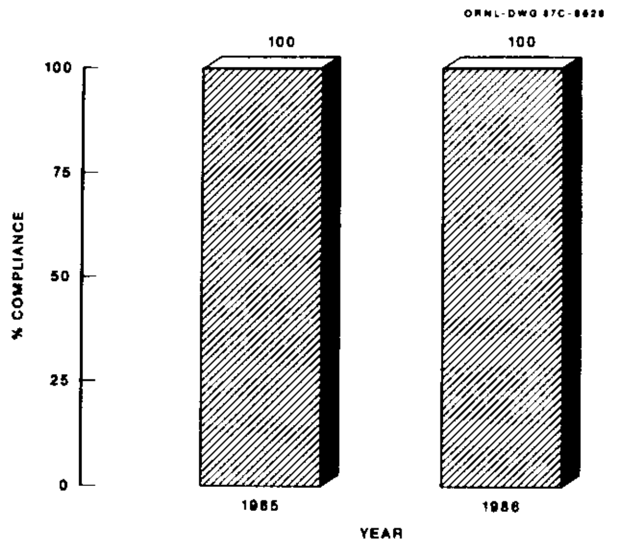

Fig. 5.3.43. NPDES compliance for cadmium at S-3 Ponds Liquid Treatment Facility (507).

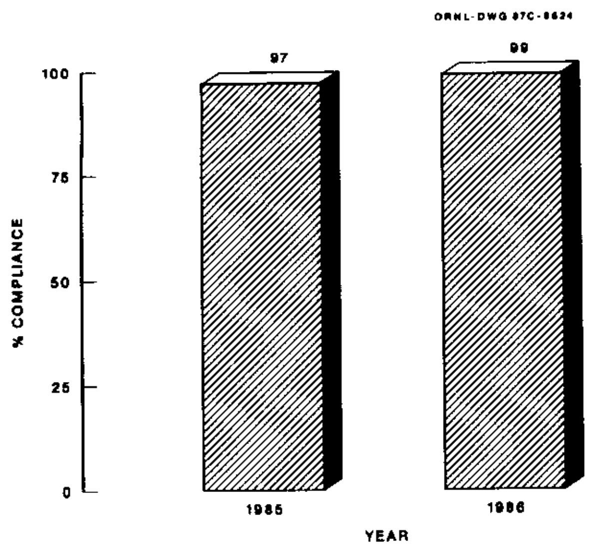

Fig. 5.3.42. NPDES compliance for pH at Steam Plant (623).

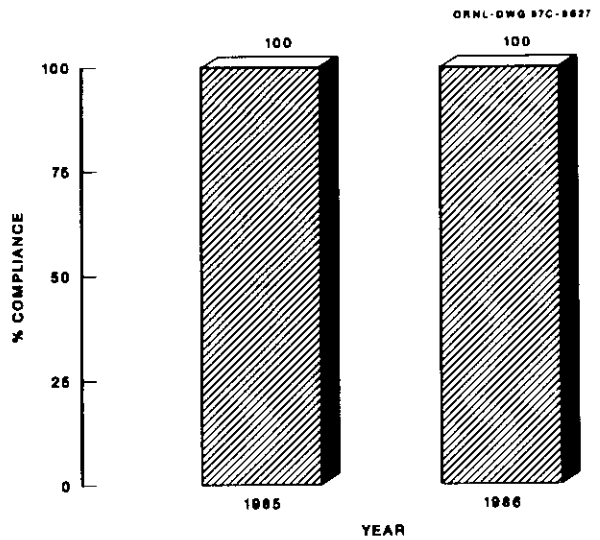

Fig. 5.3.44. NPDES compliance for chromium at S-3 Ponds Liquid Treatment Facility (507).

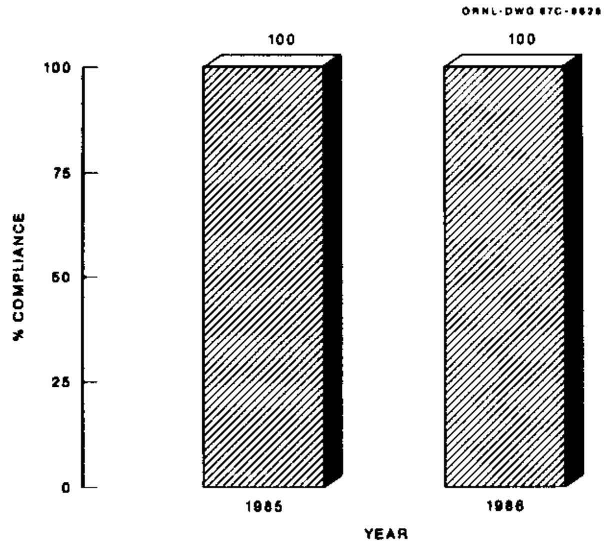

Fig. 5.3.45. NPDES compliance for copper at S-3 Ponds Liquid Treatment Facility (507).

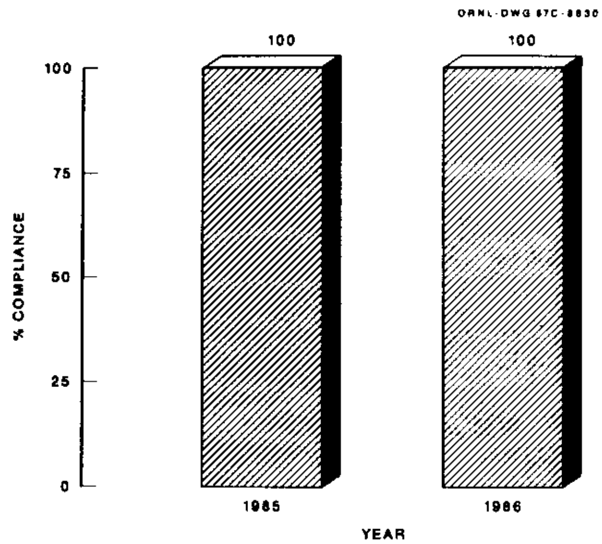

Fig. 5.3.47. NPDES compliance for lead at S-3 Ponds Liquid Treatment Facility (507).

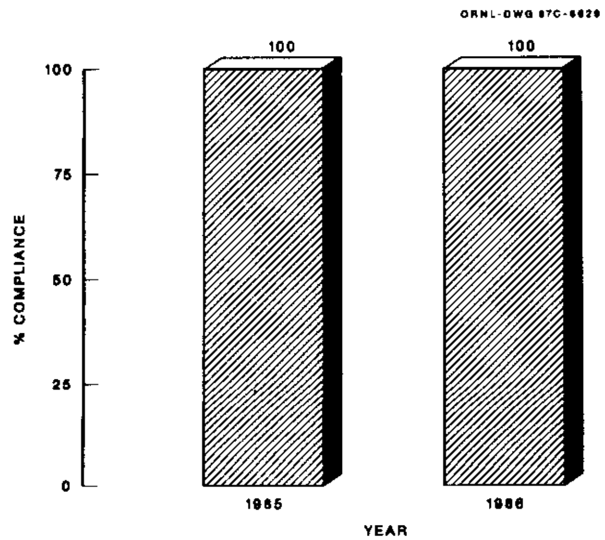

Fig. 5.3.46. NPDES compliance for cyanide at S-3 Ponds Liquid Treatment Facility (507).

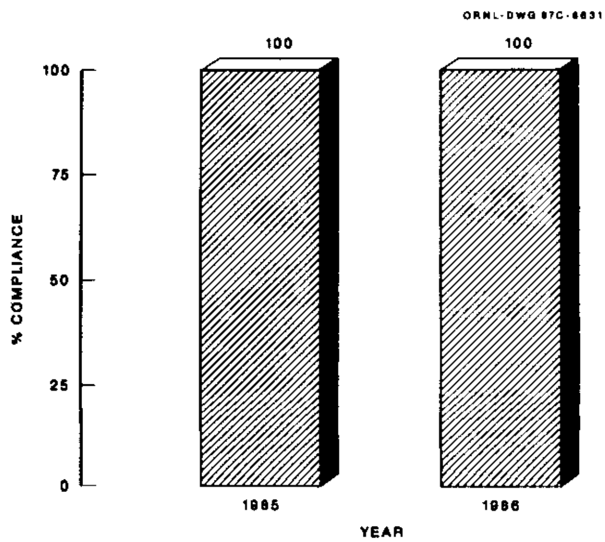

Fig. 5.3.48. NPDES compliance for nickel at S-3 Ponds Liquid Treatment Facility (507).

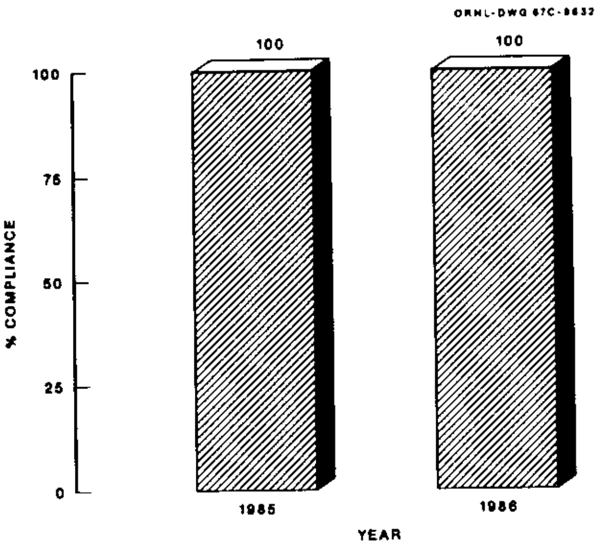

Fig. 5.3.49. NPDES compliance for oil and grease at S-3 Ponds Liquid Treatment Facility (507).

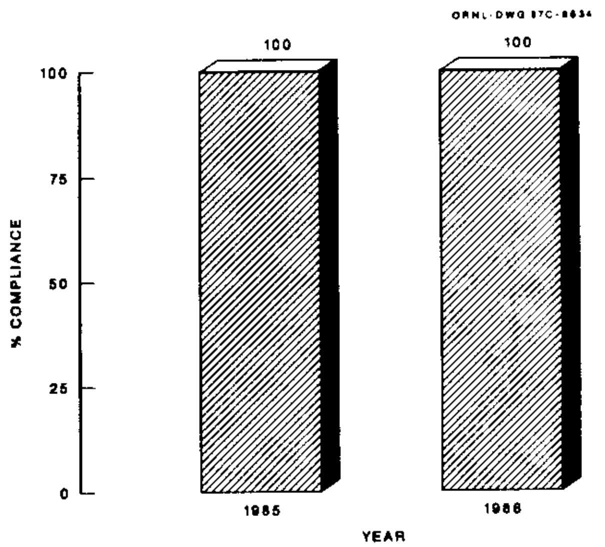

Fig. 5.3.51. NPDES compliance for silver at S-3 Ponds Liquid Treatment Facility (507).

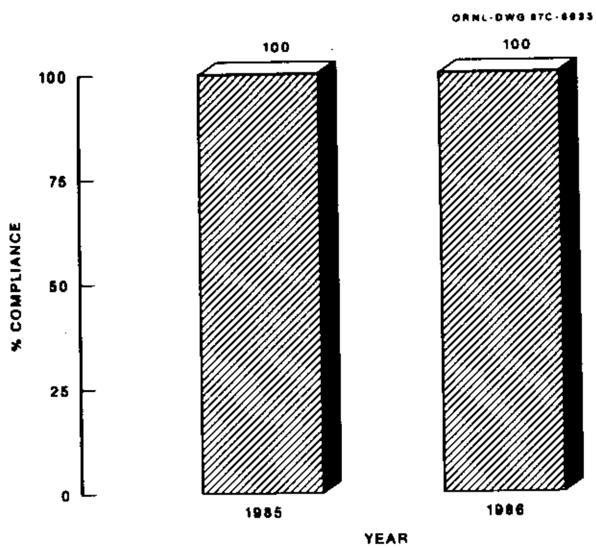

Fig. 5.3.50. NPDES compliance for pH at S-3 Ponds Liquid Treatment Facility (507).

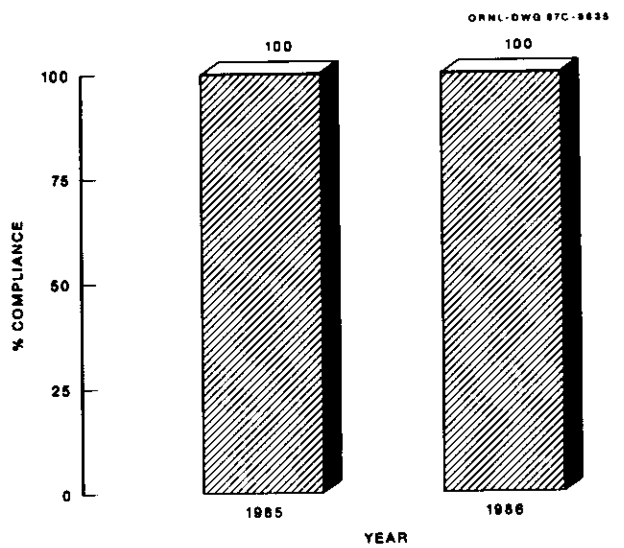

Fig. 5.3.52. NPDES compliance for temperature at S-3 Ponds Liquid Treatment Facility (507).

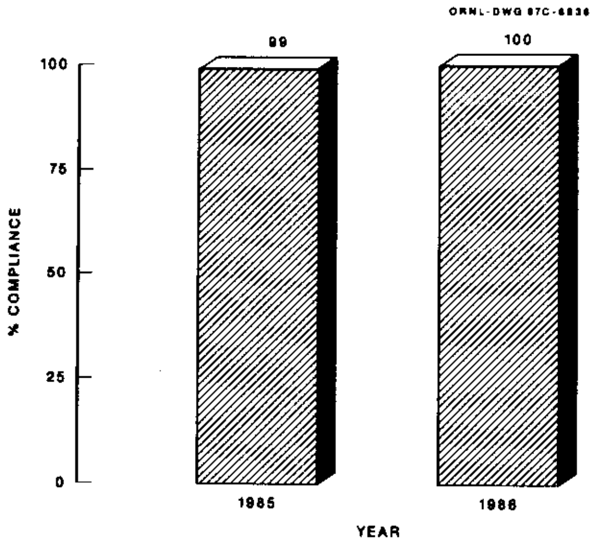

Fig. 5.3.53. NPDES compliance for total suspended solids at S-3 Ponds Liquid Treatment Facility (507).

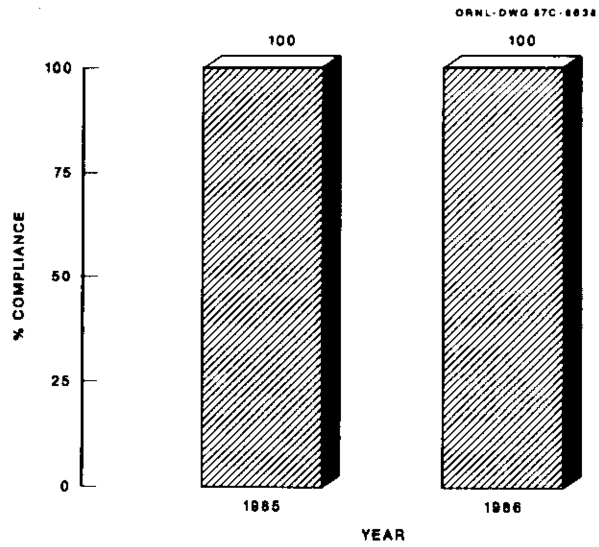

Fig. 5.3.55. NPDES compliance for zinc at S-3 Ponds Liquid Treatment Facility (507).

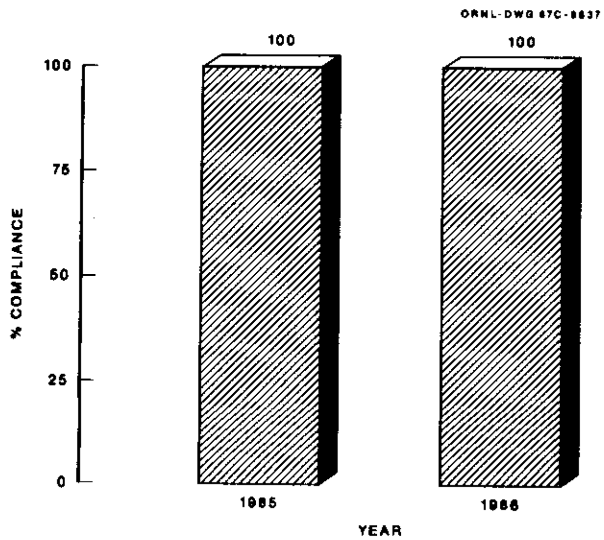

Fig. 5.3.54. NPDES compliance for total toxic organics at S-3 Ponds Liquid Treatment Facility (507).

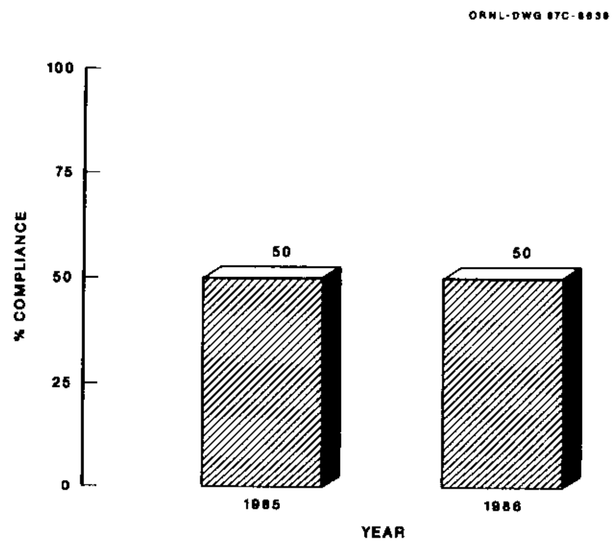

Fig. 5.3.56. NPDES compliance for mercury at Experimental Mobile Wastewater Treatment Facility (508).

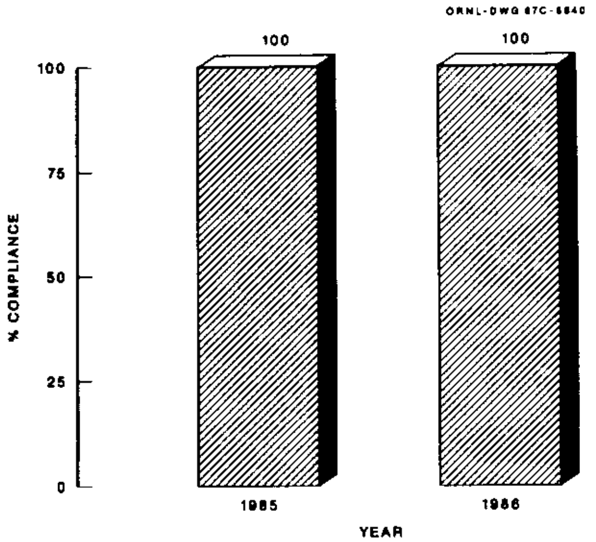

Fig. 5.3.57. NPDES compliance for pH at Experimental Mobile Wastewater Treatment Facility (508).

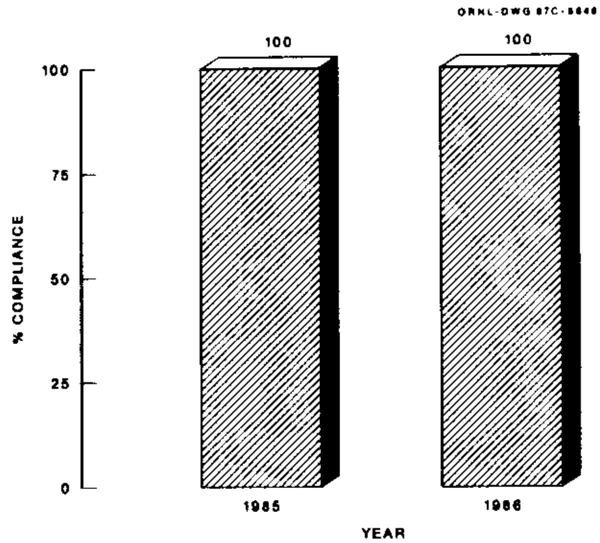

Fig. 5.3.59. NPDES compliance for chromium at cooling tower discharges.

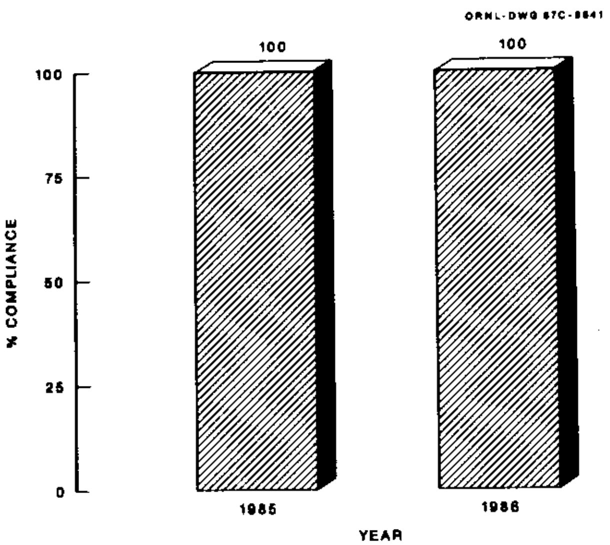

Fig. 5.3.58. NPDES compliance for total suspended solids at Experimental Mobile Wastewater Treatment Facility (508).

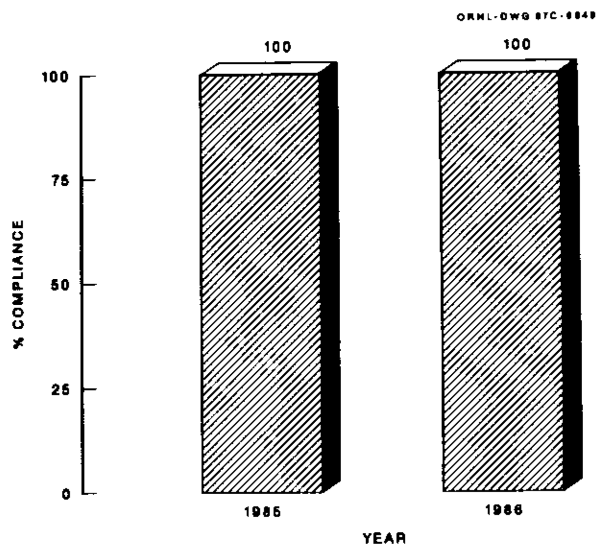

Fig. 5.3.60. NPDES compliance for copper at cooling tower discharges.

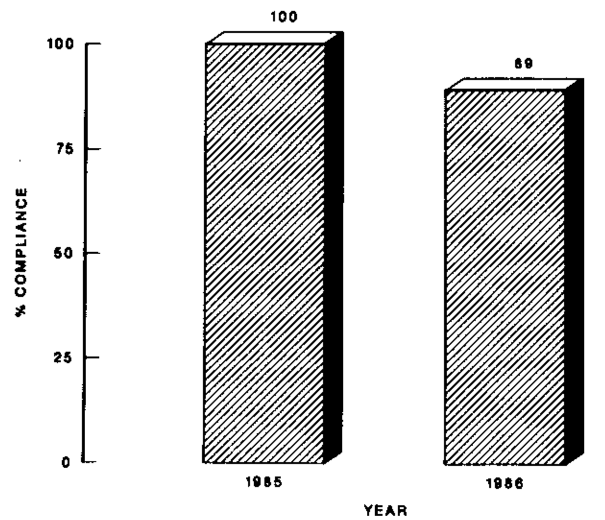

Fig. 5.3.61. NPDES compliance for free available chlorine at cooling tower discharges.

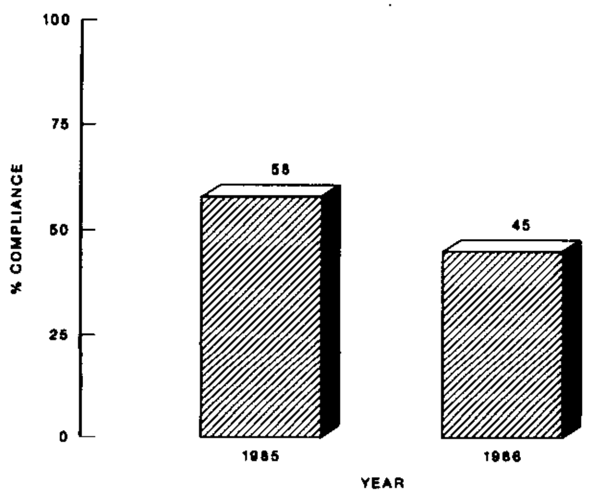

Fig. 5.3.62. NPDES compliance for pH at cooling tower discharges.

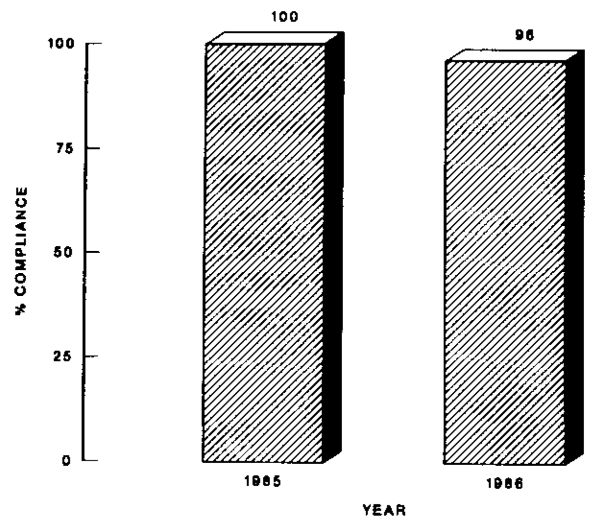

Fig. 5.3.63. NPDES compliance for temperature at cooling tower discharges.

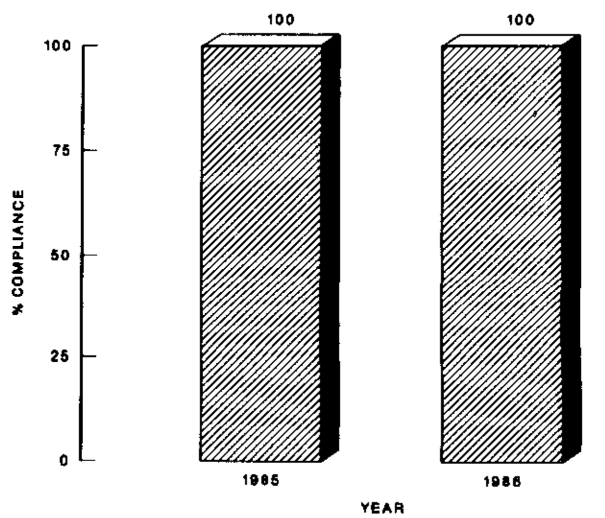

Fig. 5.3.64. NPDES compliance for zinc at cooling tower discharges.

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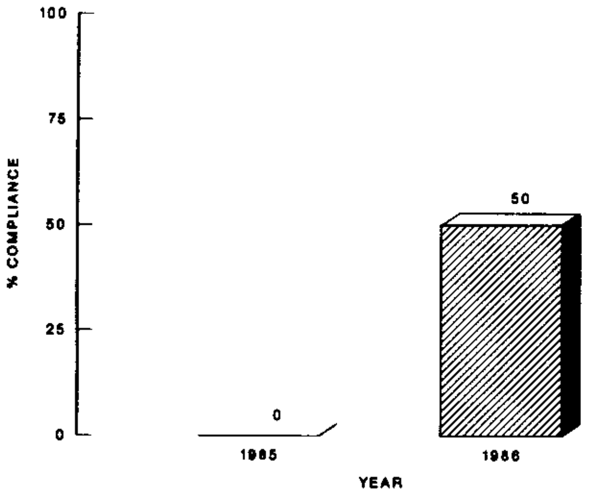

Fig. 5.3.65. NPDES compliance for pH at demineralizer discharges.

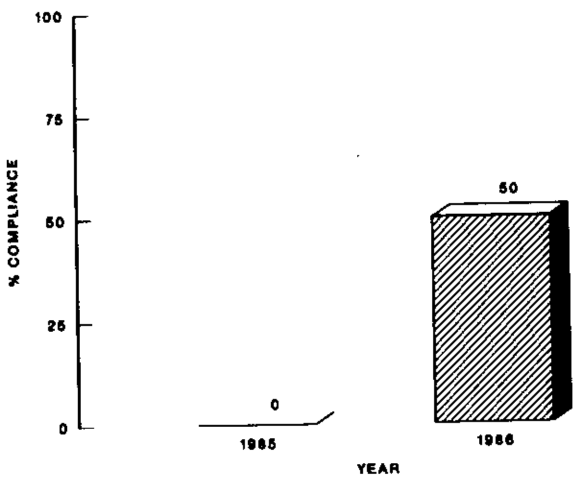

Fig. 5.3.66. NPDES compliance for total suspended solids at demineralizer discharges.

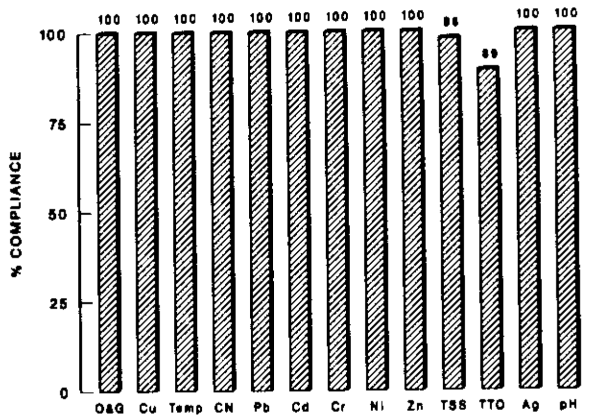

Fig. 5.3.67. 1986 NPDES compliance at CPCF-I (501).

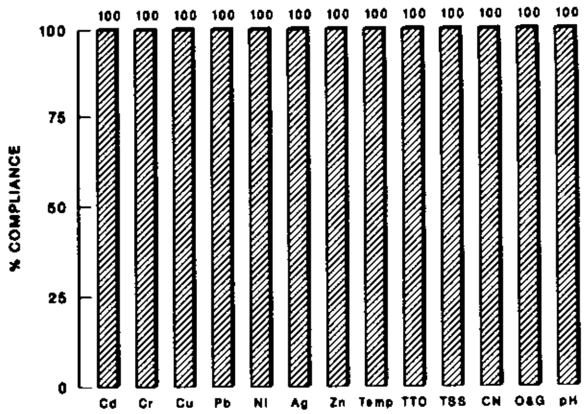

Fig. 5.3.68. 1986 NPDES compliance at CPCF-II (502).

Table 5.3.8. 1986 NPDES Permit Number TN 0002968
Discharge Point 301[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Total suspended solids			*Mercury*			*Lithium*			*Zirconium*		
March	<5.0	<5.0	<5.0	<0.0005	<0.0005	<0.0005	0.05	0.04	0.045	<0.001	<0.001	<0.001
April	<5.0	<5.0	<5.0	<0.0005	<0.0005	<0.0005	0.08	0.08	0.08	0.001	0.001	0.001
August	<5.0	<5.0	<5.0	<0.0005	<0.0005	<0.0005	0.05	0.05	0.05	<0.001	<0.001	<0.001
	Potassium			*Sodium*			*pH (units)*			*Arsenic*		
March	0.9	0.7	0.8	0.6	0.5	0.55	7.9	7.2	NA[b]	<0.06	<0.06	<0.06
April	0.9	0.9	0.9	0.6	0.6	0.6	7.7	7.7	NA	<0.06	<0.06	<0.06
August	1.4	1.4	1.4	1.0	1.0	1.0	7.8	7.8	NA	<0.06	<0.06	<0.06
	Cadmium			*Chromium*			*Copper*			*Iron*		
March	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.11	0.09	0.10
April	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.06	<0.06	<0.06
August	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.06	<0.06	<0.06
	Nickel			*Selenium*			*Zinc*			*Lead*		
March	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01
April	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01
August	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01
	Temperature (°C)											
March	14.5	8.8	11.6									
April	17.3	17.3	17.3									
August	26.1	26.1	26.1									

[a]Y-12 Plant, Kerr Hollow Quarry; sample ID W43.
[b]NA—not applicable.

Table 5.3.9. 1986 NPDES Permit Number TN 0002968 Discharge Point 302[a] (Part 1)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Total suspended solids			*Chemical oxygen demand*			*Sulfate as SO_4*			*Oil and grease*		
January	8.0	<5.0	<7.0	<5.0	<5.0	<5.0	85.0	76.0	81.0	<2.0	<2.0	<2.0
February	11.0	<5.0	<7.25	10.0	<5.0	<6.75	87.0	84.0	86.0	<2.0	<2.0	<2.0
March	7.0	<5.0	<5.4	<5.0	<5.0	<5.0	89.0	76.0	82.0	<2.0	<2.0	<2.0
April	<5.0	<5.0	<5.0	15.0	<5.0	<7.5	87.0	73.0	78.0	3.0	<2.0	<2.25
May	6.0	<5.0	<5.5	11.0	<5.0	<7.1	82.0	77.0	79.0	<2.0	<2.0	<2.0
June	<5.0	<5.0	<5.0	6.2	<5.0	<5.3	78.0	74.0	75.6	<2.0	<2.0	<2.0
July	12.0	5.0	7.0	16.0	<5.0	<12.0	720.0	67.0	234.0	<2.0	<2.0	<2.0
August	9.0	<5.0	<6.37	16.0	12.0	13.5	73.0	57.0	66.3	3.0	<2.0	<2.25
September	11.0	<5.0	<6.2	13.0	4.5	7.1	73.0	66.0	70.0	<2.0	<2.0	<2.0
October	7.0	<5.0	<5.75	8.7	<5.0	<6.53	78.0	71.0	74.3	3.0	<2.0	<2.0
November	5.0	<5.0	<5.0	5.3	<5.0	<5.0	100.0	75.0	86.8	2.0	<2.0	<2.0
December	6.0	<5.0	<5.4	12.0	<5.0	<6.4	90.0	82.0	86.4	<2.0	<2.0	<2.0
	Settleable solids (mL/L)			*Selenium*			*Mercury*			*Arsenic*		
January	<0.1	<0.1	<0.1	0.021	0.014	0.019	<0.0005	<0.0005	<0.0005	0.28	<0.06	<0.20
February	<0.1	<0.1	<0.1	0.024	0.018	0.020	<0.0005	<0.0005	<0.0005	0.26	0.21	0.24
March	<0.1	<0.1	<0.1	0.02	0.015	0.018	<0.0005	<0.0005	<0.0005	0.26	0.20	0.22
April	<0.1	<0.1	<0.1	0.018	0.012	0.015	<0.0005	<0.0005	<0.0005	0.20	0.20	0.20
May	<0.1	<0.1	<0.1	0.018	0.013	0.016	<0.0005	<0.0005	<0.0005	0.20	0.16	0.18
June	<0.1	<0.1	<0.1	0.02	0.014	0.018	<0.0005	<0.0005	<0.0005	0.22	0.14	0.18
July	<0.1	<0.1	<0.1	0.021	0.018	0.019	<0.0005	<0.0005	<0.0005	0.21	0.14	0.17
August	<0.1	<0.1	<0.1	0.110	0.018	0.042	<0.0005	<0.0002	<0.0004	0.18	0.10	0.15
September	<0.1	<0.1	<0.1	0.017	0.002	0.013	<0.0002	<0.0002	<0.0002	0.24	0.21	0.22
October	<0.1	<0.1	<0.1	0.022	0.018	0.02	0.0002	<0.0002	<0.0002	0.22	0.18	0.20
November	<0.1	<0.1	<0.1	0.018	0.016	0.017	<0.0002	<0.0002	<0.0002	0.28	0.22	0.25
December	<0.1	<0.1	<0.1	0.023	0.015	0.019	<0.0002	<0.0002	<0.0002	0.32	0.24	0.28

[a]Y-12 Plant, Rogers Quarry; sample ID W44.

Table 5.3.10. 1986 NPDES Permit Number TN 0002968
Discharge Point 302[a] (Part 2)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Cadmium			*Chromium*			*Copper*			*Iron*		
January	<0.002	<0.002	<0.002	0.03	<0.01	<0.015	0.015	<0.004	<0.007	17.0	0.17	4.41
February	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.29	0.12	0.19
March	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.16	0.08	0.11
April	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.10	0.07	0.825
May	0.004	<0.002	<0.0025	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.17	<0.06	<0.12
June	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	0.005	<0.004	<0.0042	0.09	<0.06	<0.066
July	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.10	<0.06	<0.08
August	<0.003	<0.002	<0.0023	<0.01	<0.006	<0.009	<0.004	<0.002	<0.0035	0.12	0.04	0.07
September	<0.003	<0.003	<0.003	<0.006	<0.006	<0.006	<0.002	<0.002	<0.002	0.07	0.03	0.05
October	<0.003	<0.003	<0.003	<0.006	<0.006	<0.006	<0.002	<0.002	<0.002	0.16	0.07	0.095
November	<0.003	<0.003	<0.003	<0.006	<0.006	<0.006	0.003	<0.002	<0.002	0.28	0.04	0.19
December	<0.003	<0.003	<0.003	<0.006	<0.006	<0.006	0.008	0.002	0.004	1.4	0.21	0.55
	Nickel			*Zinc*			*Lead*			*pH (units)*		
January	0.03	<0.01	<0.02	0.05	<0.02	<0.03	<0.01	<0.01	<0.01	8.4	7.9	NA[b]
February	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	7.9	7.1	NA
March	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	8.4	7.5	NA
April	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	8.7	7.4	NA
May	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	9.0	8.3	NA
June	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	9.0	8.8	NA
July	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	9.1	9.0	NA
August	<0.01	<0.007	<0.0093	0.02	<0.003	<0.016	<0.02	<0.01	<0.013	9.5	8.9	NA
September	<0.007	<0.007	<0.007	0.007	<0.001	<0.003	<0.02	<0.02	<0.02	9.5	8.3	NA
October	<0.007	<0.007	<0.007	0.005	0.001	<0.02	<0.02	<0.02	<0.02	8.7	7.4	NA
November	<0.007	<0.007	<0.007	0.003	<0.001	<0.001	<0.02	<0.02	<0.02	8.2	6.8	NA
December	<0.007	<0.007	<0.007	0.006	<0.001	<0.003	<0.02	<0.02	<0.02	8.3	8.2	NA

[a] Y-12 Plant, Rogers Quarry; sample ID W44.
[b] NA—not applicable.

Table 5.3.11. 1986 NPDES Permit Number TN 0002968 Discharge Point 302[a] (Part 3)

Month	Concentration (mg/L)					
	Max	Min	Av	Max	Min	Av
	Turbidity (NTU)			*Temperature (°C)*		
January	4.0	0.06	2.4	9.3	7.6	8.5
February	5.3	0.65	2.6	8.4	8.0	8.2
March	2.7	0.33	1.38	13.0	8.0	9.9
April	3.5	1.4	2.2	17.0	12.1	14.6
May	51.0	2.5	15.4	22.0	16.1	19.8
June	3.1	1.4	2.1	28.1	23.1	25.8
July	7.0	0.4	3.5	30.2	27.4	28.6
August	8.0	0.25	4.81	26.7	25.7	26.1
September	2.5	1.5	2.2	26.0	21.3	23.5
October	4.1	1.8	3.2	23.8	16.5	19.6
November	5.8	0.9	3.6	16.4	13.0	14.9
December	7.0	4.0	5.5	12.7	10.1	11.7

[a]Y-12 Plant, Rogers Quarry; sample ID W44.

Table 5.3.12. 1986 NPDES Permit Number TN 0002968 Discharge Point 303[a] (Part 1)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Ammonia (as N)			*Chromium*			*Fluoride*			*Lithium*		
January	0.3	<0.2	<0.22	<0.01	<0.01	<0.01	1.1	1.0	1.0	0.11	<0.01	<0.04
February	1.1	0.2	0.7	<0.01	<0.01	<0.01	1.0	0.7	0.85	0.04	0.02	0.025
March	3.0	<0.2	<0.25	<0.01	<0.01	<0.01	1.1	0.73	0.83	0.02	<0.01	<0.015
April	<0.2	<0.2	<0.2	<0.01	<0.01	<0.01	1.6	0.8	1.175	0.03	0.01	0.0175
May	<0.2	<0.2	<0.2	<0.01	<0.01	<0.01	1.20	0.85	1.11	0.03	<0.01	<0.02
June	<0.2	<0.2	<0.2	0.02	<0.01	<0.012	1.3	1.2	1.23	0.40	<0.01	<0.12
July	0.3	<0.2	<0.22	<0.01	<0.01	<0.01	1.1	0.8	1.04	0.13	<0.01	<0.054
August	<0.2	<0.2	<0.2	<0.01	<0.006	<0.008	1.0	0.7	0.85	0.047	0.01	0.0265
September	0.3	<0.2	<0.23	<0.006	<0.006	<0.006	1.2	0.9	1.06	0.23	0.02	0.06
October	0.3	<0.2	<0.22	<0.006	<0.006	<0.006	1.3	0.9	1.1	0.26	0.021	0.076
November	0.7	0.2	0.46	0.007	<0.006	<0.006	1.1	0.6	0.9	0.117	0.014	0.031
December	1.9	<0.2	<0.53	0.008	<0.006	<0.006	1.0	0.5	0.88	0.46	0.011	0.043
	Surfactants (as MBAS)			*Dissolved solids*			*Nickel*			*Beryllium*		
January	<0.05	<0.05	<0.05	250	170	218	<0.010	<0.010	<0.0100	<0.0005	<0.0005	<0.0005
February	<0.05	<0.05	<0.05	290	190	242	<0.010	<0.010	<0.0100	<0.0005	<0.0005	<0.0005
March	<0.05	<0.05	<0.05	260	190	230	0.010	<0.010	<0.0100	0.0006	<0.0005	<0.0005
April	<0.05	<0.05	<0.05	830	220	412	<0.010	<0.010	<0.0100	<0.0005	<0.0005	<0.0005
May	0.06	<0.05	<0.05	300	250	276	<0.010	<0.010	<0.0100	<0.0005	<0.0005	<0.0005
June	<0.05	<0.05	<0.05	260	240	248	0.010	<0.010	<0.0100	<0.0005	<0.0005	<0.0005
July	<0.05	<0.05	<0.05	250	170	210	<0.010	<0.010	<0.0100	0.0007	<0.0005	<0.0005
August	<0.05	<0.05	<0.05	260	190	220	<0.010	<0.007	<0.0085	<0.0005	<0.0001	<0.0003
September	<0.05	<0.05	<0.05	430	240	320	0.010	<0.007	<0.0080	<0.0001	<0.0001	<0.0001
October	<0.05	<0.05	<0.05	340	250	288	0.008	<0.007	<0.0070	<0.0001	<0.0001	<0.0001
November	<0.05	<0.05	<0.05	430	240	293	0.012	<0.007	<0.0100	<0.0001	<0.0001	<0.0001
December	<0.05	<0.05	<0.05	370	170	254	0.023	<0.007	<0.0100	0.0002	<0.0001	<0.0001

[a]New Hope Pond; sample ID W45.

Table 5.3.13. 1986 NPDES Permit Number TN 0002968
Discharge Point 303[a] (Part 2)

Month	Concentration (mg/L)											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Residual chlorine			*Perchloroethylene*			*Settleable solids (mL/L)*			*Dissolved oxygen*		
January	0.40	0.20	0.300	0.025	<0.010	<0.014	<0.1	<0.1	<0.1	12.2	9.0	10.60
February	0.20	<0.10	<0.180	0.013	<0.010	<0.011	<0.1	<0.1	<0.1	11.2	8.7	9.80
March	0.30	0.20	0.220	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	11.1	8.4	9.80
April	0.30	0.20	0.220	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	14.0	6.9	10.60
May	0.40	<0.10	<0.200	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	9.9	6.4	8.20
June	0.60	0.20	0.410	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	10.8	6.0	8.30
July	0.40	0.25	0.300	<0.010	<0.010	<0.010	0.1	0.1	0.1	11.0	7.0	8.80
August	0.25	0.20	0.225	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	10.1	6.2	8.10
September	0.25	<0.10	<0.140	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	9.9	5.8	7.20
October	0.40	<0.10	<0.280	<0.010	<0.010	<0.010	<0.1	<0.1	<0.1	10.3	6.2	8.1
November	0.30	<0.10	<0.100	<10.0	<10.0	<10.0	<0.1	<0.1	<0.1	10.1	7.1	8.6
December	1.20	<0.10	<0.400	<10.0	<10.0	<10.0	<0.1	<0.1	<0.1	11.3	8.2	9.30
Annual	1.20	<0.10	<0.200	<10.00	<0.010	<1.700	<0.1	<0.1	<0.1	14.0	5.8	9.00
	Oil and grease			*Total suspended solids*			*Zinc*			*Nitrogen (total)*		
January	<2	<2	<2.0	13.0	<5	<7.60	0.100	0.060	0.070	5.6	3.7	4.50
February	5	<2	<2.8	92.0	<5	<27.5	0.110	0.050	0.070	8.7	5.7	6.60
March	<2	<2	<2.0	140.0	<5	<42.0	0.080	0.040	0.060	53.0	4.1	17.10
April	<2	<2	<2.0	<5.0	<5	<5.00	0.070	0.030	0.048	4.4	3.3	3.90
May	3	<2	<2.3	<5.0	<5	<5.00	0.040	0.020	0.030	5.0	3.0	3.8
June	<2	<2	<2.0	5.5	<5	<5.10	0.040	0.030	0.033	23.0	3.3	8.68
July	<2	<2	<2.0	98.0	<5	<23.6	0.130	0.020	0.054	4.8	3.1	3.80
August	3	<2	<2.2	32.0	<5	<12.5	0.040	0.030	0.030	5.7	2.3	3.50
September	3	<2	<2.1	14.0	<5	<6.20	0.060	0.030	0.044	3.1	2.8	2.93
October	4	<2	<2.0	14.0	<5	<9.27	0.100	0.040	0.054	4.0	3.0	3.40
November	4	<2	<2.0	17.0	<5	<7.35	0.093	0.042	0.066	4.0	3.0	3.48
December	3	<2	<2.0	19.0	<5	<7.40	0.162	0.044	0.073	4.8	3.1	3.90
Annual	5	<2	<2.1	140.0	<5	<13.20						

[a]Y-12 Plant, New Hope Pond; sample ID W45.

Table 5.3.14. 1986 NPDES Permit Number TN 0002968 Discharge Point 303[a] (Part 3)

Month	Concentration (mg/L)											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Cadmium			*Lead*			*Copper*			*Mercury*		
January	<0.002	<0.002	<0.0020	<0.01	<0.01	<0.010	0.018	0.008	0.012	0.0048	0.0018	0.0030
February	<0.002	<0.002	<0.0020	0.01	<0.01	<0.010	0.018	0.004	0.011	0.0031	0.0016	0.0020
March	<0.002	<0.002	<0.0020	<0.01	<0.01	<0.010	0.014	0.007	0.011	0.0049	0.0011	0.0025
April	<0.002	<0.002	<0.0020	<0.01	<0.01	<0.010	0.010	0.007	0.008	0.0015	0.0010	0.0012
May	<0.002	<0.002	<0.0020	<0.01	<0.01	<0.010	0.008	0.005	0.007	0.0009	0.0007	0.0008
June	<0.002	<0.002	<0.0020	<0.01	<0.01	<0.010	0.009	0.009	0.009	0.0014	0.0007	0.0011
July	<0.002	<0.002	<0.0020	0.02	<0.01	<0.012	0.029	<0.004	<0.012	0.0054	0.0011	0.0021
August	<0.003	<0.002	<0.0025	<0.02	<0.01	<0.015	0.009	0.006	0.007	0.0017	0.0010	0.0013
September	<0.003	<0.003	<0.0030	0.02	<0.02	<0.020	0.008	0.005	0.006	0.0018	0.0007	0.0011
October	<0.003	<0.003	<0.0030	<0.02	<0.02	<0.020	0.014	0.006	0.008	0.0024	0.0010	0.0014
November	0.012	<0.003	0.0035	<0.02	<0.02	<0.020	0.014	0.004	0.008	0.0400	0.0009	0.0048
December	<0.003	<0.003	<0.0030	<0.02	<0.02	<0.020	0.026	<0.002	<0.008	0.0460	0.0014	0.0053
	Temperature (°C)			*Biochemical oxygen demand*			*Chemical oxygen demand*			*pH (units)*		
January	14.3	6.7	11.40	<5.0	<5	<5.0	23	6.6	14.5	6.8	8.4	NA[b]
February	15.7	12.3	13.70	<5.0	<5	<5.0	42	<5.0	<17.0	6.8	7.7	NA
March	15.8	12.8	14.10	8.0	<5	<5.8	45	10.0	231	7.3	7.8	NA
April	19.7	17.2	18.40	<5.0	<5	<5.0	11	5.0	8.0	7.0	9.5	NA
May	21.3	17.7	20.5	<5.0	<5.0	<5.0	13	8.0	10.2	7.0	8.4	NA
June	24.0	21.6	23.00	<5.0	<5	<5.0	13	8.8	10.7	7.2	8.4	NA
July	25.7	23.5	24.40	<5.0	<5	<5.0	29	7.0	13.0	6.9	8.8	NA
August	24.7	22.0	23.40	<5.0	<5	<5.0	10	<5.0	<6.9	6.9	8.5	NA
September	23.1	20.0	22.20	<5.0	<5	<5.0	10	4.9	7.3	7.0	8.4	NA
October	23.9	18.5	20.00	<5.0	<5	<5.0	12	6.4	9.3	6.6	8.1	NA
November	21.5	14.2	18.00	9.4	<5	<5.0	200	5.3	36.5	6.5	8.8	NA
December	15.9	11.6	13.60	6.0	<5	<5.0	61	<5.0	<13.6	6.7	8.3	NA

[a]Y-12 Plant, New Hope Pond; sample ID W45.
[b]NA = not applicable.

Table 5.3.15. 1986 NPDES Permit Number TN 0002968
Discharge Point 304 (Part 1)[a]

	Concentration (mg/L)											
Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Oil and grease			*Biochemical oxygen demand*			*Chemical oxygen demand*			*Dissolved solids*		
January	<2	<2	<2	<5	<5	<5	<10	<5.0	<7.00	280	150	198
February	10	<2	<4	<5	<5	<5	26	<5.0	<11.30	240	130	190
March	3	<2	<2	<5	<5	<5	18	<5	<9	230	160	188
April	<2	<2	<2	<5	<5	<5	19	<5	<10.25	280	210	250
May	3	<2	<2	<5	<5	<5	11	<5.0	<7.70	290	180	220
June	3	<2	<2	<5	<5	<5	21	5.9	10.20	240	200	212
July	<2	<2	<2	<5	<5	<5	12	8.0	9.80	370	170	234
August	<2	<2	<2	7.7	<5	<6.1	17	7.5	11.90	400	180	250
September	<2	<2	<2	<5	<5	<5	31	<5.0	<13.80	610	140	335
October	4	<2	<2	<5	<5	<5	93	8.5	28.50	460	250	366
November	<2	<2	<2	<5	<5	<5	26	5.0	17.00	380	290	333
December	3	<2	<2	<5	<5	<5	14	5.1	9.20	260	150	218
	Total suspended solids			*Nitrates (as N)*			*Conductivity (μmhos/cm)*			*Dissolved oxygen*		
January	<5	<5.0	<5.0	16.0	5.20	10.1	430	400	410	12.5	11.1	11.9
February	52	<5.0	19.0	18.0	4.00	10.1	390	290	330	11.2	10.2	11.0
March	52	<5.0	<17.0	14.0	4.20	8.6	370	280	326	12.2	9.8	11.0
April	<5	<5.0	<5.0	18.0	8.10	13.8	390	360	378	9.9	8.5	9.5
May	20	<5.0	<8.0	11.0	2.00	4.5	660	380	452	8.5	7.4	8.0
June	13	8.5	10.9	5.2	0.60	2.7	460	380	418	7.5	5.7	6.8
July	25	<5.0	12.4	23.0	0.60	7.8	480	370	422	9.1	6.0	7.7
August	78	<5.0	<33.8	36.0	0.27	11.3	370	340	357	9.1	7.4	8.2
September	43	15.0	29.0	14.0	4.00	9.2	590	410	488	9.0	6.1	7.4
October	34	<5.0	<20.6	30.0	4.00	18.8	580	430	513	8.9	7.4	8.2
November	45	<5.0	<17.0	22.0	8.90	13.7	560	530	545	8.8	7.3	8.2
December	26	<5.0	9.6	14.0	3.10	7.4	460	340	408	10.5	8.9	9.9

[a]Y-12 Plant; sample ID W46.

Table 5.3.16. 1986 NPDES Permit Number TN 0002968 Discharge Point 304[a] (Part 2)

Month	Max	Min	Av	Max	Min	Av[b]
	Turbidity (NTU)			*pH (units)*		
January	6.0	<0.05	<3.06	8.4	8.1	NA
February	35.0	4.00	12.80	7.8	6.9	NA
March	7.0	0.37	2.90	8.2	7.6	NA
April	5.0	0.30	3.10	8.0	7.8	NA
May	9.3	2.30	5.40	8.2	6.9	NA
June	10.0	4.00	6.40	8.5	6.8	NA
July	100.0	4.90	33.20	7.8	6.8	NA
August	15.0	6.70	10.30	7.7	7.1	NA
September	18.0	1.00	8.80	7.4	6.7	NA
October	93.0	5.50	29.30	7.5	6.6	NA
November	51.0	4.00	20.00	6.9	6.8	NA
December	5.7	2.10	4.40	8.3	6.6	NA

[a]Y-12 Plant, Bear Creek; sample ID W46.
[b]NA = not applicable.

Table 5.3.17. 1986 NPDES Permit Number TN 0002968 Discharge Point 305[a] (Part 1)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Oil and grease			*Total suspended solids*			*Mercury*			*pH (units)*		
January	3	3	3	6	6	6	0.0040	0.0040	0.0040	7.8	7.8	NA[b]
February	3	3	3	12	12	12	<0.0005	<0.0005	<0.0005	7.5	7.5	NA
March	<2	<2	<2	6	6	6	<0.0005	<0.0005	<0.0005	8.2	8.2	NA
April	<2	<2	<2	18	18	18	0.0007	0.0007	0.0007	7.3	7.3	NA
May	4	4	4	28	28	28	<0.0005	<0.0005	<0.0005	7.7	7.7	NA
June	2	2	2	22	22	22	<0.0005	<0.0005	<0.0005	7.1	7.1	NA
July	<2	<2	<2	70	21	41	<0.0005	<0.0005	<0.0005	7.2	7.2	NA
August	5	5	5	42	9	29	<0.0005	<0.0005	<0.0005	7.0	7.0	NA
September	<2	<2	<2	<5	<5	<5	0.0002	0.0002	0.0002	6.8	6.8	NA
October	<2	<2	<2	32	32	32	0.0002	0.0002	0.0002	7.2	7.2	NA
November	3	3	3	<5	<5	<5	<0.0002	<0.0002	<0.0002	6.5	6.5	NA
December	<2	<2	<2	<5	<5	<5	<0.0002	<0.0002	<0.0002	7.8	7.8	NA
	Beryllium			*Cadmium*			*Lead*			*Silver*		
January	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
February	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
March	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
April	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
May	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
June	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
July	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
August	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010
September	<0.0001	<0.0001	<0.0001	<0.003	<0.003	<0.003	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
October	<0.0001	<0.0001	<0.0001	<0.003	<0.003	<0.003	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
November	<0.0001	<0.0001	<0.0001	<0.003	<0.003	<0.003	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
December	<0.0001	<0.0001	<0.0001	<0.003	<0.003	<0.003	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004

[a]Y-12 Plant, leaking burial grounds and wet weather springs (Bear Creek Valley Oil Pond No. 1).
[b]NA—not applicable.

Table 5.3.18. 1986 NPDES Permit Number TN 0002968 Discharge Point 306[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Oil and grease			*Total suspended solids*			*Mercury*			*pH (units)*		
January	<2	<2	<2	8.0	8.0	8.0	0.0035	0.0035	0.0035	8.2	8.2	NA[b]
February	<2	<2	<2	<5	<5	<5	<0.0005	<0.0005	<0.0005	7.8	7.8	NA
March	<2	<2	<2	16	16	16	<0.0005	<0.0005	<0.0005	7.5	7.5	NA
April	<2	<2	<2	18	18	18	0.0005	0.0005	0.0005	7.2	7.2	NA
May[c]	3	3	3	76	76	76	<0.0005	<0.0005	<0.0005	8.0	8.0	NA
August	3	3	3	8	8	8	0.0002	0.0002	0.0002	7.2	7.2	NA
September	4	4	4	5.5	5.5	5.5	0.0002	0.0002	0.0002	7.6	7.6	NA
October	4	4	4	18	18	18	<0.0002	<0.0002	<0.0002	7.1	7.1	NA
November	4	4	4	20	20	20	<0.0002	<0.0002	<0.0002	7.5	7.5	NA
December	<2	<2	<2	<5	<5	<5	<0.0002	<0.0002	<0.0002	8.3	8.3	NA
	Cadmium			*Nickel*			*Lead*			*Silver*		
January	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
February	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
March	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
April	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
May	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
August	<0.003	<0.003	<0.003	<0.007	<0.007	<0.007	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
September	<0.003	<0.003	<0.003	<0.007	<0.007	<0.007	<0.02	<0.02	<0.02	0.116	0.116	0.116
October	<0.003	<0.003	<0.003	<0.007	<0.007	<0.007	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
November	<0.003	<0.003	<0.003	<0.007	<0.007	<0.007	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004
December	<0.003	<0.003	<0.003	<0.007	<0.007	<0.007	<0.02	<0.02	<0.02	<0.004	<0.004	<0.004

[a]Y-12 Plant, seepage from burial pit and surface water runoff (Bear Creek Valley Oil Pond No. 2); sample ID W48.
[b]NA = not applicable.
[c]There was no discharge during June and July from this outfall.

Table 5.3.19. 1986 NPDES Permit Number TN 0002968
Discharge Point 501[a] (Part 1)

Concentration (mg/L)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Oil and grease			*Cyanide*			*Chromium*			*Copper*		
January	<2	<2	<2	0.062	0.062	0.062	<0.01	<0.01	<0.01	0.10	0.10	0.10
February	<2	<2	<2	0.006	<0.002	<0.003	<0.01	<0.01	<0.01	0.017	0.006	0.011
March	6	<2	<3	0.047	0.002	0.020	0.01	<0.01	<0.01	0.015	0.006	0.010
April	14.0	<2	<5.4	0.018	<0.002	<0.006	<0.01	<0.01	<0.01	0.091	0.01	0.028
May	8.0	<2	<3	0.005	<0.002	<0.0026	<0.01	<0.01	<0.01	0.022	0.008	0.0134
June	4.0	<2	<2.6	0.003	<0.002	<0.002	<0.01	<0.01	<0.01	0.024	<0.004	<0.010
July	2.9	<2	<2.18	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	0.005	<0.004	<0.0042
August	3	<2	<2	0.003	0.002	0.0026	<0.06	<0.01	<0.01	<0.02	<0.004	<0.004
September	9	<2	<0.36	0.01	<0.002	<0.004	<0.03	<0.006	<0.011	0.04	<0.01	<0.02
October	10	<2	<4.17	0.015	<0.002	<0.006	<0.06	<0.006	<0.006	0.009	<0.002	<0.0045
November	4	<2	<2	<0.002	<0.002	<0.002	<0.006	<0.006	<0.006	0.004	<0.002	0.003
December	4	<2	<2	<0.002	<0.002	<0.002	<0.006	<0.006	<0.0006	0.014	<0.002	<0.008
	Lead			*Nickel*			*Temperature (°C)*			*Cadmium*		
January	<0.01	<0.01	<0.01	0.6	0.6	0.6	9.8	9.8	9.8	0.14	0.14	0.14
February	<0.01	<0.01	<0.01	0.31	0.14	0.27	14.6	9.9	12.05	0.003	<0.002	<0.002
March	0.04	<0.01	<0.02	0.52	0.19	0.32	17.7	11.3	14.8	<0.002	<0.002	<0.002
April	0.02	<0.01	<0.012	2.90	0.13	1.06	19.5	14.8	16.7	0.006	<0.002	<0.003
May	0.09	<0.01	<0.03	0.93	0.14	0.51	23.5	19.6	21.6	0.003	<0.002	<0.002
June	<0.01	<0.01	<0.01	0.56	0.34	0.43	27.5	24.6	25.8	0.002	<0.002	<0.002
July	<0.01	<0.01	<0.01	0.79	0.18	0.44	30.4	27.0	28.4	<0.002	<0.002	<0.002
August	<0.20	<0.01	<0.048	3.62	0.16	1.02	28.5	25.5	26.5	<0.03	<0.002	<0.008
September	<0.10	<0.02	<0.04	1.25	0.19	0.44	26.1	23.5	24.8	<0.02	<0.003	<0.006
October	<0.02	<0.02	<0.02	0.39	0.02	0.20	25.3	17.6	20.0	<0.003	<0.003	<0.003
November	<0.02	<0.02	<0.02	0.11	0.06	0.09	20	10.5	16.7	<0.003	<0.003	<0.003
December	<0.02	<0.02	<0.02	0.42	<0.007	<0.142	14.4	10.6	12.6	<0.003	<0.003	<0.003

[a]Y-12 Plant, Central Pollution Control Facility; sample ID W53.

Table 5.3.20. 1986 NPDES Permit Number TN 0002968 Discharge Point 501[a] (Part 2)

Month	Concentration (mg/L)											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Zinc			*Total toxic organics*			*Total suspended solids*			*Silver*		
January	0.60	0.60	0.60	<0.153	<0.153	<0.153	12.0	12.0	12.0	<0.01	<0.01	<0.01
February	1.3	0.32	0.73	0.083	<0.014	<0.035	18	11	15	<0.01	<0.01	<0.01
March	0.62	0.24	0.36	<0.145	<0.01	<0.09	25	6	14.5	<0.01	<0.01	<0.01
April	0.38	0.11	0.22	1.586	0.017	0.434	14	<5	<7.4	<0.01	<0.01	<0.01
May	1.0	0.06	0.26	1.224	<0.01	<0.223	35	<5	<12.6	<0.01	<0.01	<0.01
June	0.21	0.07	0.14	3.01	<0.010	<0.649	27	13	20.0	<0.01	<0.01	<0.01
July	0.20	0.07	0.13	0.227	0.054	0.171	30	9	14.6	<0.01	<0.01	<0.01
August	0.16	0.11	0.14	2.59	0.26	1.05	46	10	25	<0.04	<0.01	<0.02
September	0.22	0.12	0.16	4.75	<0.01	<0.96	34	22	28	<0.02	<0.004	<0.007
October	0.22	0.07	0.14	0.39	<0.01	<0.07	28	15	20.8	<0.004	<0.004	<0.004
November	0.06	0.03	0.05	0.55	<0.01	<0.34	30	<5	<13.5	<0.004	<0.004	<0.004
December	0.134	0.026	0.070	0.311	<0.01	<0.0596	18	<5	<10	<0.004	<0.004	<0.004
	pH (units)			*Color (units)*			*Sodium*			*Nitrates (N)*		
January	7.2	7.2		15	15	15	250	250	250	3.8	3.8	3.8
February	8.0	6.9		35	20	30	330	250	303	0.8	0.2	0.4
March	7.3	6.8		85	10	27	450	270	384	6.3	0.2	1.8
April	7.9	6.9		30	10	18	1300	370	825	0.3	0.1	0.18
May	7.6	7.0		25	1.5	13.1	1200	480	754	0.3	0.14	0.21
June	6.9	6.5		40	15	22	1800	550	872	0.3	0.20	0.26
July	7.9	6.7		25	1.5	15.3	1000	380	636	0.2	0.1	0.12
August	6.8	6.3		2	<1.0	<1.5	289	220	262	100.0	0.06	33.49
September	6.9	6.4		5	1.0	2.2	487	140	314	0.4	<0.1	<0.16
October	8.3	6.1		20	<1.0	<4.3	474	277	340	8.5	0.1	2.22
November	8.1	6.0		5	<1.0	<2	305	133	200	0.8	0.2	0.4
December	8.7	6.7		1.5	<1.0	<1.0	315	149	199	0.3	<0.1	<0.17

[a]Y-12 Plant, Central Pollution Control Facility I; sample ID W53.

Table 5.3.21. 1986 NPDES Permit Number TN 0002968
Discharge Point 501[a] (Part 3)

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Surfactants (as MBAS)			*Beryllium*			*Phosphorus*			*Chlorides*		
January	0.10	0.10	0.10	<0.0005	<0.0005	<0.0005	0.18	0.18	0.18	150	150	150
February	<0.05	<0.05	<0.05	<0.0005	<0.0005	<0.0005	0.40	0.16	0.31	180	130	152
March	0.06	<0.05	<0.05	<0.0005	<0.0005	<0.0005	1.10	0.40	0.70	330	190	320
April	0.44	<0.05	<0.19	<0.0005	<0.0005	<0.0005	1.10	0.50	0.84	620	220	444
May	0.36	<0.05	<0.10	0.0047	<0.0005	<0.0011	1.20	0.17	0.69	1200	490	774
June	0.50	<0.05	<0.15	<0.0005	<0.0005	<0.0005	1.90	0.24	0.77	7400	970	2670
July	<0.05	<0.05	<0.05	<0.0005	<0.0005	<0.0005	1.20	0.35	0.68	1600	650	1110
August	0.21	<0.05	<0.10	<0.0010	<0.0005	<0.0006	6.6	0.17	1.77	6600	850	3450
September	0.38	<0.05	<0.12	0.0007	<0.0005	<0.0005	6.8	2.3	3.7	9300	3000	6960
October	0.15	<0.05	<0.07	0.0004	<0.0001	<0.0002	1.5	0.49	0.87	19000	1500	6520
November	<5.0	0.05	<1.3	<0.0004	<0.0001	<0.0002	0.56	0.15	0.35	6200	3300	4550
December	<0.05	<0.05	<0.05	0.0005	<0.0001	<0.0001	0.71	0.13	0.39	4000	320	1380
	Phenols			*Sulfates*			*Fluorides*			*Aluminum*		
January	0.013	0.013	0.013	1600	1600	1600	1.10	1.10	1.10	0.05	0.05	0.05
February	0.003	<0.001	<0.002	1900	1300	1600	2.10	0.60	1.40	0.17	0.08	0.13
March	0.800	0.001	0.18	2000	1500	1660	0.95	0.38	0.56	0.30	0.11	0.20
April	9.70	0.012	2.152	3400	1300	2500	2.60	0.53	1.75	0.61	0.37	0.44
May	0.170	<0.001	<0.027	2800	420	1550	6.20	0.65	2.9	1.00	0.40	0.60
June	4.50	0.004	0.98	1600	160	530	2.90	0.40	1.60	0.25	0.06	0.13
July	0.81	0.027	0.395	1700	77	557	1.10	0.40	0.72	0.87	0.17	0.45
August	5.40	0.222	1.628	2100	1600	1920	0.74	0.33	0.47	0.19	0.06	0.11
September	7.0	0.014	1.44	2000	750	1340	2.6	0.6	1.4	0.03	<0.01	<0.03
October	2.4	0.01	0.56	2800	2000	2330	2.5	0.6	1.4	0.14	<0.01	<0.035
November	3.5	0.016	2.2	1800	1800	1800	0.9	0.4	0.6	<0.01	<0.01	<0.01
December	0.38	0.002	0.08	1900	1200	1600	6.0	0.6	2.4	0.33	<0.01	<0.11

[a]Y-12 Plant, Central Pollution Control Facility I; sample ID W53.

Table 5.3.22. 1986 NPDES Permit Number TN 0002968 Discharge Point 501[a] (Part 4)

Month	Concentration (mg/L)					
	Max	Min	Av	Max	Min	Av
		Iron			*Mercury*	
January	0.35	0.35	0.35	<0.0005	<0.0005	<0.0005
February	2.0	0.34	1.2	<0.0005	<0.0005	<0.0005
March	2.6	0.87	1.5	0.0013	<0.0005	<0.0007
April	3.7	0.29	1.81	0.0006	<0.0005	<0.0005
May	1.1	0.15	0.41	<0.0005	<0.0005	<0.0005
June	6.7	0.87	2.89	<0.0005	<0.0005	<0.0005
July	5.80	1.50	3.42	<0.0005	<0.0005	<0.0005
August	1.1	0.65	0.86	<0.0005	0.0002	<0.0004
September	0.6	0.27	0.37	0.0002	<0.0002	<0.0002
October	5.25	0.14	2.37	0.0004	<0.0002	<0.0002
November	1.53	0.57	1.01	0.0002	<0.0002	<0.0002
December	5.12	0.12	1.56	0.0006	<0.0002	<0.0003

[a]Y-12 Plant, Central Pollution Control Facility I; sample ID W53.

Table 5.3.23. 1986 NPDES Permit Number TN 0002968
Discharge Point 507[a]

	Concentration (mg/L)											
Month[b]	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
		Silver			*Cadmium*			*Cyanide*			*Chromium*	
April	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.010	<0.010	<0.010
May	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01
June	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01
September	<0.004	<0.004	<0.004	<0.003	<0.003	<0.003	0.011	0.003	0.005	<0.006	<0.006	<0.006
October	<0.004	<0.004	<0.004	<0.003	<0.003	<0.003	0.01	<0.002	<0.006	<0.006	<0.006	<0.006
		Copper			*Nickel*			*Lead*			*Zinc*	
April	0.011	<0.004	<0.005	0.07	0.03	0.05	<0.010	<0.010	<0.010	0.130	0.040	0.091
May	0.010	<0.004	<0.005	0.120	0.030	0.049	<0.01	<0.01	<0.01	0.05	<0.02	<0.03
June	0.013	0.007	0.010	0.30	0.08	0.14	<0.01	<0.01	<0.01	0.08	0.040	0.06
September	0.118	0.041	0.077	0.42	0.28	0.36	<0.02	<0.02	<0.02	0.46	0.09	0.18
October	0.076	0.016	0.042	0.444	0.342	0.383	<0.02	<0.02	<0.02	0.19	0.09	0.12
		Total toxic organics			*Total suspended solids*			*Oil and grease*			*Temperature (°C)*	
April	0.063	0.022	0.045	6.0	<5	<5.1	5.0	<2.0	<2.5	21.3	12.3	16.7
May	0.272	0.146	0.196	6.2	<5	<5.1	5.0	<2	<2.7	24.3	16.4	21.61
June	0.013	0.013	0.013	21	<5	<11	<2	<2	<2	29.3	26.0	27.6
September	<0.01	<0.01	<0.01	32	14.0	19.8	<2	<2	<2	25.9	24.3	25.0
October	0.73	0.47	0.60	52	15	26.31	4	<2	<2	26.1	20.4	23.3
		pH (units)			*Arsenic*			*Beryllium*			*Sulfates*	
April	8.1	6.9		<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005	4000	3000	3600
May	8.4	6.9		<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005	4000	3000	3600
June	7.6	6.9		<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005	3900	3400	3700
September	8.1	7.6		<0.04	<0.04	<0.04	<0.0001	<0.0001	<0.0001	12000	6500	9100
October	8.0	6.8		<0.04	<0.04	<0.04	<0.0001	<0.0001	<0.0001	12000	6100	8600
		Aluminum			*Mercury*			*Fluorides*			*Calcium*	
April	0.16	0.05	0.07	<0.0005	<0.0005	<0.0005	2.10	0.92	1.59	920	510	786
May	0.10	<0.05	<0.06	<0.0005	<0.0005	<0.0005	2.4	0.7	1.03	1100	770	882
June	0.07	<0.05	<0.06	<0.0005	<0.0005	<0.0005	2.2	<0.1	<0.5	710	580	660
September	0.46	<0.01	<0.11	0.0004	<0.0002	<0.0002	25.0	1.1	19.26	425	191	280
October	0.27	0.06	0.12	0.0004	<0.0002	<0.0003	26.0	15.0	21.23	309	198	229

Table 5.3.23 (continued)

Month[b]	Concentration (mg/L) Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Barium			*Nitrates (N)*			*Total residual chlorine*					
April	<0.2	<0.2	<0.2	5.0	0.2	1.2	2.0	0.1	0.6			
May	<0.2	<0.2	<0.2	28.0	0.3	7.2	3.0	0.2	0.7			
June	<0.2	<0.2	<0.2	0.5	0.2	0.3	3.2	0.9	2.4			
September	0.021	0.014	0.018	0.20	<0.1	<0.11	<0.1	<0.1	<0.1			
October	0.026	0.016	0.020	0.1	<0.1	<0.1	<0.1	<0.1	<0.1			

[a]Y-12 Plant, S-3 Ponds Liquid Treatment Facility; sample ID W50.

[b]No flow occurred in January, February, March, July, August, November, or December.

Table 5.3.24. 1986 NPDES Permit Number TN 0002968
Discharge Point 508[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration (mg/L)											
	Mercury			*Total suspended solids*			*Sulfates*			*Sulfides*		
January	0.0056	0.0006	0.0025	18.0	7.0	12.5	4000	4000	4000	0.01	<0.01	<0.01
June	0.0006	0.0006	0.0006	15.0	6.5	10.8	3800	3800	3800	0.6	<0.1	<0.4
July	<0.0005	<0.0005	<0.0005	7.0	7.0	7.0	3900	3900	3900	<0.1	<0.1	<0.1
	Fluorides			*Aluminum*			*Arsenic*			*Beryllium*		
January	1.0	1.0	1.0	<0.05	<0.05	<0.05	<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005
June	1.0	1.0	1.0	<0.05	<0.05	<0.05	<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005
July	1.0	1.0	1.0	<0.05	<0.05	<0.05	<0.06	<0.06	<0.06	<0.0005	<0.0005	<0.0005
	Cadmium			*Chromium*			*Copper*			*Iron*		
January	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	0.006	<0.004	<0.005	1.5	0.36	0.93
June	<0.002	<0.002	<0.002	0.02	<0.01	<0.015	<0.004	<0.004	<0.004	2.6	1.7	2.2
July	<0.002	<0.002	<0.002	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	0.1	0.1	0.1
	Lead			*Nickel*			*Silver*			*Sodium*		
January	<0.01	<0.01	<0.01	0.02	0.02	0.02	<0.01	<0.01	<0.01	1200	1200	1200
June	<0.01	<0.01	<0.01	0.02	<0.01	<0.015	<0.01	<0.01	<0.01	1300	1100	1200
July	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<40	<40	<40
	Zinc			*Color (units)*			*Oil and grease*			*Cyanide*		
January	1.8	0.54	1.2	10	10	10	<2	<2	<2	0.024	0.019	0.022
June	0.15	0.13	0.14	25	25	25	<2	<2	<2	<0.002	<0.002	<0.002
July	<0.02	<0.02	<0.02	<5	<5	<5	<2	<2	<2	0.002	0.002	0.002
	Chlorinated organic compounds			*pH (units)*								
January	<0.843	<0.478	<0.66	8.1	8.1	NA[b]						
June	0.013	<0.010	<0.011	8.1	7.1	NA						
July	<0.01	<0.01	<0.01	7.8	7.8	NA						

[a]Y-12 Plant, Experimental Mobile Wastewater Treatment Facility; sample ID W51.
[b]NA = not applicable.

Table 5.3.25. 1986 NPDES Permit Number TN 0002968 Discharge Point 502[a]

Month	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration											
	Cadmium (mg/L)			*Chromium (mg/L)*			*Copper (mg/L)*			*Lead (mg/L)*		
October	<0.003	<0.003	<0.003	<0.006	<0.006	<0.006	0.051	0.041	0.047	<0.02	<0.02	<0.02
November	<0.004	<0.003	<0.003	0.012	<0.006	<0.006	0.078	0.037	0.051	<0.02	<0.02	<0.02
	Nickel (mg/L)			*Silver (mg/L)*			*Zinc (mg/L)*			*Temperature (°C)*		
October	0.44	0.371	0.40	<0.004	<0.004	<0.004	0.14	0.098	0.11	19.6	17	18.3
November	0.67	0.42	0.55	<0.004	<0.004	<0.004	0.482	0.068	0.165	20.9	10.3	16.5
	Total toxic organics (mg/L)			*Total suspended solids (mg/L)*			*Cyanide (mg/L)*			*Oil and grease (mg/L)*		
October	0.47	0.47	0.47	26	20	23	0.016	0.006	0.010	7.0	<2.0	<3.4
November	0.31	0.06	0.15	39	<5	21	0.028	0.008	0.013	31.0	<2.0	<9.3
	pH (units)			*Barium (mg/L)*			*Nitrate (mg/L)*			*Phosphorous (mg/L)*		
October	7.9	7.0	NA[b]	0.011	0.006	0.008	<0.1	<0.1	<0.1	11.9	7.79	9.52
November	8.1	6.6	NA	0.016	0.003	0.009	51	<0.1	2.7	18.0	8.7	13.6
	Sulfate (mg/L)			*Fluoride (mg/L)*			*Cobalt (mg/L)*			*Magnesium (mg/L)*		
October	10,000	6500	8525	11.0	7.8	9.2	0.003	<0.002	<0.003	7.92	3.25	5.32
November	14,000	5100	10114	17.0	4.0	10.4	0.004	<0.002	<0.003	12.4	1.73	5.96
	Manganese (mg/L)			*Molybdenum (mg/L)*			*Aluminum (mg/L)*			*Arsenic (mg/L)*		
October	0.01	0.005	0.007[c]	1.34	1.02	1.15	0.51	0.29	0.41	<0.04	<0.04	<0.04
November	0.02	0.003	0.007	1.83	1.23	1.58	0.67	0.25	0.40	<0.04	<0.04	<0.04
	Be (mg/L)			*Fe (mg/L)*			*Hg (mg/L)*			*Calcium (mg/L)*		
October	<0.0001	<0.0001	<0.0001	0.46	0.18	0.37	<0.0002	<0.0002	<0.0002	408	208	326.8
November	0.0003	<0.0001	<0.0001	0.64	0.26	0.4	0.001	<0.0002	<0.0002	412	176	269
	Na (mg/L)			*Chloride (mg/L)*			*K (mg/L)*			*Total residual chlorine (mg/L)*		
October	4250	3920	4060	2800	1800	2275	264	200	234	<0.1	<0.1	<0.1
November	4970	3370	4176	2000	18	1475	218	164	190	19	<0.1	<1.1

[a]Y-12 Plant, Central Pollution Control Facility (CPCF-II) and West End Treatment Facility (WETF); sample ID W53a.
[b]NA = not applicable.

Table 5.3.26 1986 NPDES Permit Number TN 0002968
Discharge Points [a]
Category II[d]

	Concentration											
Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 016						**Discharge Point 020**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.8	7.8	NA	10.3	10.3	10.3	NF	NF	NA	NF	NF	NF
Second	7.4	7.4	NA	17.0	17.0	17.0	8.5	8.5	NA	14.7	14.7	14.7
Third	7.4	7.4	NA	24.0	24.0	24.0	8.2	8.2	NA	23.4	23.4	23.4
Fourth	6.5	6.5	NA	20.6	20.6	20.6	6.7	6.7	NA	20.4	20.4	20.4
	Discharge Point 023						**Discharge Point 025**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.8	7.8	NA	38.4	38.4	38.4	7.7	7.7	NA	69.7	69.7	69.7
Second	7.8	7.8	NA	53.8	53.8	53.8	7.1	7.1	NA	72.0	72.0	72.0
Third	7.0	7.0	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	NF	NF	NA	NF	NF	NF	7.0	7.0	NA	69.9	69.9	69.9
	Discharge Point 026						**Discharge Point 029**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.8	7.8	NA	61.8	61.8	61.8	8.1	8.1	NA	20.5	20.5	20.5
Second	7.6	7.6	NA	67.0	67.0	67.0	6.7	6.7	NA	31.8	31.8	31.8
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	7.4	7.4	NA	65.1	65.1	65.1	7.5	7.5	NA	60.0	60.0	60.0
	Discharge Point 030						**Discharge Point 035**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	7.3	7.3	NA	16.8	16.8	16.8
Second	8.4	8.4	NA	20.7	20.7	20.7	7.0	7.0	NA	17.1	17.1	17.1
Third	NF	NF	NF	NF	NF	NF	7.5	7.5	NA	26.8	26.8	26.8
Fourth	NF	NF	NA	NF	NF	NF	7.3	7.3	NA	20.5	20.5	20.5
	Discharge Point 043						**Discharge Point 046**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.1	7.1	NA	10.7	10.7	10.7	8.0	8.0	NA	38.2	38.2	38.2
Second	7.2	7.2	NA	17.1	17.1	17.1	7.7	7.7	NA	44.8	44.8	44.8
Third	7.1	7.1	NA	23.9	23.9	23.9	7.7	7.7	NA	28.3	28.3	28.3
Fourth	6.6	6.6	NA	21.7	21.7	21.7	6.9	6.9	NA	34.5	34.5	34.5
	Discharge Point 054						**Discharge Point 058**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	8.1	8.1	NA	15.8	15.8	15.8	7.3	7.3	NA	10.1	10.1	10.1
Second	7.3	7.3	NA	21.1	21.1	21.1	7.6	7.6	NA	11.4	11.4	11.4
Third	7.6	7.6	NA	26.2	26.2	26.2	7.8	7.8	NA	25.6	25.6	25.6
Fourth	7.1	7.1	NA	21.2	21.2	21.2	6.7	6.7	NA	21.8	21.8	21.8

Table 5.3.26 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration											
	Discharge Point 060						**Discharge Point 066**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.2	7.2	NA	9.8	9.8	9.8	7.4	7.4	NA	23.6	23.6	23.6
Second	6.9	6.9	NA	20.5	20.5	20.5	8.1	8.1	NA	33.0	33.0	33.0
Third	7.5	7.5	NA	27.9	27.9	27.9	7.7	7.7	NA	33.4	33.4	33.4
Fourth	6.9	6.9	NA	21.2	21.2	21.2	7.9	7.9	NA	36.5	36.5	36.5
	Discharge Point 068						**Discharge Point 073**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.8	7.8	NA	56.3	56.3	56.3	7.6	7.6	NA	27.6	27.6	27.6
Second	7.7	7.7	NA	58.4	58.4	58.4	7.8	7.8	NA	22.7	22.7	22.7
Third	7.3	7.3	NA	45.5	45.5	45.5	NF	NF	NA	NF	NF	NF
Fourth	7.7	7.7	NA	26.2	26.2	26.2	NF	NF	NA	NF	NF	NF
	Discharge Point 074						**Discharge Point 075**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.9	7.9	NA	11.0	11.0	11.0	7.5	7.5	NA	12.9	12.9	12.9
Second	NF[c]	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
	Discharge Point 077						**Discharge Point 081**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	6.8	6.8	NA	15.7	15.7	15.7	7.5	7.5	NA	15.0	15.0	15.0
Second	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	NF	NF	NA	NF	NF	NF	8.1	8.1	NA	13.3	13.3	13.3
	Discharge Point 087						**Discharge Point 092**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	6.9	6.9	NA	8.4	8.4	8.4	NF	NF	NA	NF	NF	NF
Second	8.1	8.1	NA	20.8	20.8	20.8	NF	NF	NA	NF	NF	NF
Third	7.8	7.8	NA	21.0	21.0	21.0	NF	NF	NA	NF	NF	NF
Fourth	7.1	7.1	NA	22.1	22.1	22.1	8.1	8.1	NA	12.8	12.8	12.8
	Discharge Point 093						**Discharge Point 094**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Second	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	7.6	7.6	NA	15.2	15.2	15.2	8.0	8.0	NA	13.1	13.1	13.1

Table 5.3.26 (continued)

Quarter	Concentration											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 095						**Discharge Point 096**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	7.9	7.9	NA	13.0	13.0	13.0
Second	NF	NF	NA	NF	NF	NF	7.6	7.6	NA	15.4	15.4	15.4
Third	NF	NF	NA	NF	NF	NF	6.8	6.8	NA	20.9	20.9	20.9
Fourth	7.8	7.8	NA	11.8	11.8	11.8	7.4	7.4	NA	20.5	20.5	20.5
	Discharge Point 098						**Discharge Point 111**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	8.0	8.0	NA	8.0	8.0	8.0	7.3	7.3	NA	15.6	15.6	15.6
Second	NF	NF	NA	NF	NF	NF	7.2	7.2	NA	23.0	23.0	23.0
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	8.0	8.0	NA	13.5	13.5	13.5	7.8	7.8	NA	13.7	13.7	13.7
	Discharge Point 112						**Discharge Point 117**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	8.0	8.0	NA	32.9	32.9	32.9
Second	NF	NF	NA	NF	NF	NF	7.9	7.9	NA	25.8	25.8	25.8
Third	NF	NF	NA	NF	NF	NF	6.9	6.9	NA	47.2	47.2	47.2
Fourth	8.2	8.2	NA	13.4	13.4	13.4	7.7	7.7	NA	40.4	40.4	40.4
	Discharge Point 123						**Discharge Point 131**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	7.6	7.6	NA	11.9	11.9	11.9
Second	7.3	7.3	NA	23.4	23.4	23.4	7.8	7.8	NA	25.5	25.5	25.5
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	7.8	7.8	NA	15.8	15.8	15.8	7.6	7.6	NA	14.8	14.8	14.8
	Discharge Point 133						**Discharge Point 144**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	7.6	7.6	NA	21.8	21.8	21.8	8.2	8.2	NA	20.3	20.3	20.3
Second	7.1	7.1	NA	25.3	25.3	25.3	NF	NF	NA	NF	NF	NF
Third	7.0	7.0	NA	22.7	22.7	22.7	NF	NF	NA	NF	NF	NF
Fourth	7.0	7.0	NA	20.0	20.0	20.0	7.8	7.8	NA	16.2	16.2	16.2
	Discharge Point 185						**Discharge Point 188**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	8.4	8.4	NA	11.2	11.2	11.2	7.7	7.7	NA	15.0	15.0	15.0
Second	7.5	7.5	NA	30.0	30.0	30.0	7.5	7.5	NA	21.0	21.0	21.0
Third	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Fourth	7.2	7.2	NA	48.0	48.0	48.0	NF	NF	NA	NF	NF	NF

Table 5.3.26 (continued)

Quarter	Concentration											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 203						**Discharge Point 213**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	8.2	8.2	NA[b]	14.2	14.2	14.2	7.2	7.2	NA	11.9	11.9	11.9
Second	NF[c]	NF	NA	NF	NF	NF	7.0	7.0	NA	21.5	21.5	21.5
Third	NF	NF	NA	NF	NF	NF	7.3	7.3	NA	28.4	28.4	28.4
Fourth	NF	NF	NA	NF	NF	NF	7.6	7.6	NA	15.1	15.1	15.1
	Discharge Point 219						**Discharge Point 238**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	NF	NF	NA	NF	NF	NF	8.3	8.3	NA	15.0	15.0	15.0
Second	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Third	NF	NF	NA	NF	NF	NF	7.4	7.4	NA	25.2	25.2	25.2
Fourth	7.9	7.9	NA	14.7	14.7	14.7	6.9	6.9	NA	19.9	19.9	19.9
	Discharge Point 239						**Discharge Point 240**					
	pH (units)			*Temperature (°C)*			*pH (units)*			*Temperature (°C)*		
First	8.5	8.5	NA	14.8	14.8	14.8	8.2	8.2	NA	15.3	15.3	15.3
Second	NF	NF	NA	NF	NF	NF	NF	NF	NA	NF	NF	NF
Third	7.6	7.6	NA	25.2	25.2	25.2	7.7	7.7	NA	25.2	25.2	25.2
Fourth	6.8	6.8	NA	19.8	19.8	19.8	6.9	6.9	NA	19.7	19.7	19.7
	Discharge Point 241											
	pH (units)			*Temperature (°C)*								
First	8.1	8.1	NA	15.1	15.1	15.1						
Second	NF	NF	NA	NF	NF	NF						
Third	7.8	7.8	NA	25.2	25.2	25.2						
Fourth	7.0	7.0	NA	20.1	20.1	20.1						

[a]Y-12 Plant; Category I and II. No discharge was noted from the following Category II outfalls in 1986: 013, 024, 027, 028, 040, 053, 059, 069, 076, 078, 079, 080, 084, 100, 115, 118, 119, 120, 124, 137, 171, 172, 173, 174, 175, 201, 204, 210, 212, 214, 216, 217, 218, 220, 226, 243, 245, and 246.

[b]NA = not applicable.

[c]NF = no flow.

[d]Cooling water, condensate, precipitation runoff, and building roof and foundation drains.

Table 5.3.27. 1986 NPDES Permit Number TN 0002968
Discharge Points [a]

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 602						**Discharge Point 602**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.06	0.06	0.06	0.033	0.033	0.033	21.6	21.6	21.6
Second	<0.01	<0.01	<0.01	0.09	0.09	0.09	0.015	0.015	0.015	19.9	19.9	19.9
Third	0.008	0.008	0.008	0.092	0.092	0.092	0.029	0.029	0.029	24.6	24.6	24.6
Fourth	0.012	0.012	0.012	0.105	0.105	0.105	0.035	0.035	0.035	22.7	22.7	22.7
	Discharge Point 602						**Discharge Point 604**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	<0.1	<0.1	<0.1	8.6	8.6	NA[b]	NF	NF	NF	NF	NF	
Second	0.7	0.3	0.5	8.2	8.2	NA	NF	NF	NF	NF	NF	
Third	<0.1	<0.1	<0.1	8.1	8.1	NA	0.023	0.023	0.023	0.34	0.34	0.34
Fourth	<0.1	<0.1	<0.1	8.8	8.8	NA	0.019	0.019	0.019	0.42	0.42	0.42
	Discharge Point 604						**Discharge Point 604**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NA
Second	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NA
Third	0.035	0.035	0.035	20.3	20.3	20.3	<0.1	<0.1	<0.1	8.7	8.7	NA
Fourth	0.025	0.025	0.025	23.8	23.8	23.8	<0.1	<0.1	<0.1	9.0	9.0	NA
	Discharge Point 606						**Discharge Point 606**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.11	0.11	0.11	0.058	0.058	0.058	21.4	21.4	21.4
Second	<0.01	<0.01	<0.01	0.16	0.16	0.16	<0.002	<0.002	<0.002	17.7	17.7	17.7
Third	0.020	0.020	0.020	0.149	0.149	0.149	0.073	0.073	0.073	25.1	25.1	25.1
Fourth	0.026	0.026	0.026	0.175	0.175	0.175	0.055	0.055	0.055	17.7	17.7	17.7

Table 5.3.27 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration											
	Discharge Point 606						**Discharge Point 610**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	<0.1	<0.1	<0.1	8.4	8.4	NA[b]	<0.01	<0.01	<0.01	0.12	0.12	0.12
Second	0.2	0.2	0.2	8.5	8.5	NA	<0.01	<0.01	<0.01	0.16	0.16	0.16
Third	0.2	0.2	0.2	8.5	8.5	NA	<0.006	<0.006	<0.006	0.100	0.100	0.100
Fourth	<0.1	<0.1	<0.1	8.5	8.5	NA	0.008	0.008	0.008	0.167	0.167	0.167
	Discharge Point 610						**Discharge Point 610**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	0.040	0.040	0.040	23.9	23.9	23.9	0.1	0.1	0.1	8.9	8.7	NA
Second	0.036	0.036	0.036	24.5	24.5	24.5	0.1	0.1	0.1	8.9	8.9	NA
Third	0.019	0.019	0.019	29.9	29.9	29.9	<0.1	<0.1	<0.1	8.9	8.9	NA
Fourth	0.033	0.033	0.033	22.4	22.4	22.4	<0.1	<0.1	<0.1	8.2	8.2	NA
	Discharge Point 612						**Discharge Point 612**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.10	0.10	0.10	0.027	0.027	0.027	22.9	22.9	22.9
Second	<0.01	<0.01	<0.01	0.11	0.11	0.11	0.030	0.030	0.030	24.5	24.5	24.5
Third	0.014	<0.006	0.01	2.5	0.12	1.31	0.216	0.013	0.114	27.4	27.4	27.4
Fourth	<0.006	<0.006	<0.006	0.32	0.32	0.32	0.012	0.012	0.012	22.6	22.6	22.6
	Discharge Point 612						**Discharge Point 613**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	<0.1	<0.1	<0.1	9.0	9.0	NA	ND[d]	ND	ND	ND	ND	ND
Second	<0.1	<0.1	<0.1	9.0	9.0	NA	<0.01	<0.01	<0.01	0.10	0.10	0.10
Third	<0.1	<0.1	<0.1	8.0	8.0	NA	<0.006	<0.006	<0.006	0.072	0.072	0.072
Fourth	<0.1	<0.1	<0.1	8.1	8.1	NA	0.009	0.009	0.009	0.119	0.119	0.119

Table 5.3.27 (continued)

Quarter	Concentration											
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 613						**Discharge Point 613**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
Second	0.047	0.047	0.047	26.3	26.3	26.3	<0.1	<0.1	<0.1	8.9	8.9	NA
Third	0.023	0.023	0.023	26.5	26.5	26.5	0.2	0.2	0.2	7.5	7.5	NA
Fourth	0.026	0.026	0.026	25.7	25.7	25.7	1.2	1.2	1.2	8.3	8.3	NA
	Discharge Point 616						**Discharge Point 616**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	0.010	0.010	0.010	15.6	15.6	15.6
Second	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	0.019	0.019	0.019	16.7	16.7	16.7
Third	3.5	3.5	3.5	5.7	5.7	5.7	4.9	4.9	4.9	24.7	24.7	24.7
Fourth	0.014	0.014	0.014	0.029	0.029	0.029	0.022	0.022	0.022	27.4	27.4	27.4
	Discharge Point 616						**Discharge Point 617**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	0.1	0.1	0.1	8.5	8.5	NA	0.01	0.01	0.01	0.09	0.09	0.09
Second	0.1	0.1	0.1	8.3	8.3	NA	<0.01	<0.01	<0.01	0.14	0.14	0.14
Third	<0.1	<0.1	<0.1	7.9	7.9	NA	<0.01	<0.01	<0.01	0.07	0.07	0.07
Fourth	0.1	0.1	0.1	8.5	8.5	NA	0.011	0.011	0.011	0.116	0.116	0.116
	Discharge Point 617						**Discharge Point 617**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	0.10	0.10	0.10	19.8	19.8	19.8	<0.1	<0.1	<0.1	9.0	8.6	NA
Second	0.094	0.094	0.094	21.4	21.4	21.4	0.1	0.1	0.1	8.9	8.9	NA
Third	0.045	0.045	0.045	29.7	29.7	29.7	<0.1	<0.1	<0.1	8.3	8.3	NA
Fourth	0.048	0.048	0.048	20.1	20.1	20.1	<0.1	<0.1	<0.1	8.6	8.6	NA

Table 5.3.27 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Concentration											
	Discharge Point 618						**Discharge Point 618**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.08	0.08	0.08	0.024	0.024	0.024	22.1	22.1	22.1
Second	<0.01	<0.01	<0.01	0.09	0.09	0.09	0.025	0.025	0.025	26.0	26.0	26.0
Third	0.008	0.008	0.008	0.111	0.111	0.111	0.017	0.017	0.017	27.2	27.2	27.2
Fourth	0.006	0.006	0.006	0.130	0.130	0.130	0.015	0.015	0.015	23.6	23.6	23.6
	Discharge Point 618						**Discharge Point 619**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	0.1	0.1	0.1	8.3	8.3	NA	NF	NF	NF	NF	NF	NF
Second	<0.1	<0.1	<0.1	8.1	8.1	NA	NF	NF	NF	NF	NF	NF
Third	<0.1	<0.1	<0.1	8.7	8.7	NA	0.031	0.031	0.031	0.063	0.063	0.063
Fourth	0.7	0.1	0.4	8.6	8.6	NA	0.033	0.033	0.033	0.079	0.079	0.079
	Discharge Point 619						**Discharge Point 619**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	NF	NF	NF	NF	NF	NF	ND	ND	ND	ND	ND	NA
Second	NF	NF	NF	NF	NF	NF	ND	ND	ND	ND	ND	NA
Third	0.020	0.020	0.020	28.9	28.9	28.9	0.2	0.2	0.2	8.1	8.1	NA
Fourth	0.019	0.019	0.019	25.2	25.2	25.2	<0.1	<0.1	<0.1	8.8	8.8	NA
	Discharge Point 622						**Discharge Point 622**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.21	0.21	0.21	0.040	0.040	0.040	23.0	23.0	23.0
Second	<0.01	<0.01	<0.01	0.09	0.09	0.09	0.032	0.032	0.032	27.1	27.1	27.1
Third	<0.01	<0.01	<0.01	0.11	0.11	0.11	0.017	0.017	0.017	25.7	25.7	25.7
Fourth	0.011	0.011	0.011	0.121	0.121	0.121	0.061	0.061	0.061	18.0	18.0	18.0

Table 5.3.27 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 622						**Discharge Point 624**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	0.1	0.1	0.1	8.8	8.8	NA	<0.01	<0.01	<0.01	0.15	0.15	0.15
Second	<0.1	<0.1	<0.1	8.9	8.9	NA	<0.01	<0.01	<0.01	0.11	0.11	0.11
Third	<0.1	<0.1	<0.1	8.4	8.4	NA	<0.01	<0.01	<0.01	0.13	0.13	0.13
Fourth	2.3	1.4	1.85	8.8	8.8	NA	<0.006	<0.006	<0.006	0.197	0.197	0.197
	Discharge Point 624						**Discharge Point 624**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	0.049	0.049	0.049	15.3	15.3	15.3	0.1	0.1	0.1	8.5	8.5	NA
Second	0.060	0.060	0.060	23.4	23.4	23.4	<0.1	<0.1	<0.1	8.4	8.4	NA
Third	0.048	0.048	0.048	25.6	25.6	25.6	<0.1	<0.1	<0.1	8.1	8.1	NA
Fourth	0.024	0.024	0.024	20.5	20.5	20.5	<0.1	<0.1	<0.1	8.6	8.6	NA
	Discharge Point 626						**Discharge Point 626**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	0.02	0.02	0.02	0.07	0.07	0.07	0.060	0.060	0.060	23.1	23.1	23.1
Second	0.02	0.02	0.02	0.10	0.10	0.10	0.075	0.075	0.075	19.6	19.6	19.6
Third	0.053	0.053	0.053	0.151	0.151	0.151	0.103	0.103	0.103	25.6	25.6	25.6
Fourth	0.037	0.037	0.037	0.068	0.068	0.068	0.061	0.061	0.061	19.4	19.4	19.4
	Discharge Point 626						**Discharge Point 628**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	<0.1	<0.1	<0.1	9.0	9.0	NA	0.03	0.03	0.03	0.08	0.08	0.08
Second	0.1	0.1	0.1	8.9	8.9	NA	<0.01	<0.01	<0.01	0.06	0.06	0.06
Third	<0.1	<0.1	<0.1	8.7	8.7	NA	NF	NF	NF	NF	NF	NF
Fourth	0.1	0.1	0.1	8.7	8.7	NA	NF	NF	NF	NF	NF	NF

Table 5.3.27 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 628						**Discharge Point 628**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	0.036	0.036	0.036	14.7	14.7	14.7	0.1	0.1	0.1	8.4	8.4	NA
Second	0.092	0.092	0.092	31.0	31.0	31.0	<0.1	<0.1	<0.1	9.0	9.0	NA
Third	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NA
Fourth	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NA
	Discharge Point 630						**Discharge Point 630**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	<0.01	<0.01	<0.01	0.09	0.09	0.09	0.009	0.009	0.009	22.5	22.5	22.5
Second	0.01	0.01	0.01	0.09	0.09	0.09	0.023	0.023	0.023	23.2	23.2	23.2
Third	0.019	0.019	0.019	0.098	0.098	0.098	0.023	0.023	0.023	30.1	30.1	30.1
Fourth	0.026	0.026	0.026	0.066	0.066	0.066	0.007	0.007	0.007	21.1	21.1	21.1
	Discharge Point 630						**Discharge Point 632**					
	Free available chlorine (mg/L)			*pH (units)*			*Chromium (mg/L)*			*Zinc (mg/L)*		
First	<0.1	<0.1	<0.1	8.3	8.3	NA	NF	NF	NF	NF	NF	NF
Second	0.3	0.3	0.3	8.8	8.8	NA	<0.01	<0.01	<0.01	0.14	0.14	0.14
Third	<0.1	<0.1	<0.1	8.9	8.9	NA	<0.01	<0.01	<0.01	0.13	0.13	0.13
Fourth	<0.1	<0.1	<0.1	8.6	8.6	NA	<0.006	<0.006	<0.006	0.043	0.043	0.043
	Discharge Point 632						**Discharge Point 632**					
	Copper (mg/L)			*Temperature (°C)*			*Free available chlorine (mg/L)*			*pH (units)*		
First	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NA
Second	0.086	0.086	0.086	19.7	19.7	19.7	0.4	0.4	0.4	8.0	8.0	NA
Third	0.063	0.063	0.063	30.3	30.3	30.3	<0.1	<0.1	<0.1	8.9	8.9	NA
Fourth	0.024	0.024	0.024	20.8	20.8	20.8	0.7	0.7	0.7	8.8	8.8	NA

Table 5.3.27 (continued)

Quarter	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Discharge Point 634						**Discharge Point 634**					
	Chromium (mg/L)			*Zinc (mg/L)*			*Copper (mg/L)*			*Temperature (°C)*		
First	0.01	0.01	0.01	0.03	0.03	0.03	0.093	0.093	0.093	26.9	26.9	26.9
Second	0.02	0.02	0.02	0.07	0.07	0.07	0.13	0.13	0.13	26.4	26.4	26.4
Third	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
Fourth	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
	Discharge Point 634											
	Free available chlorine (mg/L)			*pH (units)*								
First	0.1	0.1	0.1	8.9	8.9	NA						
Second	<0.1	<0.1	<0.1	8.8	8.8	NA						
Third	NF	NF	NF	NF	NF	NA						
Fourth	NF	NF	NF	NF	NF	NA						

[a] Y-12 Plant; cooling towers.
[b] NA = not applicable.
[c] NF = no flow.
[d] ND = no data.

Table 5.3.28. 1986 NPDES Permit Number TN 0002968
Category I outfalls[a]

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 001						**Discharge Point 001**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil grease (mg/L)*		
8.2	7.2	NA[c]	<2.0	2.0	<2.0	<5	<5	<5	<2	<2	<2
Discharge Point 001						**Discharge Point 001**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	<5	<5	<5	<0.0001	<0.001	<0.001	<2	<2	<2
Discharge Point 003						**Discharge Point 003**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.2	6.9	NA	2.4	2.4	2.4	<5	<5	<5	<2	<2	<2
Discharge Point 003						**Discharge Point 003**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	10	10	10	0.002	0.002	0.002	0.96	0.96	0.96
Discharge Point 006						**Discharge Point 007**					
			pH (units)			*pH (units)*			*Total organic carbon (mg/L)*		
			6.9	6.9	NA	7.9	7.3	NA	5.4	5.4	5.4
Discharge Point 007						**Discharge Point 007**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
30	30	30	3	3	3	0.0030	0.0030	0.0030	120	120	120
Discharge Point 007						**Discharge Point 015**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.021	0.021	0.021	0.68	0.68	0.68	8.0	6.9	NA	4.8	4.8	4.8
Discharge Point 015						**Discharge Point 015**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
18	18	18	2	2	2	<0.0005	<0.0005	<0.0005	<5	<5	<5

Table 5.3.28. (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 015						**Discharge Point 017**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.118	0.118	0.118	0.52	0.52	0.52	7.6	6.9	NA	2.4	2.4	2.4
Discharge Point 017						**Discharge Point 017**					
Chemical oxygen demand (mg/L)			*Oil grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
<5	<5	<5	<2	<2	<2	<0.0005	<0.0005	<0.0005	<5	<5	<5
Discharge Point 017						**Discharge Point 018**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
<0.0001	<0.001	<0.001	<2	<2	<2	8.1	7.8	NA[b]	6	6	6
Discharge Point 018						**Discharge Point 018**					
Chemical oxygen deman (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
28	28	28	<2	<2	<2	0.0029	0.0029	0.0029	12	12	12
Discharge Point 018						**Discharge Point 019**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.009	0.009	0.009	1.08	1.08	1.08	8.8	7.9	NA	8.7	8.7	8.7
Discharge Point 019						**Discharge Point 019**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
27	27	27	2	2	2	<0.0005	<0.0005	<0.0005	22	22	22
Discharge Point 019						**Discharge Point 032**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.139	0.139	0.139	0.26	0.26	0.2	8.5	8.3	NA	12	12	12
Discharge Point 032						**Discharge Point 032**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
150	150	150	<2	<2	<2	0.0094	0.0094	0.0094	560	560	560

Table 5.3.28. (continued)

Concentration (annual)[b]											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 032						**Discharge Point 041**					
Uranium (mg/L)			*^{235}U (%)*						*pH (units)*		
0.251	0.251	0.251	0.38	0.38	0.38				8.2	8.2	NA
Discharge Point 044						**Discharge Point 044**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
8.1	7.8	NA[b]	6.1	6.1	6.1	33	33	33	<2	<2	<2
Discharge Point 044						**Discharge Point 044**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	54	54	54	0.018	0.018	0.018	1.21	1.21	1.21
Discharge Point 045						**Discharge Point 045**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen deman (mg/L)*			*Oil and grease (mg/L)*		
8.1	7.0	NA	2.5	2.5	2.5	6	6	6	<2	<2	<2
Discharge Point 045						**Discharge Point 045**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	<5	<5	<5	0.008	0.008	0.008	1.26	1.26	1.26
Discharge Point 057						**Discharge Point 057**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	300	300	300	0.003	0.003	0.003	3.69	3.69	3.69
Discharge Point 057						**Discharge Point 057**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen deman (mg/L)*			*Oil and grease (mg/L)*		
8.1	7.7	NA	9.5	9.5	9.5	57	57	57	2	2	2
Discharge Point 086						**Discharge Point 086**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.3	7.3	NA	15	15	15	82	82	82	17	17	17
Discharge Point 086						**Discharge Point 086**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0024	0.0024	0.0024	22	22	22	0.005	0.005	0.005	3.34	3.34	3.34

Table 5.3.28 (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 108						**Discharge Point 127**					
pH (units)						*pH (units)*					
6.7	6.7	NA				7.4	7.4	NA			
Discharge Point 134						**Discharge Point 134**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.4	7.2	NA	2.8	2.8	2.8	<5	<5	<5	4	4	4
Discharge Point 134						**Discharge Point 134**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	<5	<5	<5	<0.001	<0.001	<0.001	<2	<2	<2
Discharge Point 149						**Discharge Point 149**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
8.5	8.5	NA	2.5	2.5	2.5	9.2	9.2	9.2	<2	<2	<2
Discharge Point 149						**Discharge Point 149**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0042	0.0042	0.0042	<5	<5	<5	0.002	0.002	0.002	1.13	1.13	1.13
Discharge Point 151						**Discharge Point 151**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
8.3	8	NA[b]	4.8	4.8	4.8	15	15	15	<2	<2	<2
Discharge Point 151						**Discharge Point 151**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	<5	<5	<5	0.030	0.030	0.030	0.91	0.91	0.91
Discharge Point 152						**Discharge Point 152**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.8	7.8	NA[c]	<2	<2	<2	14	14	14	<2	<2	<2
Discharge Point 152						**Discharge Point 152**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.038	0.038	0.038	<5	<5	<5	0.005	0.005	0.005	1.17	1.17	1.17

Table 5.3.28. (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 153						**Discharge Point 153**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
8.1	8.1	NA	2.1	2.1	2.1	8.4	8.4	8.4	<2	<2	<2
Discharge Point 153						**Discharge Point 153**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
<0.0005	<0.0005	<0.0005	<5	<5	<5	0.006	0.006	0.006	2.28	2.28	2.28
Discharge Point 155						**Discharge Point 156**					
pH (units)						*pH (units)*					
7.8	7.8	NA				7.1	7.1	NA			
Discharge Point 159						**Discharge Point 159**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.3	7.3	NA[b]	9.0	9.0	9.0	60	60	60	6	6	6
Discharge Point 159						**Discharge Point 159**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0014	0.0014	0.0014	45	45	45	0.004	0.004	0.004	2.28	2.28	2.28
Discharge Point 161						**Discharge Point 170**					
pH (units)						*pH (units)*					
6.9	6.9	NA				6.8	6.8	NA			
Discharge Point 177						**Discharge Point 177**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.0	7.0	NA	5.6	5.6	5.6	66	66	66	<2	<2	<2
Discharge Point 177						**Discharge Point 177**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0005	0.0005	0.0005	32	32	32	0.002	0.002	0.002	1.92	1.92	1.92
Discharge Point 178						**Discharge Point 178**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.2	7.2	NA[b]	6.7	6.7	6.7	47	47	47	<2	<2	<2

Table 5.3.28. (continued)

Concentration											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 178						**Discharge Point 178**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0023	0.0023	0.0023	82	82	82	0.019	0.019	0.019	0.63	0.63	0.63
Discharge Point 179						**Discharge Point 179**					
pH (units)			*Total organic carbon (mg/L)*			*Chemical oxygen demand (mg/L)*			*Oil and grease (mg/L)*		
7.0	7.0	NA	5.9	5.9	5.9	50	50	50	<2	<2	<2
Discharge Point 179						**Discharge Point 179**					
Mercury (mg/L)			*Suspended solids (mg/L)*			*Uranium (mg/L)*			*^{235}U (%)*		
0.0010	0.0010	0.0010	830	830	830	0.009	0.009	0.009	0.75	0.75	0.75
Discharge Point 180						**Discharge Point 182**					
pH (units)						*pH (units)*			*Total organic carbon (mg/L)*		
7.7	7.7	NA				7.8	7.8	NA	21	21	21
Discharge Point 182						**Discharge Point 182**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
55	55	55	<2	<2	<2	<0.0005	<0.0005	<0.0005	<5	<5	<5
Discharge Point 182						**Discharge Point 184**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.135	0.135	0.135	0.38	0.38	0.38	7.6	7.4	NA	95	95	95
Discharge Point 184						**Discharge Point 184**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
9	9	9	<2	<2	<2	<0.0005	<0.0005	<0.0005	<5	<5	<5
Discharge Point 184						**Discharge Point 193**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.001	0.001	0.001	0.89	0.89	0.89	8.0	8.0		12	12	12
Discharge Point 193						**Discharge Point 193**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
17	17	17	<2	<2	<2	0.0014	0.0014	0.0014	69	69	69

Table 5.3.28. (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 193						**Discharge Point 197**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.206	0.206	0.206	0.58	0.58	0.58	7.1	7.1	NA	20	20	20
Discharge Point 197						**Discharge Point 197**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
28	28	28	3	3	3	0.014	0.014	0.014	2500	2500	2500
Discharge Point 197						**Discharge Point 198**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.051	0.051	0.051	1.04	1.04	1.04	7.3	7.3	NA	3.6	3.6	3.6
Discharge Point 198						**Discharge Point 198**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
13	13	13	<2	<2	<2	0.0006	0.0006	0.0006	<5	<5	<5
Discharge Point 198						**Discharge Point 202**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.012	0.012	0.012	0.97	0.97	0.97	9.1	9.1	NA	100	100	100
Discharge Point 202						**Discharge Point 202**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
370	370	370	<2	<2	<2	0.0008	0.0008	0.0008	210	210	210
Discharge Point 202						**Discharge Point 207**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.014	0.014	0.014	1.16	1.16	1.16	8.1	6.9	NA[b]	20	20	20
Discharge Point 207						**Discharge Point 207**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
110	110	110	3	3	3	0.0023	0.0023	0.0023	280	280	280

Table 5.3.28. (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 207						**Discharge Point 221**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.124	0.124	0.124	0.87	0.87	0.87	7.8	7.2	NA	48	48	48
Discharge Point 221						**Discharge Point 221**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
180	180	180	<2	<2	<2	0.0049	0.0049	0.0049	260	260	260
Discharge Point 221						**Discharge Point 223**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.251	0.251	0.251	2.09	2.09	2.09	7.4	7.4	NA	10	10	10
Discharge Point 223						**Discharge Point 223**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
36	36	36	2	2	2	0.0056	0.0056	0.0056	390	390	390
Discharge Point 223						**Discharge Point 236**					
Uranium (mg/L)			*^{235}U (%)*			*(units)*	*pH (mg/L)*	*(mg/L)*	*Total organic carbon (mg/L)*		
0.034	0.034	0.034	0.76	0.76	0.76	7.2	7.2	NA	5.2	5.2	5.2
Discharge Point 236						**Discharge Point 236**					
Chemical oxygen demand			*Oil and grease*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
30	30	30	<2	<2	<2	0.0044	0.0044	0.0044	9.5	9.5	9.5
Discharge Point 236						**Discharge Point 247**					
Uranium (mg/L)			*^{235}U (%)*			*pH (units)*			*Total organic carbon (mg/L)*		
0.011	0.011	0.011	0.87	0.87	0.87	7.3	7.3	NA	6.5	6.5	6.5
Discharge Point 247						**Discharge Point 247**					
Chemical oxygen demand (mg/L)			*Oil and grease (mg/L)*			*Mercury (mg/L)*			*Suspended solids (mg/L)*		
44	44	44	3	3	3	0.015	0.015	0.015	300	300	300

Table 5.3.28 (continued)

Concentration (annual)											
Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
Discharge Point 247											
Uranium (mg/L)			^{235}U (%)								
0.012	0.012	0.012	1.12	1.12	1.12						

[a]Y-12 Plant.
[b]The following Category I outfalls had no flow noted during 1986: 009, 011, 012, 031, 062, 101, 102, 136, 138, 140, 145, 146, 164, 183, 186, 194, 195, 196, 199, 200, 205, 206, 208, 209, 215, 224, 228, 229, 230, 231, 232, 233, 235, 237, 248.
[c]NA = not applicable.

Table 5.3.29. 1986 NPDES Permit Number TN 0002968 Discharge Point 623[a]

Month	Concentration	
	Max	Min
	pH (units)	
January	7.8	7.3
February	8.0	4.3
March	8.1	7.7
April	7.8	7.5
May	8.1	7.6
June	8.3	7.3
July	8.2	7.5
August	7.6	7.4
September	7.8	6.9
October	7.6	6.9
November	7.8	7.2
December	7.9	7.5

[a]Y-12 steam plant fly ash sluice water; sample ID W49.

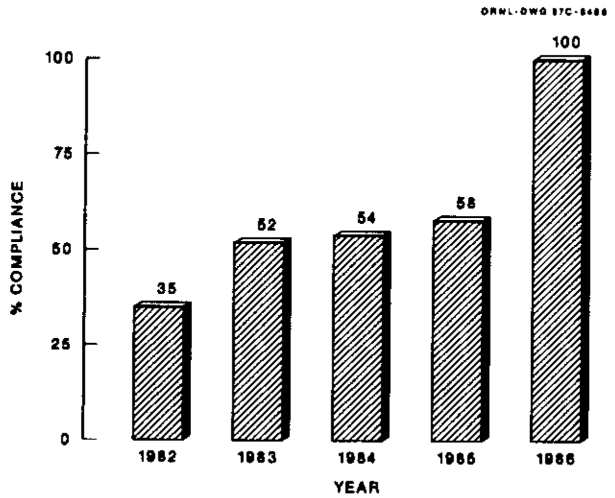

Fig. 5.3.69. NPDES compliance for ammonia (N) at Sewage Treatment Plant (X01).

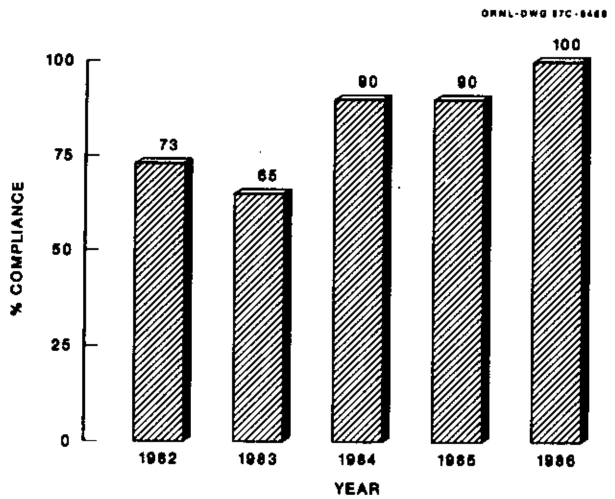

Fig. 5.3.70. NPDES compliance for biochemical oxygen demand at Sewage Treatment Plant (X01).

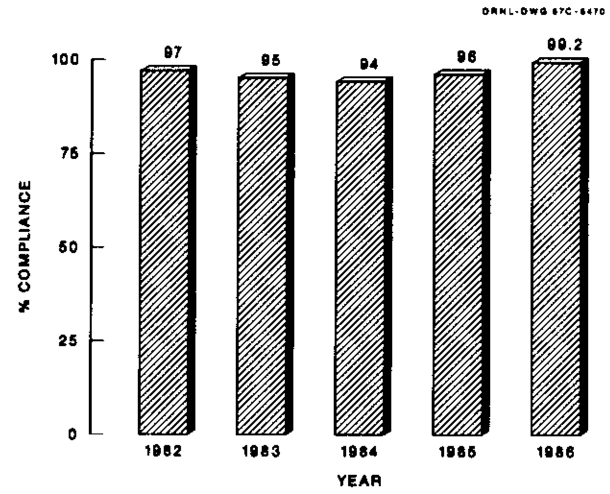

Fig. 5.3.71. NPDES compliance for residual chlorine at Sewage Treatment Plant (X01).

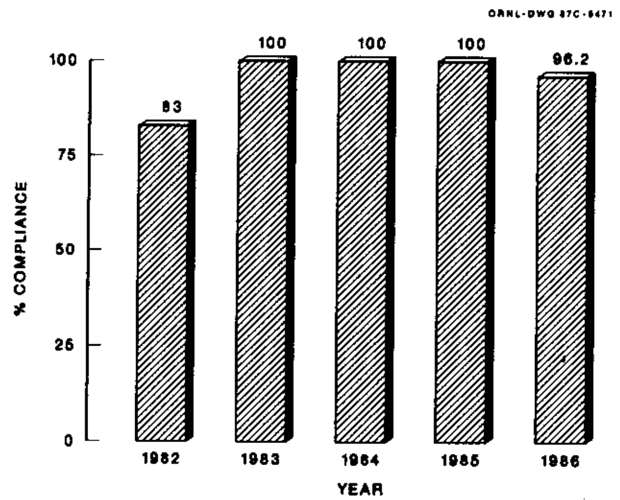

Fig. 5.3.72. NPDES compliance for fecal coliform at Sewage Treatment Plant (X01).

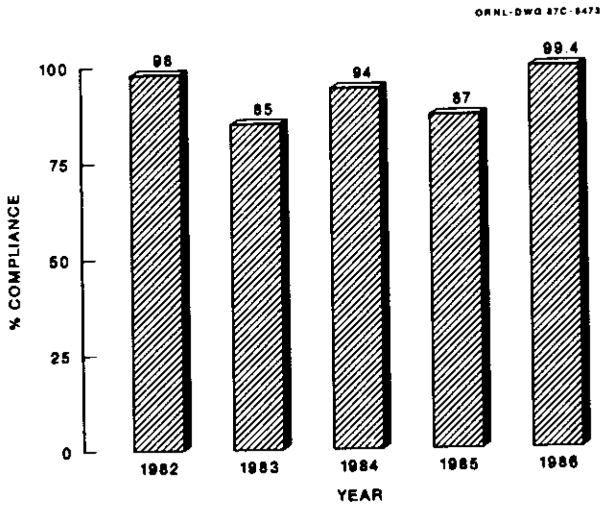

Fig. 5.3.73. NPDES compliance for suspended solids at Sewage Treatment Plant (X01).

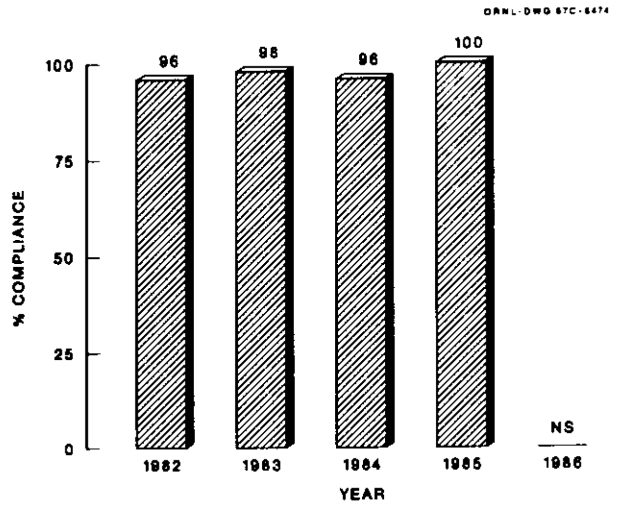

Fig. 5.3.75. NPDES compliance for settleable solids at Sewage Treatment Plant (X01).

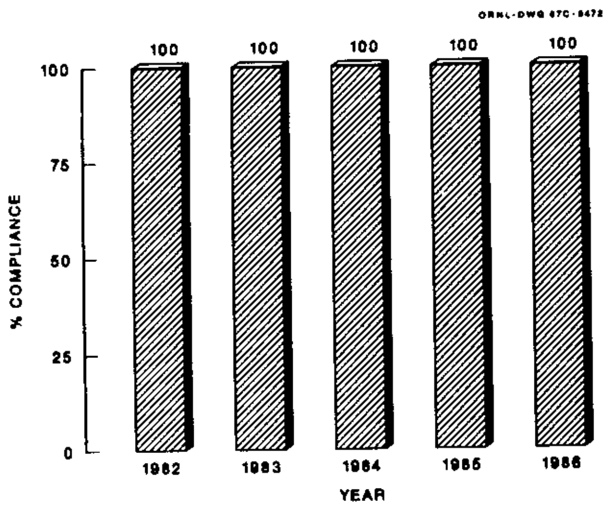

Fig. 5.3.74. NPDES compliance for pH at Sewage Treatment Plant (X01).

Table 5.3.30. 1986 NDPES Permit Number TN 0002941 Discharge Point X01[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	9	0.030	<0.0050	<0.023	0.0071
BOD	119	11	<5	<5	0.19
CN	9	0.0050	0.0020	0.0023	0.00067
Cu	9	0.025	0.0020	0.014	0.0049
DO	159	9.9	0.60	7.1	0.19
Downstream pH[c]	31	8.4	7.5	NA[d]	0
Fecal coliform[e]	121	2600	0.00	60	49
Flow[f]	191	2.6	0.057	0.79	0.011
Hg	9	0.00030	<0.0002	<0.0002	0.00005
NH_4-N	119	3.04	0.040	0.23	0.079
Oil and grease	119	72	2.0	3.6	1.6
pH[c]	39	8.2	6.9	NA[d]	0
Phenols	9	0.048	0.0010	0.0063	0.010
Residual Cl	118	0.72	<0.05	<0.23	0.023
TSS[g]	119	140	<2	<7.9	3.0
TTO[h]	3	15	0.00	4.8	9.7
Zn	9	0.088	0.042	0.064	0.0096

[a]ORNL Sewage Treatment Plant.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units.
[d]NA = not applicable.
[e]Expressed in colonies per 100 mL.
[f]Measured in millions of gallons per day.
[g]Total suspended solids.
[h]Total toxic organics.

Table 5.3.31. 1986 NDPES Permit Number TN 0002941 Discharge Point X02[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	26	0.042	<0.005	<0.03	0.0024
As	44	0.52	<0.001	<0.06	0.022
Cd	44	0.0086	<0.002	<0.003	0.00037
Cr	44	0.10	<0.002	<0.2	0.0046
Cu	44	0.30	<0.004	<0.02	0.013
Downstream pH[c]	160	8.7	6.8	NA[d]	
Fe	44	45	0.012	1.3	2.0
Flow[e]	181	0.016	0.00	0.033	0.0016
Mn	26	0.76	0.011	0.052	0.057
Ni	44	0.16	<0.006	<0.04	0.0065
Oil and grease	44	14	2.0	3.1	0.83
Pb	44	0.14	<0.01	<0.1	0.011
pH[c]	160	8.6	6.1	NA	
Se	26	0.14	<0.04	<0.1	0.0071
SO_4	6	2500	780	1400	520
Temperature[f]	40	29	7.9	21	1.7
TOC[g]	4	2.7	1.1	1.8	0.67
TSS[h]	44	54	<2	<9	3.1
Zn	28	0.68	<0.004	<0.06	0.048

[a]ORNL Coal Yard Runoff Facility.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in millions of liters per day.
[f]Measured in degrees centigrade.
[g]Total organic carbon.
[h]Total suspended solids.

Table 5.3.32. 1986 NDPES Permit Number TN 0002941 Discharge Point X03[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	1	0.03	<0.03	<0.030	0.000
As	19	0.06	<0.01	<0.05	0.0090
Cd	19	0.0044	<0.002	<0.003	0.00049
Cr	19	0.12	<0.004	<0.03	0.011
Cu	19	0.34	0.014	0.045	0.33
Downstream pH[c]	34	8.8	7.1	NA[d]	
Fe	19	0.77	0.018	0.23	0.097
Ni	19	0.10	<0.006	<0.03	0.0092
Oil and grease	19	22	<2	<4	2.2
Pb	19	0.12	<0.02	<0.1	0.018
pH[c]	34	8.4	7.0	NA	
Temperature[e]	18	24	16	20	1.1
TOC[f]	19	37	2.7	8.6	4.7
TP[g]	19	3.6	0.30	1.1	0.43
TSS[h]	19	43	<5	<8	4.0
Zn	19	0.37	0.062	0.14	0.034

[a]1500 area, ORNL.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total phosphorus.
[h]Total suspended solids.

Table 5.3.33. 1986 NDPES Permit Number TN 0002941 Discharge Point X04[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	19	0.03	<0.005	<0.03	0.0043
As	19	0.06	<0.01	<0.05	0.009
Cd	19	0.0042	<0.002	<0.003	0.0005
Cr	19	0.024	<0.004	<0.02	0.0036
Cu	19	0.089	0.012	0.028	0.0087
Downstream pH[c]	36	8.4	0.40	NA[d]	
Fe	3	0.028	<0.003	<0.011	0.017
Ni	19	0.036	<0.006	<0.03	0.0054
Oil and grease	19	32	2.0	3.8	3.1
Pb	19	0.12	<0.02	<0.02	0.018
pH[c]	40	8.6	6.9	NA	
Temperature[e]	18	23	7.4	17	2.4
TOC[f]	19	38	1.8	4.9	3.7
TP[g]	19	2.5	0.20	0.61	0.25
TSS[h]	19	5.0	<5	<5	0.00
Zn	19	0.26	0.061	0.10	0.018

[a]2000 area, ORNL.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total phosphorus.
[h]Total suspended solids.

Table 5.3.34. 1986 NDPES Permit Number TN 0002941 Discharge Point X06[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
As	19	0.060	<0.01	<0.05	0.0090
Cd	19	0.0030	<0.002	<0.002	0.00045
Cr	19	0.070	<0.004	<0.002	0.0063
Cu	19	0.36	0.025	0.086	0.036
Downstream pH[c]	36	8.6	7.4	NA[d]	0.095
Fe	1	0.0054	0.0054	0.0054	0.000
Flow[e]	9	0.98	0.42	0.68	0.037
Ni	19	0.036	<0.006	<0.02	0.0054
Oil and grease	19	29	<2	<4.1	2.9
Pb	19	0.12	<0.02	<0.01	0.016
pH[c]	40	8.9	7.0	NA	
Se	18	0.12	<0.02	<0.1	0.017
SO_4	18	32	22	27	1.4
Temperature[f]	18	24	10	18	2.2
TOC[g]	18	55	2.9	8.1	5.7
TSS[h]	19	19	<5	<6.6	1.7
Zn	19	0.11	0.053	0.081	0.0077

[a]3539/3540 ponds, ORNL.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in millions of liters per day.
[f]Measured in degrees centigrade.
[g]Total organic carbon.
[h]Total suspended solids.

Table 5.3.35. 1986 NPDES Permit Number 0002941 Discharge Point X07[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	17	0.030	<0.005	<0.03	0.0044
As	18	0.074	<0.01	<0.05	0.0098
Cd	18	0.0033	<0.002	<0.002	0.00047
Cr	18	0.14	<0.004	<0.03	0.014
Cu	18	0.065	<0.005	<0.02	0.0085
Downstream pH[c]	36	8.5	7.3	NA[d]	
Fe	1	0.23	0.23	0.23	0.000
Flow[e]	169	1.7	0.045	0.53	0.026
Ni	18	0.036	<0.006	<0.029	0.0057
NO_3-N	18	100	2.0	17	11
Oil and grease	18	16	<2	<3.9	1.9
Pb	18	0.12	<0.02	<0.097	0.019
pH[c]	40	8.7	1.2	NA	
SO_4	18	3600	46	460	370
Temperature[f]	18	26	10.7	20	2.4
TOC[g]	17	420	1.5	29	48
TSS[h]	18	190	<5.0	<20	21
TTO[i]	16	2000	0.00	150	250
Zn	18	0.077	<0.02	<0.017	0.0075

[a]Process Waste Treatment Plant (3544).
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in millions of liters per day.
[f]Measured in degrees centigrade.
[g]Total organic carbon.
[h]Total suspended solids.
[i]Total toxic organics.

Table 5.3.36. 1986 NPDES Permit Number 0002941 Discharge Point X08[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
As	23	0.10	<0.01	<0.04	0.011
Cd	23	0.0062	<0.002	<0.003	0.00064
Cr	23	0.16	<0.004	<0.02	0.013
Cu	23	0.056	<0.01	<0.02	0.0045
Downstream pH[c]	16	8.2	7.5	NA[d]	
Fe	2	5.9	0.94	3.4	5.0
Mg	1	9.0	9.0	9.0	0.0
Na	1	40	40	40	0.0
Ni	23	0.098	<0.001	<0.03	0.009
NO_3-N	23	1200	<2	<60	100
Oil and grease	23	180	<2	<20	16
Pb	23	0.20	<0.01	<0.09	0.022
pH[c]	20	9.4	6.6	NA	
SO_4	23	2800	23	450	260
Temperature[e]	20	27	4	15	3.1
TOC[f]	22	51	2.3	12	6.0
TSS[g]	23	210	<2	<30	18
Zn	23	1.0	0.059	0.26	0.11

[a]TRU waste basins.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total suspended solids.

Table 5.3.37. 1986 NPDES Permit Number 0002941 Discharge Point X09[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
As	20	0.061	<0.01	<0.05	0.0073
Cd	20	0.035	<0.002	<0.005	0.0033
Cr	20	0.084	<0.004	<0.023	0.0070
Cu	20	0.14	0.014	0.048	0.013
Downstream pH[c]	17	8.2	7.2	NA[d]	
Fe	1	0.066	0.066	0.066	0.00
Mg_2	1	15	15	15	0.00
Na	1	60	60	60	0.00
Ni	20	0.041	<0.006	<0.03	0.0051
NO_3-N	20	66	<5	<10	6.7
Oil and grease	20	18	2.0	4.8	1.9
pH[c]	20	9.6	6.8	NA	
Pb	20	0.12	<0.02	<0.09	0.016
SO_4	20	2100	60	250	200
Temperature[e]	20	26	5.6	13	2.5
TOC[f]	20	28	2.0	5.4	2.7
TSS[g]	20	12	5.0	<6	0.87
Zn	20	0.16	0.012	0.060	0.018

[a]HFIR basins.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total suspended solids.

Table 5.3.38. 1986 NPDES Permit Number 0002941 Discharge Point X10[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
As	19	0.10	<0.01	<0.06	0.0081
Ca	1	5.0	5.0	5.0	0.00
Cd	19	0.0052	0.0005	0.0029	0.0005
Cr	19	0.57	0.012	0.077	0.057
Cu	19	0.26	0.010	0.092	0.036
Downstream pH[c]	16	8.6	7.2	NA[d]	
Fe	16	6.8	0.018	1.1	0.80
Na	1	420	420	420	0.00
Ni	19	0.48	0.0094	0.066	0.047
NO_3-N	19	2700	24	1400	250
Oil and grease	19	110	2.0	12	13
Pb	19	0.46	0.020	0.13	0.041
pH[c]	20	8.8	7.2	NA	
SO_4	19	2000	71	270	220
Temperature[e]	20	220	6.7	13	2.2
TOC[f]	17	170	4.3	17	19
TSS[g]	19	290	5.0	97	43
Zn	19	1.6	0.035	0.51	0.24

[a]ORR Resin Regeneration Facility.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total suspended solids.

Table 5.3.39. 1986 NPDES Permit Number 0002941 Discharge Point X11[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
As	13	0.06	<0.02	<0.06	0.0062
Cd	13	0.0030	<0.002	<0.003	0.0003
Cr	13	0.086	0.015	0.034	0.010
Cu	13	0.089	0.0040	0.031	0.015
Downstream pH[c]	37	8.4	1.0	NA[d]	
Fe	1	0.63	0.63	0.63	0.00
NH_4-N	1	2.0	<2	<2	0.00
Ni	13	0.049	<0.012	<0.04	0.0044
NO_3-N	28	8.5	<2	<3.4	0.69
Oil and grease	13	98	<2	<10	15
Pb	13	0.12	<0.04	<0.1	0.012
pH[c]	39	8.8	6.0	NA	
SO_4	28	2800	410	1300	220
Temperature[e]	18	23	8.2	17	2.1
TOC[f]	27	16	2.0	5.3	1.2
TP[g]	13	10	1.5	3.7	1.3
TSS[h]	13	37	5.0	19	5.9
Zn	13	0.68	0.29	0.49	0.069

[a]3518 Acid Neutralization Facility.
[b]95% confidence coefficient about the average.
[c]Expressed in standard units; average not applicable.
[d]NA = not applicable.
[e]Measured in degrees centigrade.
[f]Total organic carbon.
[g]Total phosphorus.
[h]Total suspended solids.

Table 5.3.40. 1986 NPDES Permit Number 0002941 Discharge Point X13[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	8	<0.03	<0.005	<0.02	0.0089
Al	9	0.84	<0.02	0.24	0.17
As	9	<0.06	<0.01	0.05	0.014
BOD	9	13	<5	6.1	1.8
Cd	9	<0.002	<0.002	<0.002	0
Chloroform	9	16	0.005	<3.5	3.5
Conductivity[c]	9	1000	150	720	170
Cr	9	0.024	<0.004	0.019	0.0057
Cu	9	<0.01	<0.002	0.0093	0.0028
DO	40	12	4.0	7.7	0.51
F	9	25	<1	4.4	5.2
Fe	9	0.65	0.05	0.24	0.13
Flow[d]	191	91	0.30	3.0	0.57
Hg	9	<0.0002	<0.0002	<0.0001	0.00001
Mn	9	0.45	0.031	0.16	0.089
NH_4-N	9	2.0	0.03	0.30	0.43
Ni	9	<0.04	<0.006	0.028	0.0085
NO_3-N	9	14	<2	5.0	2.5
Oil and grease	41	69	2.0	4.7	3.3
P	9	1.7	0.11	0.87	0.31
Pb	9	<0.004	<0.004	<0.004	0.00
PCB	9	0.0006	<0.0005	0.0005	0.00
pH[e]	7	7.9	7.0	NA[f]	
Phenols	9	0.002	0.001	0.0011	0.0002
Residual Cl	34	0.16	<0.05	<0.001	0.0098
SO_4	9	1100	21	340	200
TDS[g]	9	1000	120	610	200
Temperature[h]	9	27	13	20	3.1
TOC[i]	9	5.0	3.1	4.0	0.44
Trichloroeth[j]	9	5	<0.005	<2	1.3
TSS[k]	9	16	5.0	6.8	2.4
TTO[l]	4	72	0.00	36	42
Turbidity[m]	9	60	<0.05	<15	14
Zn	9	0.15	0.017	0.054	0.027

[a]Melton Branch.
[b]95% confidence coefficient about the average.
[c]Expressed in μmhos/cm.
[d]Measured in millions of liters per day.
[e]Expressed in standard units; average not applicable.
[f]NA = not applicable.
[g]Total dissolved solids.
[h]Measured in degrees centigrade.
[i]Total organic carbon.
[j]Trichloroethylene.
[k]Total suspended solids.
[l]Total toxic organics.
[m]Measured in Jackson turbidity units.

Table 5.3.41. 1986 NPDES Permit Number 0002941 Discharge Point X14[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
Ag	8	<0.03	<0.03	<0.03	0.00
Al	9	0.41	<0.02	0.16	0.086
As	9	<0.06	<0.01	<0.04	0.014
BOD	9	10	<5	<6.2	1.3
Cd	9	0.002	<0.002	<0.002	0.00
Chloroform	9	10	0.005	<4	2.5
Conductivity[c]	9	480	300	390	37
Cr	9	0.024	<0.004	<0.02	0.0057
Cu	9	0.013	<0.002	<0.009	0.0029
DO	40	9.2	6.0	7.4	0.32
F	9	<1	<1	<1	<0.00
Fe	9	0.49	0.022	0.16	0.11
Flow[d]	191	140	11	20	0.94
Hg	9	0.002	<0.0002	<0.002	0.0000
Mn	9	0.043	0.023	0.031	0.0039
NH_4-N	9	0.20	0.03	0.092	0.043
Ni	9	<0.04	<0.006	<0.03	0.0085
NO_3-N	9	5.6	<2	<4.1	1.1
Oil and grease	41	110	<2	<6.0	5.3
P	9	0.8	0.13	0.55	0.15
Pb	9	0.005	<0.004	<0.004	0.0002
PCB	9	0.0016	<0.0005	<0.0006	0.0002
pH[e]	7	8.0	7.1	NA[f]	
Phenols	9	0.0030	<0.001	0.0012	0.00
Residual Cl	37	0.05	<0.05	<0.05	0.00
SO_4	9	300	24	82	55
TDS[g]	9	320	170	260	30
Temperature[h]	9	24	12	19	2.8
TOC[i]	9	4.6	2.2	3.0	0.48
Trichloroeth[j]	9	10	<0.005	<3	2.1
TSS[k]	9	20	5.0	7.2	3.3
TTO[l]	4	0.010	0.00	0.0025	0.005
Turbidity[m]	9	20	<0.05	<8.6	4.6
Zn	9	0.040	0.027	0.032	0.0027

[a]White Oak Creek.
[b]95% confidence coefficient about the average.
[c]Expressed in μmhos/cm.
[d]Measured in millions of liters per day.
[e]Expressed in standard units; average not applicable.
[f]NA = not applicable.
[g]Total dissolved solids.
[h]Measured in degrees centigrade.
[i]Total organic carbon.
[j]Trichloroethylene.
[k]Total suspended solids.
[l]Total toxic organics.
[m]Measured in Jackson turbidity units.

Table 5.3.42. 1986 NPDES Permit Number 0002941 Discharge Point X15[a]

Parameter	No. of samples	Concentration (mg/L) Max	Min	Av	95% CC[b]
Ag	8	<0.03	<0.03	<0.03	0.00
Al	9	1.3	<0.10	0.39	0.26
As	9	<0.06	<0.01	<0.05	0.011
BOD	9	11	<5	<6	1.4
Cd	9	<0.002	<0.002	<0.002	0.00
Chloroform	10	10	<0.005	<2.6	1.9
Conductivity[c]	9	410	200	360	46
Cr	9	0.024	<0.004	<0.02	0.0044
Cu	9	0.015	<0.002	<0.01	0.0024
DO	40	12	2.0	6.6	0.83
F	9	1.0	<1.0	<1	0.00
Fe	9	1.3	0.086	0.48	0.28
Flow[d]	191	290	0.27	25	1.8
Hg	9	<0.0002	<0.0002	<0.0002	0.0000
Mn	9	1.5	0.028	0.35	0.37
NH_4-N	9	0.47	0.050	0.19	0.11
Ni	9	<0.036	<0.006	<0.03	0.0066
NO_3-N	9	5.0	<2	<4	1.1
Oil and grease	40	27	<2	<4	1.7
P	9	0.76	0.17	0.4	0.12
Pb	9	0.005	<0.004	<0.004	0.0003
PCB	9	0.0005	<0.0005	<0.0005	0.00
pH[e]	7	8.0	7.0	NA[f]	
Residual Cl	37	0.10	<0.05	0.05	0.01
SO_4	9	310	25	90	55
TDS[g]	9	360	140	270	43
Temperature[h]	9	29	14	22	3.5
TOC[i]	9	5.7	1.9	3.9	0.70
Trichloroeth[j]	10	10	<0.005	<2	2.0
TSS[k]	9	52	5.0	19	13
TTO[l]	4	0.010	0.00	0.0025	0.0050
Turbidity[m]	9	240	35	120	60
Zn	9	0.061	<0.01	0.023	0.011

[a]White Oak Dam.
[b]95% confidence coefficient about the average.
[c]Expressed in μmhos/cm.
[d]Measured in millions of liters per day.
[e]Expressed in standard units; average not applicable.
[f]NA = not applicable.
[g]Total dissolved solids.
[h]Measured in degrees centigrade.
[i]Total organic carbon.
[j]Trichloroethylene.
[k]Total suspended solids.
[l]Total toxic organics.
[m]Measured in Jackson turbidity units.

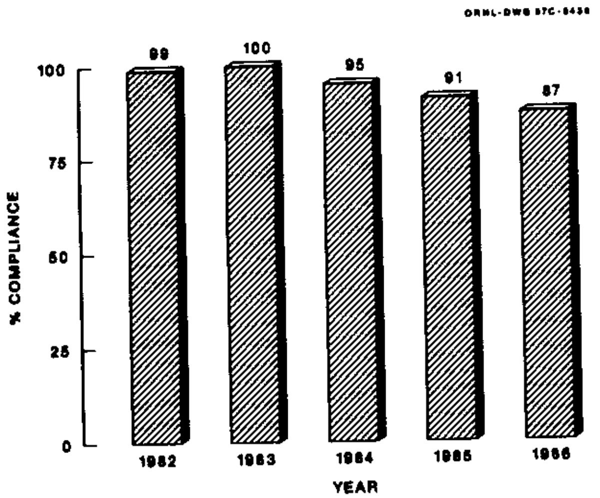

Fig. 5.3.76. NPDES compliance for aluminum at K-1700 discharge (001).

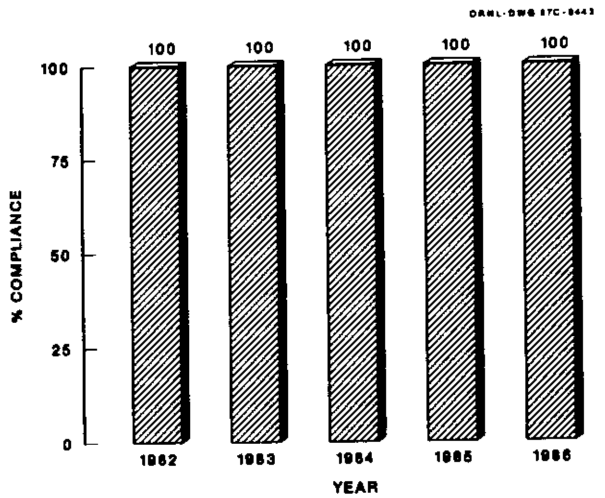

Fig. 5.3.78. NPDES compliance for nitrate (N) at K-1700 discharge (001).

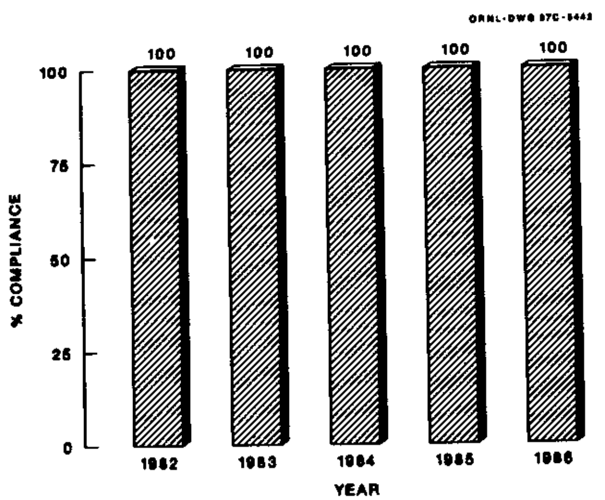

Fig. 5.3.77. NPDES compliance for chromium at K-1700 discharge (001).

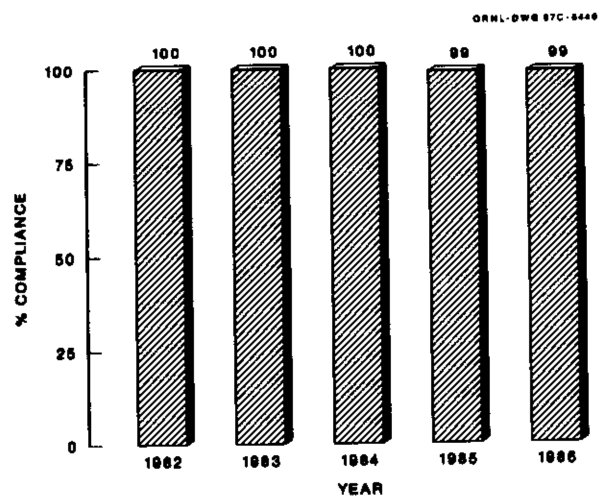

Fig. 5.3.79. NPDES compliance for suspended solids at K-1700 discharge (001).

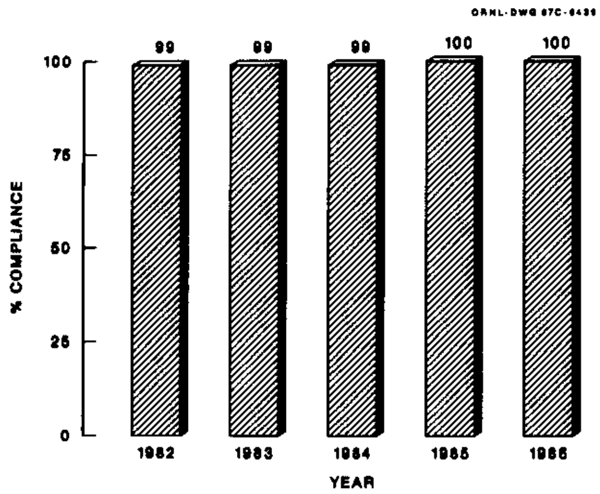

Fig. 5.3.80. NPDES compliance for pH at K-1700 discharge (001).

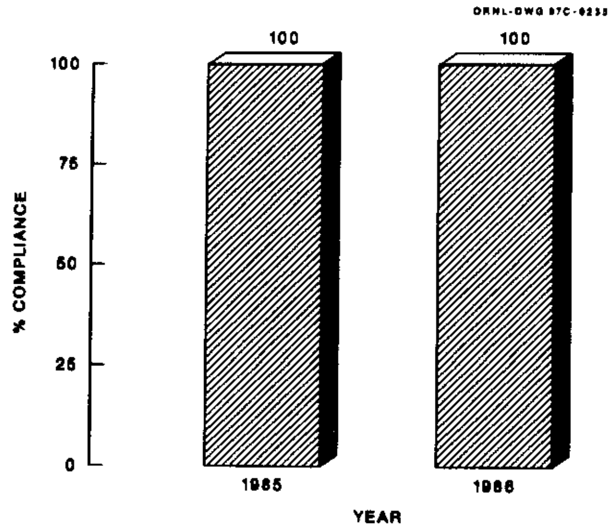

Fig. 5.3.82. NPDES compliance for oil and grease at K-1700 discharge (001).

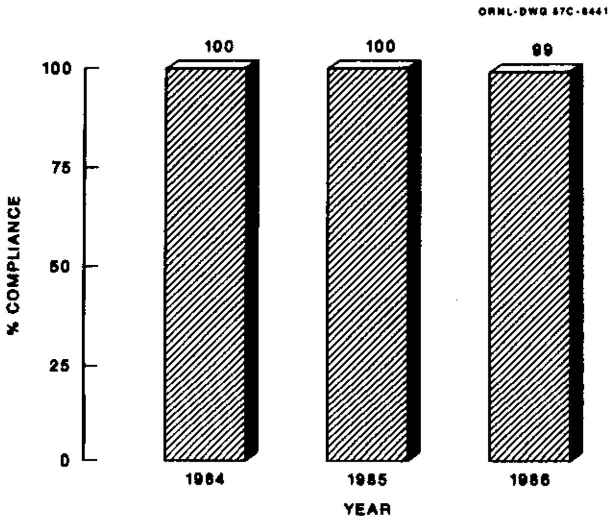

Fig. 5.3.81. NPDES compliance for lead at K-1700 discharge (001).

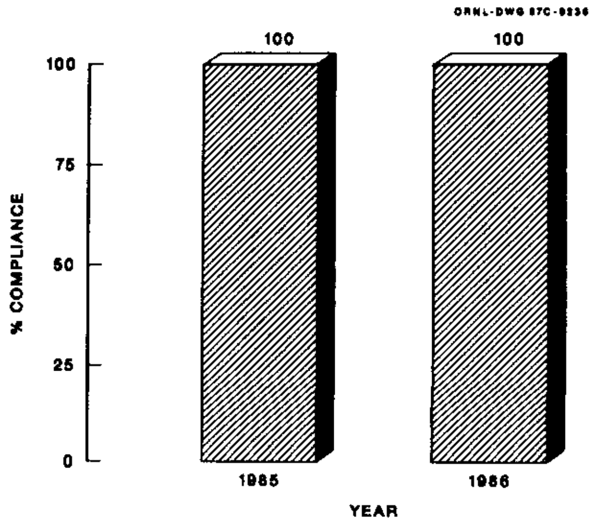

Fig. 5.3.83. NPDES compliance for perchloroethylene at K-1700 discharge (001).

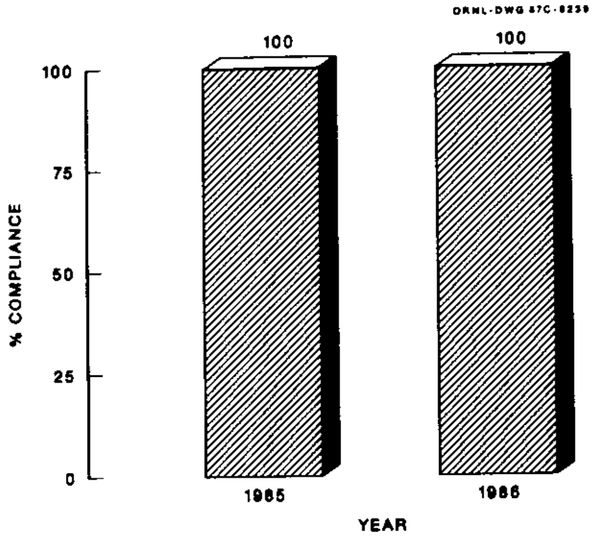

Fig. 5.3.84. NPDES compliance for trichloroethane at K-1700 discharge (001).

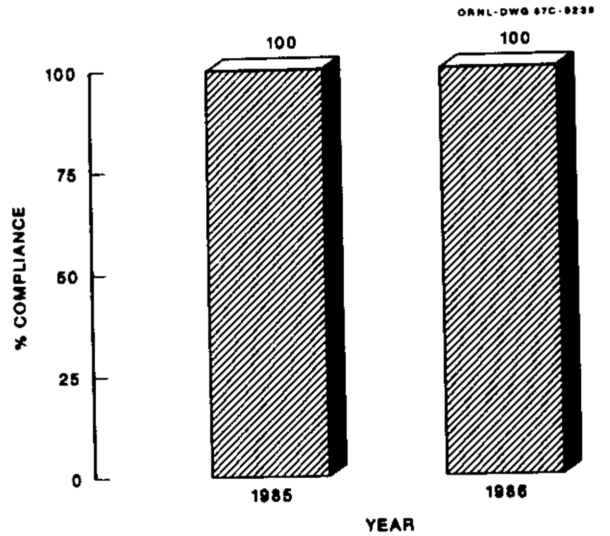

Fig. 5.3.85. NPDES compliance for methylene chloride at K-1700 discharge (001).

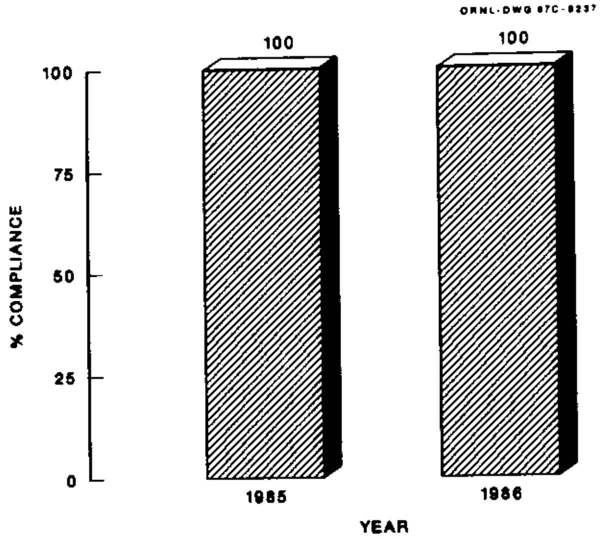

Fig. 5.3.86. NPDES compliance for trichloroethylene at K-1700 discharge (001).

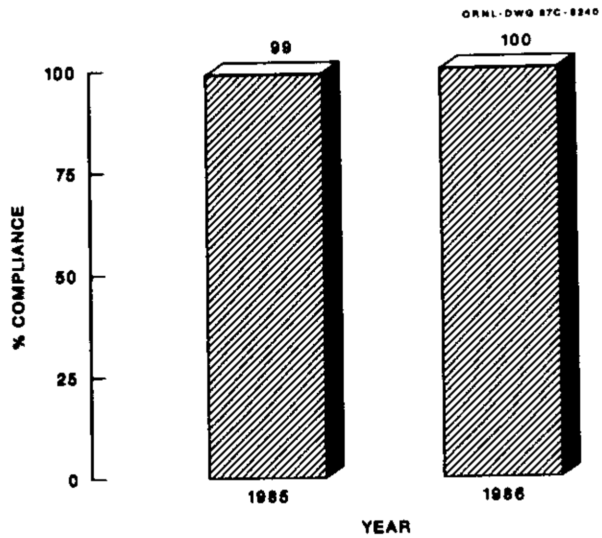

Fig. 5.3.87. NPDES compliance for zinc at K-1700 discharge (001).

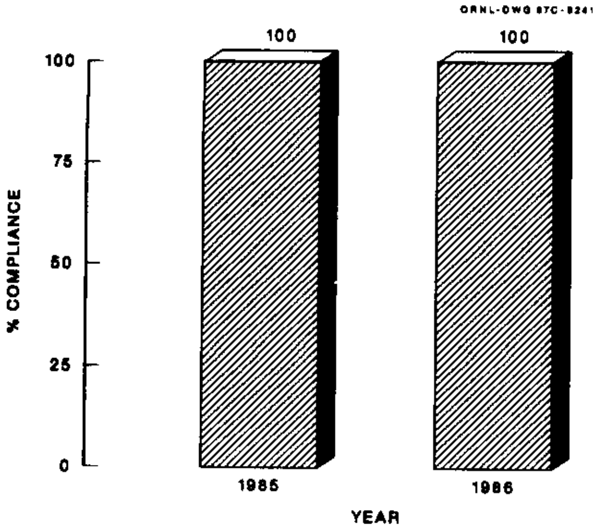

Fig. 5.3.88. NPDES compliance for total halomethanes at K-1700 discharge (001).

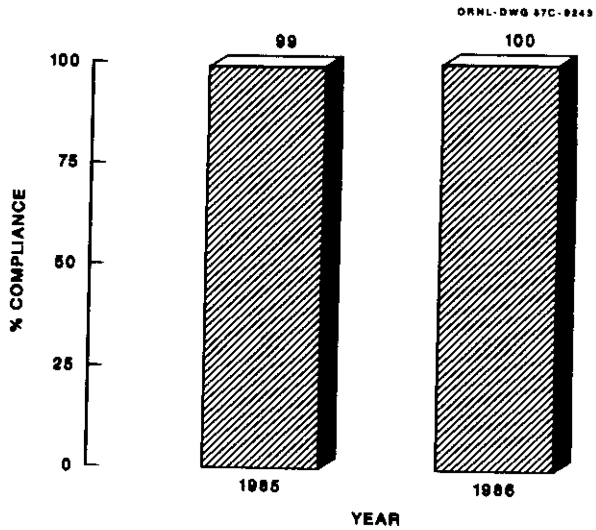

Fig. 5.3.90. NPDES compliance for cadmium at K-1700 discharge (001).

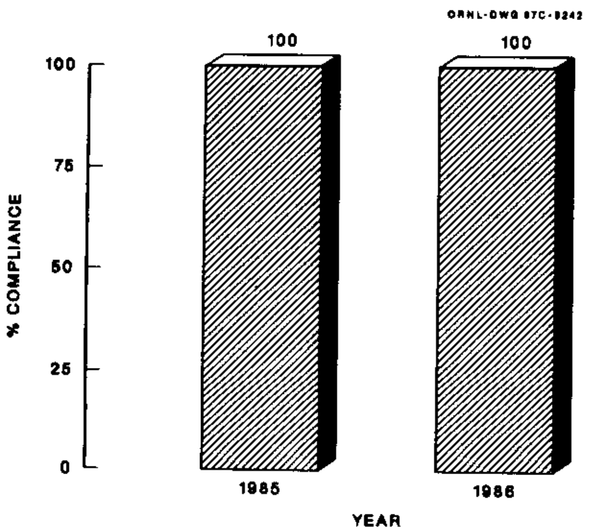

Fig. 5.3.89. NPDES compliance for beryllium at K-1700 discharge (001).

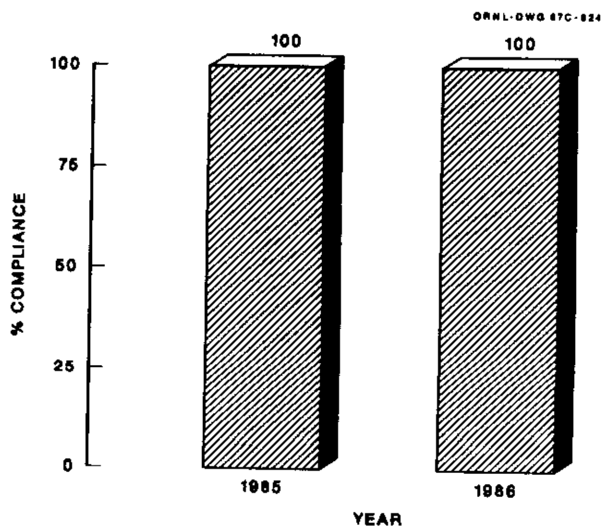

Fig. 5.3.91. NPDES compliance for mercury at K-1700 discharge (001).

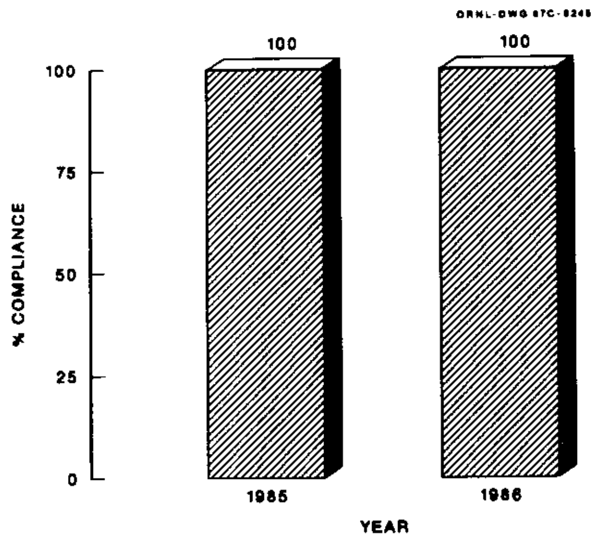

Fig. 5.3.92. NPDES compliance for selenium at K-1700 discharge (001).

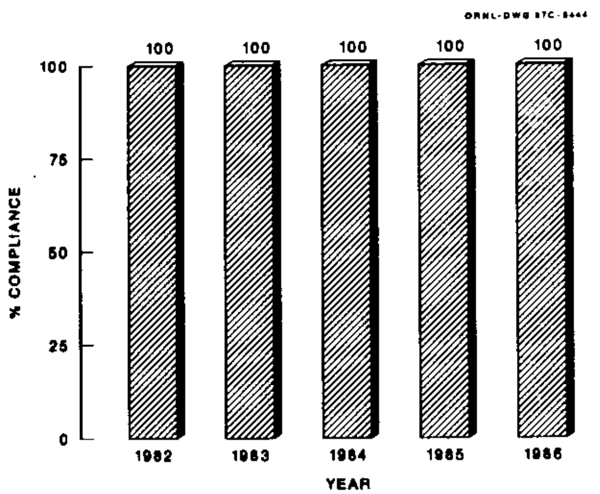

Fig. 5.3.94. NPDES compliance for ammonia nitrogen at K-1203 Sanitary Treatment Facility (005).

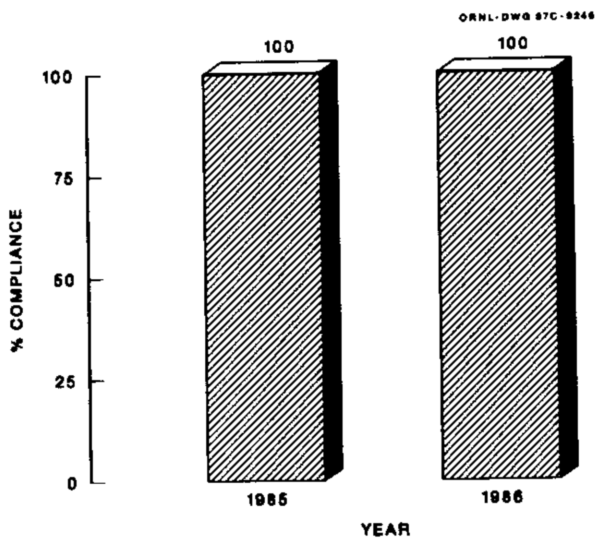

Fig. 5.3.93. NPDES compliance for silver at K-1700 discharge (001).

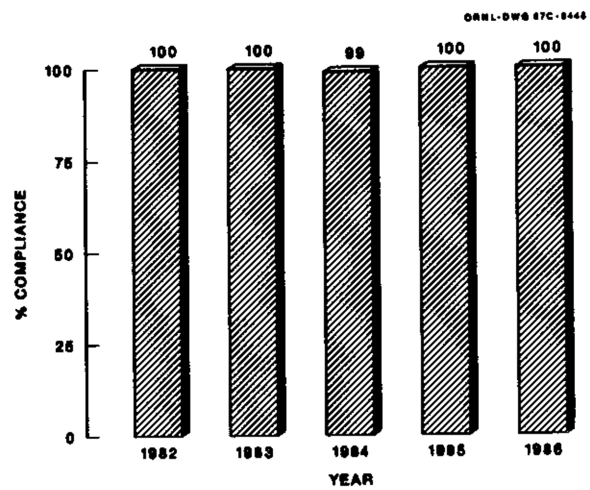

Fig. 5.3.95. NPDES compliance for BOD at K-1203 Sanitary Treatment Facility (005).

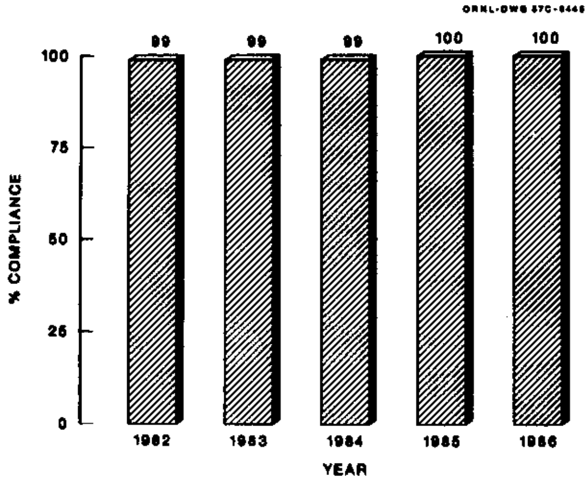

Fig. 5.3.96. NPDES compliance for residual chlorine at K-1203 Sanitary Treatment Facility (005).

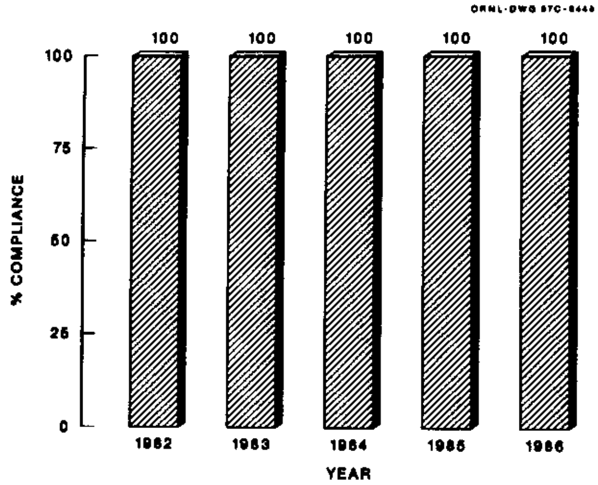

Fig. 5.3.99. NPDES compliance for pH at K-1203 Sanitary Treatment Facility (005).

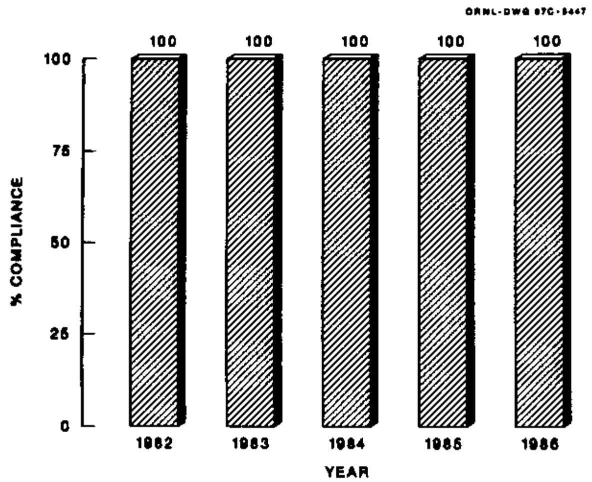

Fig. 5.3.97. NPDES compliance for dissolved oxygen at K-1203 Sanitary Treatment Facility (005).

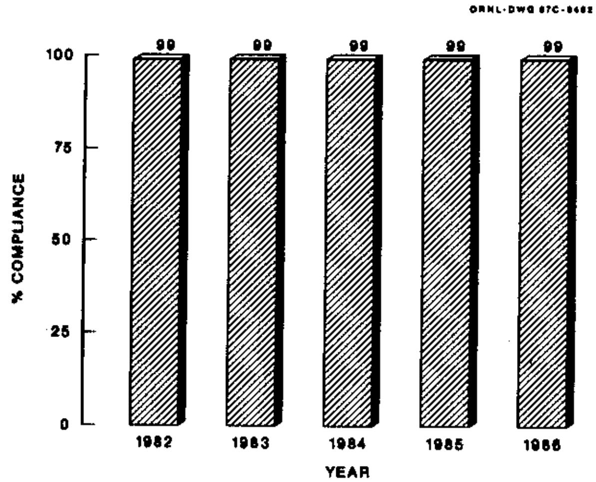

Fig. 5.3.100. NPDES compliance for suspended solids at K-1203 Sanitary Treatment Facility (005).

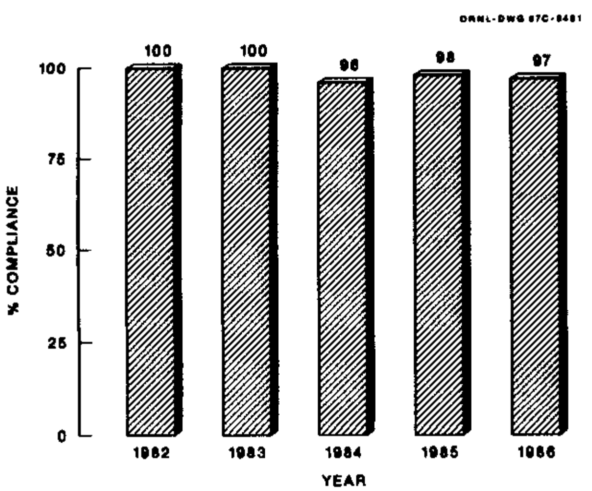

Fig. 5.3.98. NPDES compliance for fecal coliform at K-1203 Sanitary Treatment Facility (005).

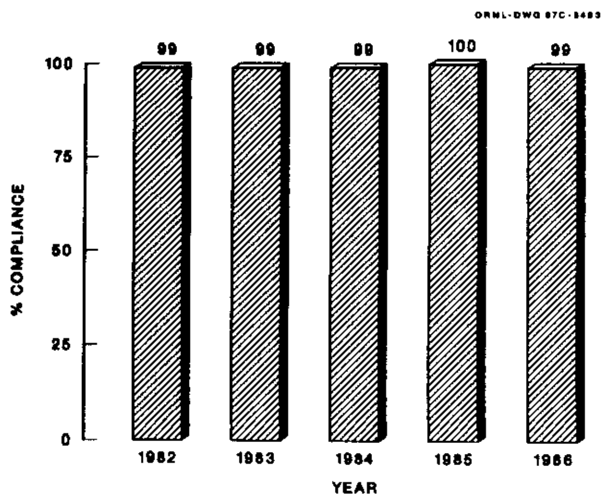

Fig. 5.3.101. NPDES compliance for settleable solids at K-1203 Sanitary Treatment Facility (005).

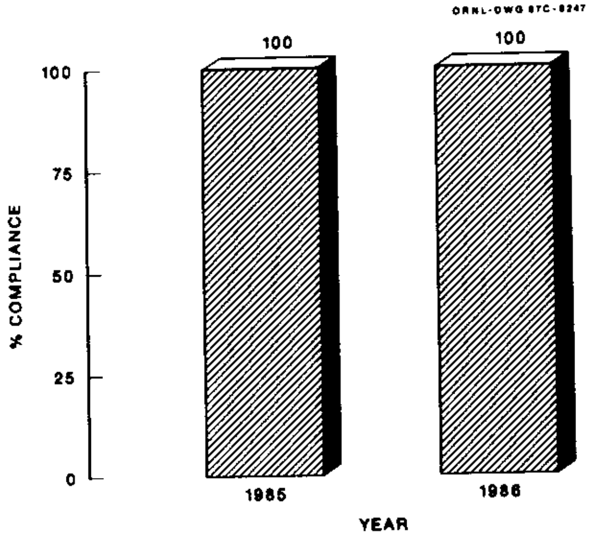

Fig. 5.3.102. NPDES compliance for beryllium at K-1203 Sanitary Treatment Facility (005).

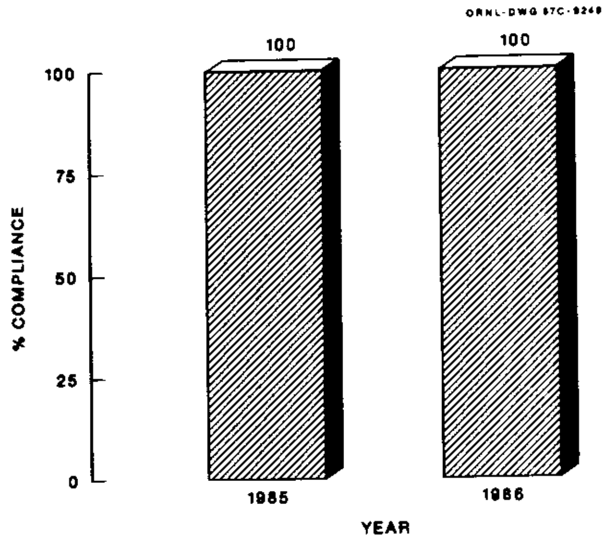

Fig. 5.3.104. NPDES compliance for mercury at K-1203 Sanitary Treatment Facility (005).

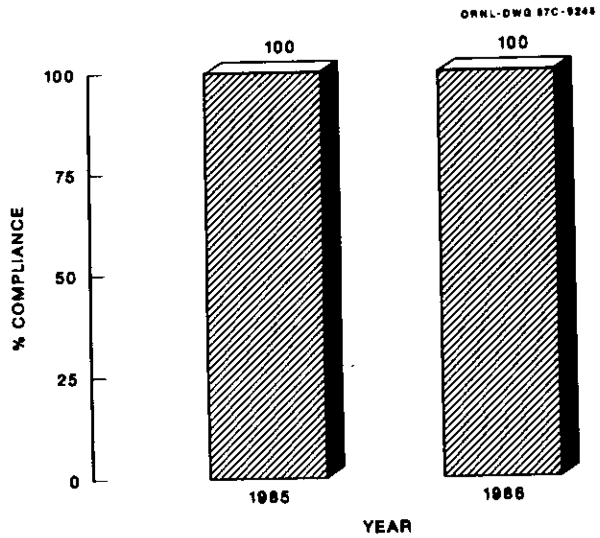

Fig. 5.3.103. NPDES compliance for cadmium at K-1203 Sanitary Treatment Facility (005).

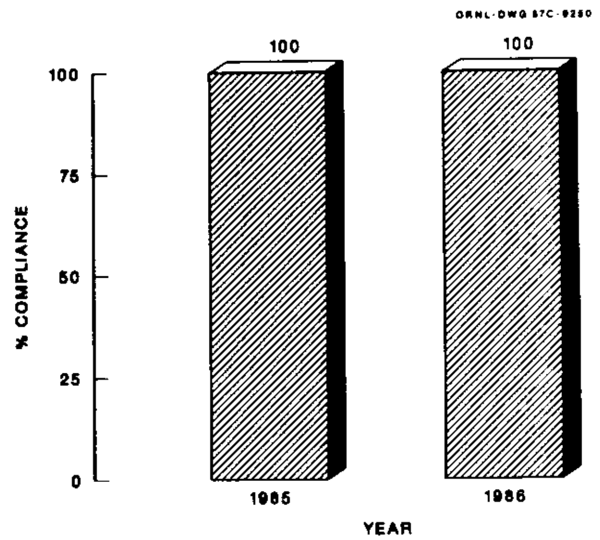

Fig. 5.3.105. NPDES compliance for selenium at K-1203 Sanitary Treatment Facility (005).

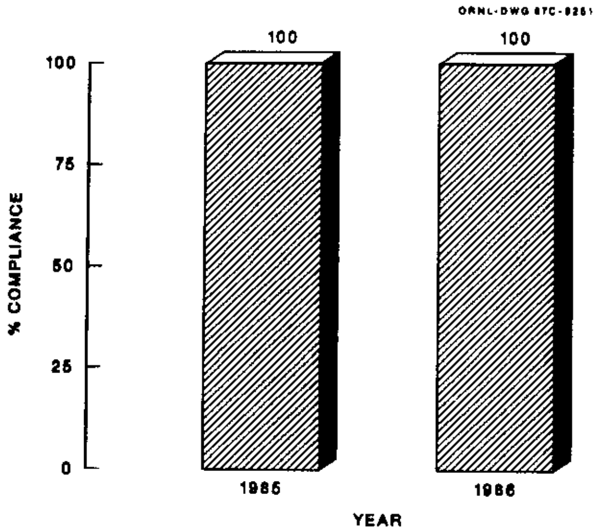

Fig. 5.3.106. NPDES compliance for silver at K-1203 Sanitary Treatment Facility (005).

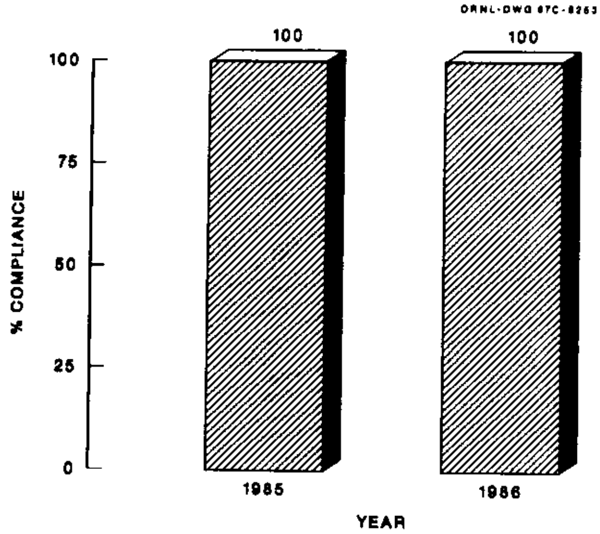

Fig. 5.3.108. NPDES compliance for zinc at K-1203 Sanitary Treatment Facility (005).

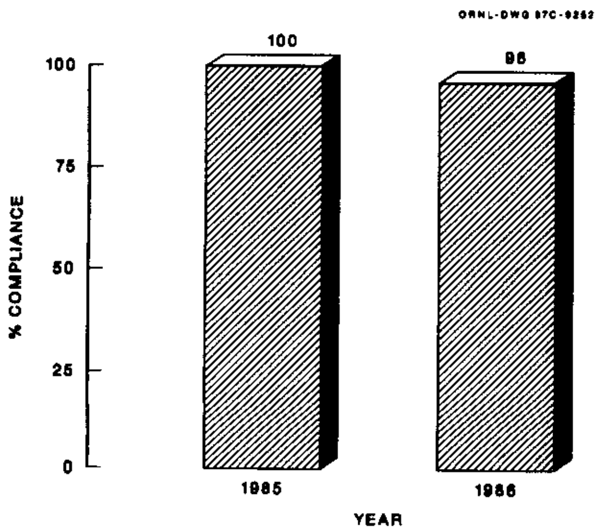

Fig. 5.3.107. NPDES compliance for lead at K-1203 Sanitary Treatment Facility (005).

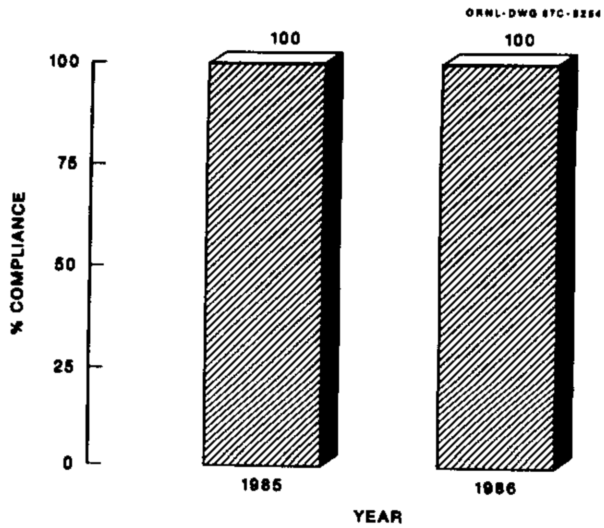

Fig. 5.3.109. NPDES compliance for perchloroethylene at K-1203 Sanitary Treatment Facility (005).

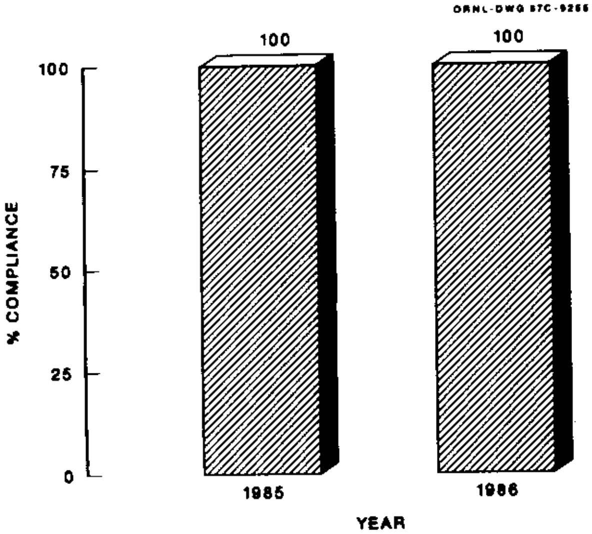

Fig. 5.3.110. NPDES compliance for trichloroethane at K-1203 Sanitary Treatment Facility (005).

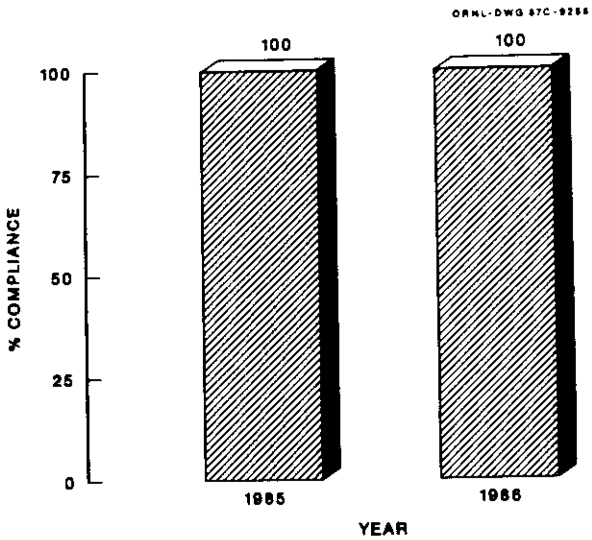

Fig. 5.3.112. NPDES compliance for trichloroethylene at K-1203 Sanitary Treatment Facility (005).

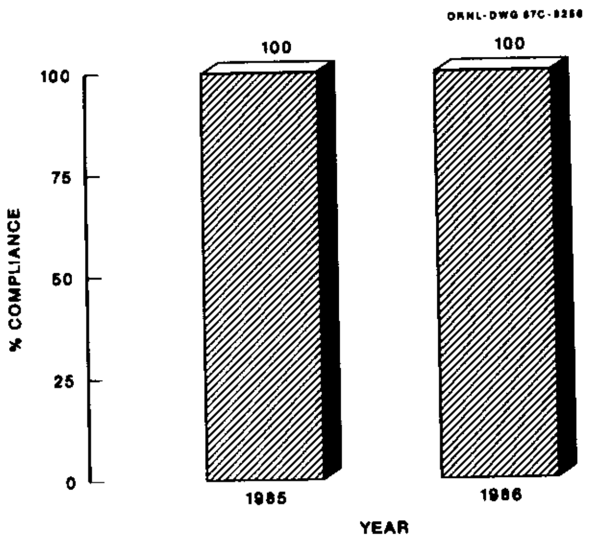

Fig. 5.3.111. NPDES compliance for methylene chloride at K-1203 Sanitary Treatment Facility (005).

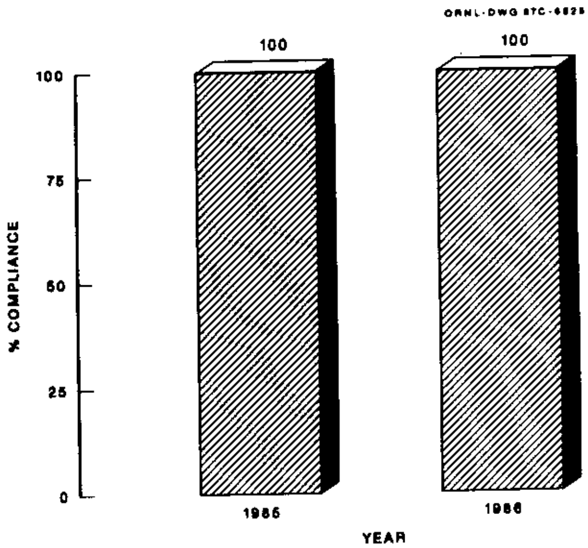

Fig. 5.3.113. NPDES compliance for total halomethanes at K-1203 Sanitary Treatment Facility (005).

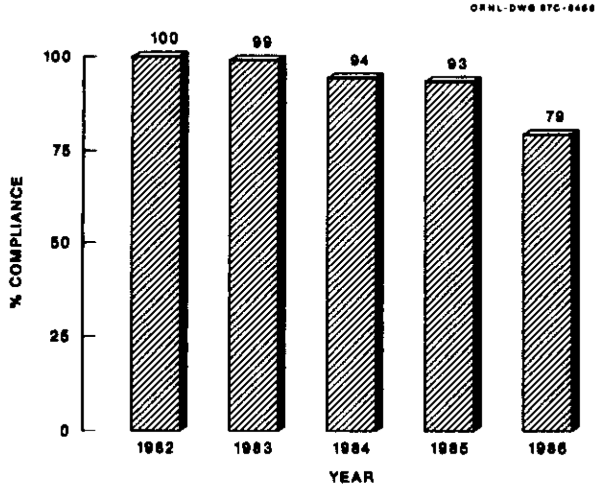

Fig. 5.3.114. NPDES compliance for total COD at K-1007-B Holding Pond (006).

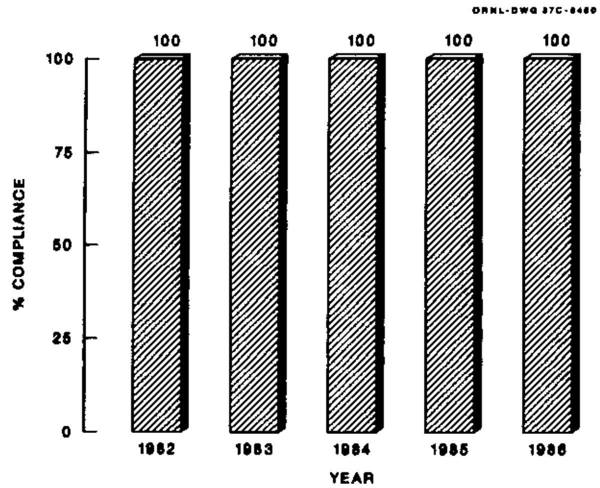

Fig. 5.3.117. NPDES compliance for total fluoride at K-1007-B Holding Pond (006).

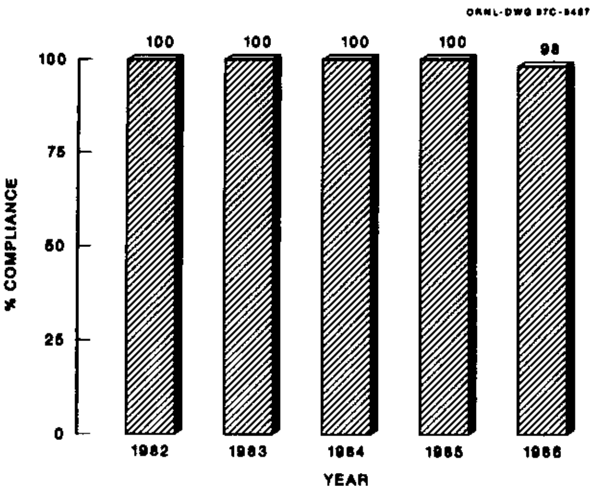

Fig. 5.3.115. NPDES compliance for total chromium at K-1007-B Holding Pond (006).

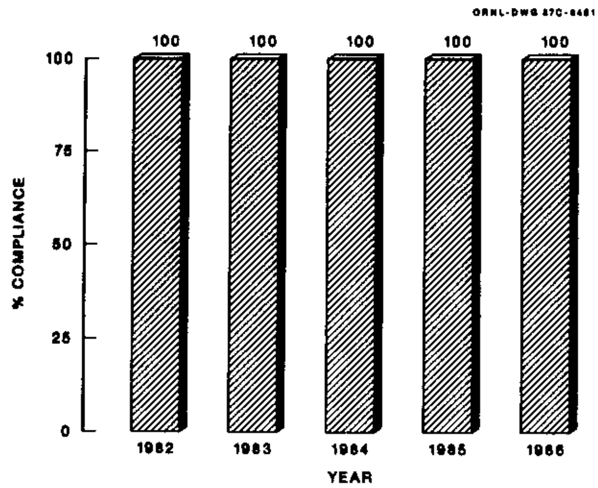

Fig. 5.3.118. NPDES compliance for total oil and grease at K-1007-B Holding Pond (006).

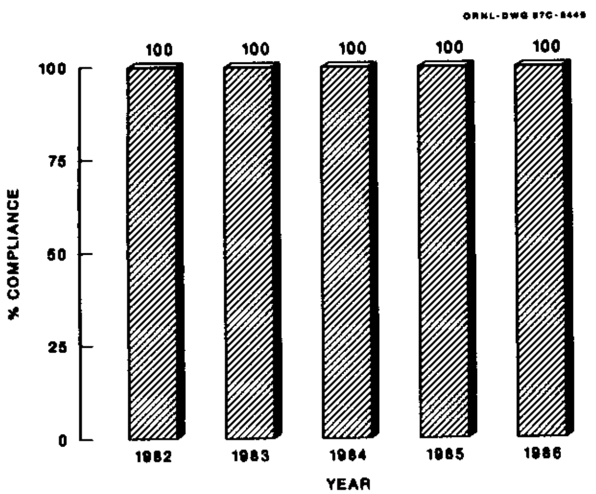

Fig. 5.3.116. NPDES compliance for total dissolved oxygen at K-1007-B Holding Pond (006).

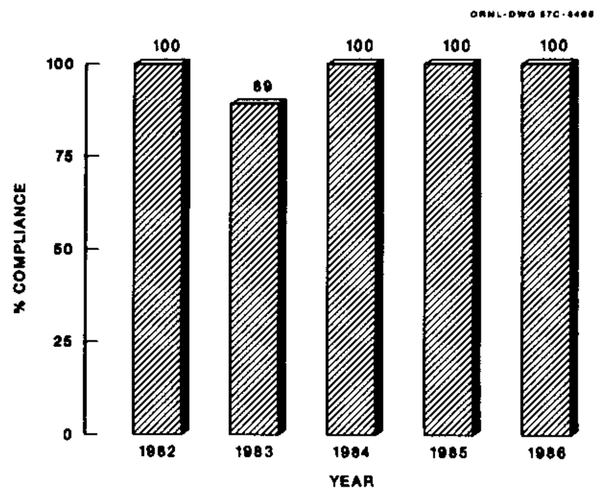

Fig. 5.3.119. NPDES compliance for total pH at K-1007-B Holding Pond (006).

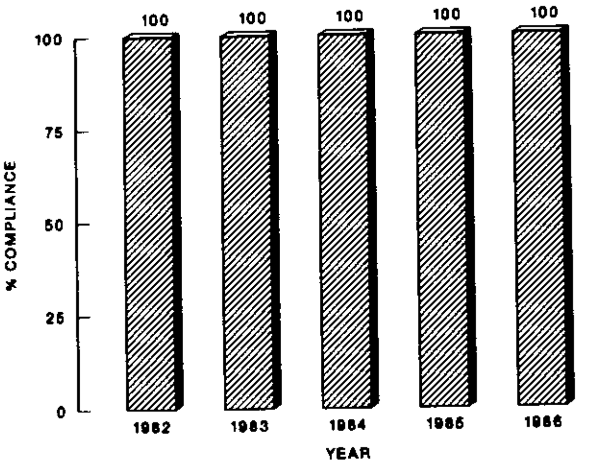

Fig. 5.3.120. NPDES compliance for total suspended solids at K-1007-B Holding Pond (006).

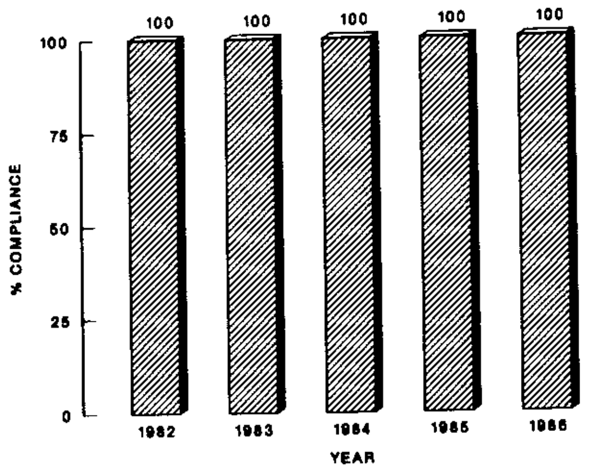

Fig. 5.3.123. NPDES compliance for total oil and grease at K-901-A Holding Pond (007).

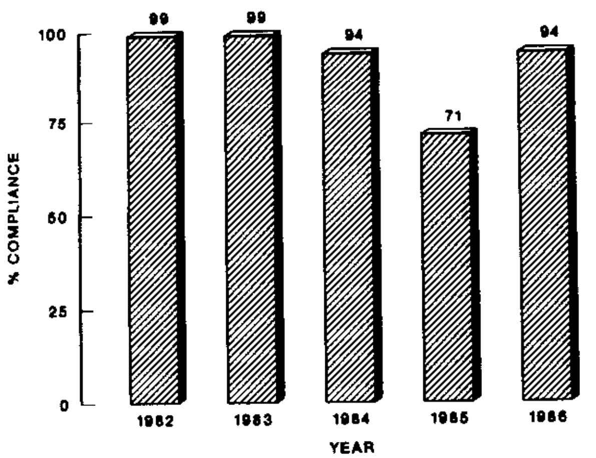

Fig. 5.3.121. NPDES compliance for total chromium at K-901-A Holding Pond (007).

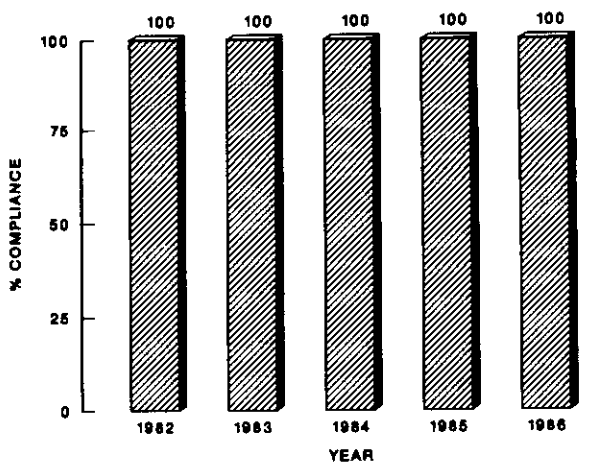

Fig. 5.3.124. NPDES compliance for total pH at K-901-A Holding Pond (007).

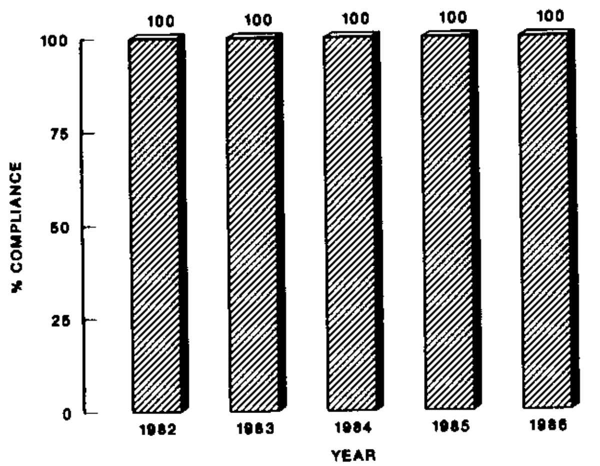

Fig. 5.3.122. NPDES compliance for total fluoride at K-901-A Holding Pond (007).

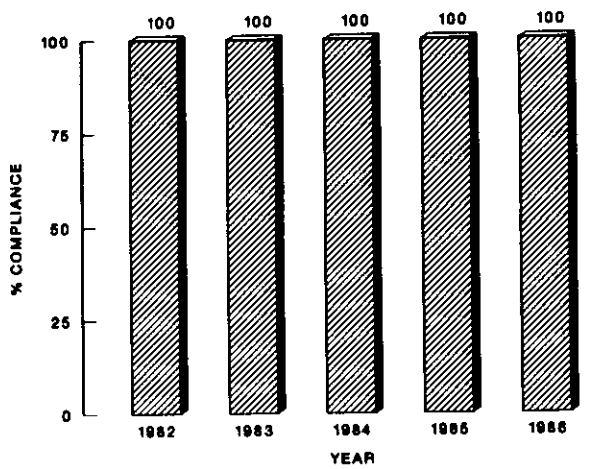

Fig. 5.3.125. NPDES compliance for total suspended solids at K-901-A Holding Pond (007).

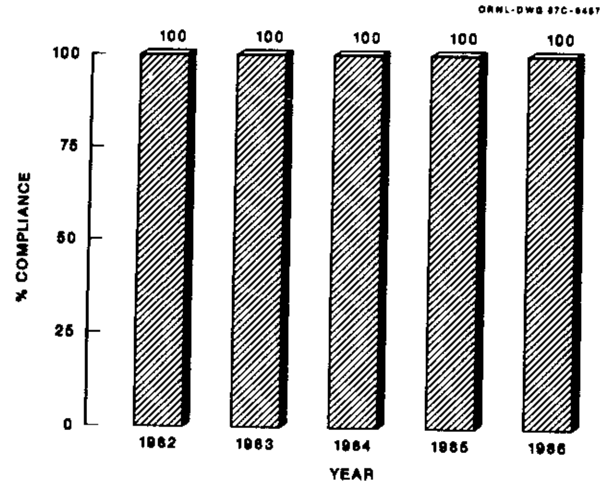

Fig. 5.3.126. NPDES compliance for total suspended solids at Sanitary Water Plant (009).

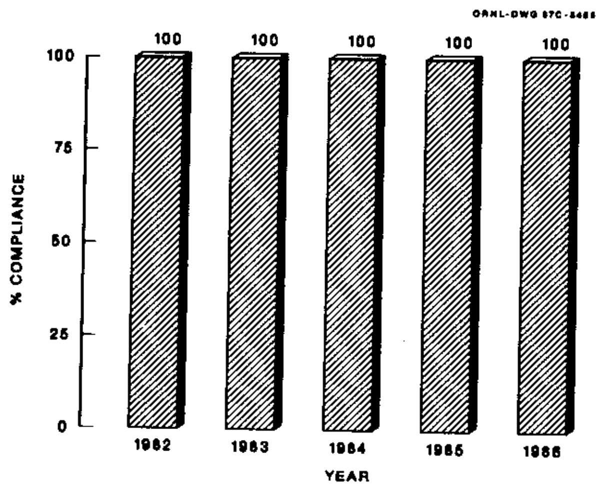

Fig. 5.3.127. NPDES compliance for total aluminum at Sanitary Water Plant (009).

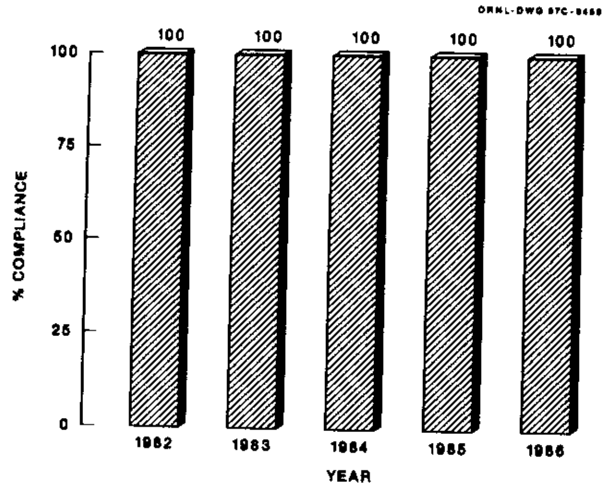

Fig. 5.3.128. NPDES compliance for total sulfate at Sanitary Water Plant (009).

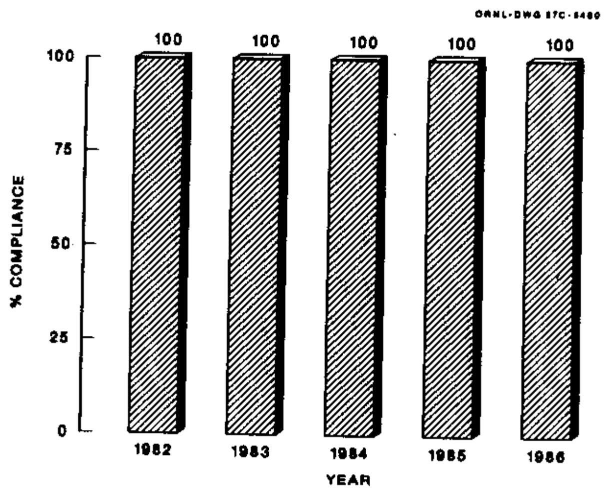

Fig. 5.3.129. NPDES compliance for total pH at Sanitary Water Plant (009).

Table 5.3.43. 1986 NPDES Permit Number TN 0002950 Discharge Point 001[a]–Part 1

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Aluminum			*COD*			*Oil and grease*			*Perchloroethylene*		
January	0.37	0.12	0.20	13	<5	<6	5	<2	<2	<0.005	<0.005	<0.005
February	5.90	0.02	1.20	10	5	6	8	<2	<3	<0.005	<0.005	<0.005
March	1.80	0.05	0.53	8	<5	<6	11	2	4	<0.005	<0.005	<0.005
April	0.80	0.05	0.17	24	5	7	6	2	3	0.006	<0.005	<0.005
May	6.90	<0.05	<0.88	20	5	8	6	<2	<3	<0.005	<0.005	<0.005
June	3.10	0.05	0.43	17	5	8	5	<2	<2	<0.005	<0.005	<0.005
July	11.0	<0.05	<1.31	20	5	11	2	<2	<2	<0.005	<0.005	<0.005
August	1.70	<0.05	<0.33	24	<5	<11	5	<2	<3	<0.005	<0.005	<0.005
September	0.52	0.07	0.16	31	<5	<10	4	<2	<2	<0.005	<0.005	<0.005
October	0.25	0.10	0.17	27.0	3.0	8.0	4.0	<2.0	<2.4	<0.005	<0.005	<0.005
November	0.49	0.12	0.21	17	<5	<10	4.0	<2.0	<2.2	0.013	<0.005	0.007
December	2.8	<0.1	<0.6	51	<5	<14	3	<2	<2	0.006	<0.005	<0.005
	Chromium (total)			*Dissolved solids*			*Trichloroethane*			*Methylene Chloride*		
January	0.03	0.01	0.02	818	239	493	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
February	0.03	<0.01	<0.02	1,011	175	530	0.019	<0.005	<0.009	0.008	<0.005	<0.005
March	0.03	<0.01	<0.02	777	216	527	0.007	<0.005	<0.005	0.008	<0.005	<0.006
April	<0.01	<0.01	<0.01	712	326	465	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
May	<0.01	<0.01	<0.01	2,245	523	957	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
June	0.02	<0.01	<0.01	1,036	449	745	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
July	0.02	<0.01	<0.01	987	394	658	0.019	<0.005	<0.008	<0.005	<0.005	<0.005
August	0.01	<0.01	<0.01	1,322	318	696	<0.005	<0.005	<0.005	0.015	<0.005	<0.007
September	<0.01	<0.01	<0.01	1,352	354	843	0.032	0.005	0.007	<0.005	<0.005	<0.005
October	0.016	<0.01	<0.012	966	292	688	<0.005	<0.005	<0.005	0.009	<0.005	<0.005
November	<0.01	<0.01	<0.01	782	390	550	0.007	<0.005	<0.005	<0.005	<0.005	<0.005
December	0.02	<0.01	<0.01	464	250	368	0.012	<0.005	<0.005	<0.005	<0.005	<0.005
	Fluoride			*Nitrate*			*Trichloroethylene*			*Lead*		
January	0.78	0.14	0.42	0.48	0.36	0.40	0.074	0.046	0.058	<0.004	<0.004	<0.004
February	1.00	<0.10	<0.42	0.44	0.31	0.40	0.058	0.020	0.039	<0.05	<0.05	<0.05
March	0.44	0.12	0.31	0.77	0.15	0.40	0.055	<0.005	<0.037	0.013	<0.004	<0.006
April	0.48	0.10	0.34	1.46	0.21	0.51	0.092	0.040	0.065	0.011	<0.004	<0.006
May	0.58	0.27	0.41	0.35	<0.11	<0.22	0.090	0.040	0.065	0.016	<0.004	<0.006
June	0.52	0.30	0.39	1.29	0.22	0.54	0.130	0.039	0.065	0.007	<0.004	<0.005
July	1.50	0.36	0.79	0.42	0.23	0.32	0.074	0.042	0.059	0.024	0.004	0.010
August	1.20	0.10	0.65	1.13	0.13	0.44	0.081	<0.005	<0.043	0.012	<0.004	<0.007
September	1.20	0.20	0.45	1.45	0.35	0.71	0.110	<0.005	<0.072	0.008	<0.004	<0.005
October	0.40	0.10	0.21	0.50	0.16	0.34	0.088	0.016	0.068	0.005	<0.004	<0.004
November	0.60	0.1	0.2	5.7	0.3	1.3	0.086	0.018	0.060	0.005	<0.004	<0.004
December	1.0	0.1	0.3	0.8	0.3	0.4	0.075	0.016	0.049	0.007	<0.004	<0.004

[a]ORGDP.

Table 5.3.44. 1986 NPDES Permit Number TN 0002950
Discharge Point 001[a]–Part 2

Month	Concentration (mg/L) Max	Min	Av	Concentration (mg/L) Max	Min	Av	Concentration (mg/L) Max	Min	Av	Concentration (mg/L) Max	Min	Av
	Zinc			*Total halomethanes*			*Selenium[b]*			*Silver*		
January	0.06	0.03	0.04				<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
February	0.09	<0.02	<0.04				<0.050	<0.005	<0.016	<0.01	<0.01	<0.01
March	0.10	0.004	0.04	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
April	0.04	<0.02	<0.02				<0.005	<0.005	<0.005	0.02	<0.01	<0.01
May	0.04	<0.02	<0.02	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
June	0.06	<0.02	<0.03				0.006	<0.005	<0.005	<0.01	<0.01	<0.01
July	0.09	0.02	0.04				0.008	<0.005	<0.005	0.01	<0.01	<0.01
August	0.07	0.02	0.04	<0.01	<0.01	<0.01	0.005	<0.005	<0.005	0.02	<0.01	<0.01
September	0.05	<0.02	<0.03				<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
October	0.033	<0.020	<0.027				<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
November	0.04	<0.02	<0.02	0.009	0.005	0.007	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
December	0.042	<0.02	<0.02				<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
	Total suspended solids[b]			*Beryllium[b]*			*pH (units)*			*Temperature (°F)*		
January	20	<1	<6	<0.001	<0.001	<0.001	7.89	6.01	NA	76	68	72
February	34	<1	<11	<0.003	<0.001	<0.002	8.12	6.77	NA	54	42	49
March	41	1	9	<0.001	<0.0003	<0.001	8.01	7.14	NA	58	47	53
April	26	1	6	<0.001	<0.001	<0.001	8.8	6.9	NA	67	51	58
May	24	<2	<7	<0.001	<0.001	<0.001	8.4	6.7	NA	67	56	62
June	42	1	7	<0.001	<0.001	<0.001	9.0	7.2	NA	77	62	67
July	42	<2	<11	<0.001	<0.001	<0.001	8.6	7.3	NA	73	68	71
August	27	<2	<8	<0.001	<0.001	<0.001	8.2	6.6	NA	72	64	69
September	47	1	10	<0.001	<0.001	<0.001	8.4	7.2	NA	70	63	67
October	30	5	12	<0.001	<0.001	<0.001	8.4	6.6	NA	65	57	62
November	29	1	10	<0.001	<0.001	<0.001	8.4	6.1	NA	66	50	58
December	30	<1	<7	<0.001	<0.001	<0.001	7.8	7.4	NA	56	46	48

Table 5.3.44 (continued)

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
		Cadmium			*Mercury*[b]			*Turbidity (NTU)*				
January	<0.002	<0.002	<0.002	0.0007	<0.0002	<0.0002	13	2	5			
February	<0.003	<0.002	<0.002	<0.0002	<0.0002	<0.0002	105	3	22			
March	<0.002	<0.002	<0.002	<0.0002	<0.0002	<0.0002	200	4	36			
April	0.003	<0.002	<0.002	<0.001	<0.0002	<0.0002	200	4	16			
May	<0.002	<0.002	<0.002	<0.0002	<0.0002	<0.0002	78	3	12			
June	0.002	<0.002	<0.002	0.0003	<0.0002	<0.0002	26	2	6			
July	0.002	<0.002	<0.002	0.0002	<0.0002	<0.0002	31	3	6			
August	0.004	<0.002	<0.002	0.0005	<0.0002	<0.0002	61	3	9			
September	0.003	<0.002	<0.002	<0.0002	<0.0002	<0.0002	19	3	6			
October	<0.002	<0.002	<0.002	<0.0003	<0.0002	<0.0002	5	2	3.6			
November	<0.002	<0.002	<0.002	0.0002	<0.0002	<0.0002	41	2	10			
December	<0.002	<0.002	<0.002	<0.0002	<0.0002	<0.0002	79	2	12			

[a]ORGDP.
[b]Detection limits for several parameters varied in 1986.

Table 5.3.45. 1986 NPDES Permit Number TN 0002950 Discharge Point 003[a]–Part 1

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Aluminum			*COD*			*Mercury*[b]		
September	0.37	0.13	0.23	71	20	34	<0.0002	<0.0002	<0.0002
October	0.38	0.15	0.26	41	3.0	16.9	<0.0002	<0.0002	<0.0002
November	0.36	0.11	0.22	54	14	32	<0.0002	<0.0002	<0.0002
December	0.6	<0.1	<0.3	66	<5	<19	<0.0002	<0.0002	<0.0002
	Total chromium			*Dissolved solids*			*Silver*		
September	<0.01	<0.01	<0.01	3,470	2,950	3,172	<0.01	<0.01	<0.01
October	0.012	<0.01	<0.011	3,070	934	2,151	<0.01	<0.01	<0.01
November	<0.01	<0.01	<0.01	1,922	1,358	1,605	<0.01	<0.01	<0.01
December	0.013	<0.01	<0.01	1,714	944	1,513	<0.01	<0.01	<0.01
	Fluoride			*Nitrate (N)*			*Total organic carbon*		
September	2.10	1.00	1.61	3.14	<0.11	1.15	27.0	14.0	21.2
October	4.2	0.1	1.5	<0.2	<0.2	<0.2	31	13	17.6
November	3.0	0.1	1.3	22.3	0.2	4.5	54	17	34
December	1.3	0.1	0.3	2.6	0.2	0.8	25	14	17
	Oil and Grease			*Total suspended solids*			*Selenium*[b]		
September	2	<2	<2	41	11	26	<0.050	<0.050	<0.050
October	3.0	<2	<2.2	640	20.0	32.4	<0.005	<0.005	<0.005
November	3	<2	<2	31	5	16	<0.05	<0.05	<0.05
December	<2	<2	<2	398	1	36	0.05	0.009	<0.045
	Temperature (°F)			*Lead*			*Zinc*		
September	77	74	75	<0.004	<0.004	<0.004	0.16	0.03	0.09
October	81	62	71	<0.004	<0.004	<0.004	0.094	0.026	0.052
November	68	51	60	<0.004	<0.004	<0.004	0.03	<0.02	0.023
December	60	46	52	0.007	<0.004	0.004	0.03	<0.02	0.03
	Beryllium			*Cadmium*			*Copper*		
September	<0.001	<0.001	<0.001	0.002	<0.002	<0.002	0.170	0.043	0.087
October	<0.001	<0.001	<0.001	0.002	<0.002	<0.002	0.073	0.008	0.026
November	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002	0.09	<0.004	0.02
December	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002	0.021	<0.004	0.009

[a]ORGDP.

[b]Detection levels for several parameters varied in 1986.

Table 5.3.46. 1986 NPDES Permit Number TN 0002950 Discharge Point 003[a]–Part 2

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
		Nickel			*Ammonia (N)*			*Cobalt*[b]	
September	1.70	0.15	0.51	<0.2	<0.2	<0.2	0.009	<0.005	0.006
October	1.30	0.11	0.37	<0.2	<0.2	<0.2	<0.10	<0.10	<0.10
November	0.860	0.095	0.369	0.5	<0.2	<0.38	<0.1	<0.1	<0.1
December	0.27	0.07	0.19	<0.2	<0.2	<0.2	0.18	<0.1	<0.12
		Bromide			*Chloride*			*Magnesium*	
September	2.3	2.0	2.15	870	55.4	463	35	35	35
October	3.0	<2.0	<2.26	900	187	515	31	20	26.2
November	6	2	4	296	240	267	27	21	23
December	4	1	2.3	366	105	242	26	17	22
		Total residual chlorine			*Total organic nitrogen*			*Manganese*	
September	<0.1	<0.1	<0.1	0.80	0.56	0.68	1.60	0.25	0.71
October	<0.1	<0.1	<0.1	0.8	0.6	0.7	1.40	0.12	0.52
November	<0.1	<0.1	<0.1	1.30	0.28	0.87	0.27	0.074	0.17
December	<0.1	<0.1	<0.1	1.0	0.4	0.6	0.27	0.075	0.16
		Phosphorus			*Sulfate*			*Iron*	
September	2.70	0.80	1.75	1,340	1,120	1,229	1.50	0.23	0.76
October	30.0	1.5	13.1	1,300	930	1,091	3.0	0.31	1.33
November	5.2	1.3	3.4	860	540	654	2.40	0.35	1.42
December	2.6	1.0	1.6	670	370	540	3.8	0.42	1.77
		Sulfite[b]			*Sulfide*			*Molybdenum*[b]	
September	<1	<1	<1	7	<1	4	<0.1	<0.1	<0.1
October	5.0	2.0	2.6	2.0	1.0	1.5	<0.1	<0.1	<0.1
November	3	<2	2	<1	<1	<1	0.014	<0.1	<0.1
December	<2	<2	<2	<1	<1	<1	0.01	<0.001	<0.009
		Surfactants			*Barium*			*Tin*[b]	
September	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.01	<0.01	<0.01
October	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1
November	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
December	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

[a]ORGDP.
[b]Detection levels varied for several parameters in 1986.

Table 5.3.47. 1986 NPDES Permit Number TN 0002950
Discharge Point 003[a]–Part 3

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Chloromethane			*Bromomethane*			*Bromodichloromethane*		
September	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
October	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
November	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Vinyl chloride			*Chloroethane*			*Trans-1,3-dichloropropene*		
September	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
October	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
November	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Methylene chloride			*1,1-dichloroethane*			*1,1,2-trichloroethane*		
September	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
October	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
November	0.021	<0.005	<0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	1,1-dichloroethene			*1,1,1-trichloroethane*			*1,2-dichloropropane*		
September	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
October	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
November	<0.005	<0.005	<0.005	0.062	<0.005	<0.010	<0.005	<0.005	<0.005
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	1,2-dichloroethane			*Dibromochloromethane*			*Benzene*		
September	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
October	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
November	<0.005	<0.005	<0.005	0.062	<0.005	0.010	0.011	<0.005	<0.005
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.005	<0.005	<0.005
	Carbon tetrachloride								
September	<0.005	<0.005	<0.005						
October	<0.005	<0.005	<0.005						
November	<0.005	<0.005	<0.005						
December	<0.010	<0.010	<0.010						

[a]ORGDP.

Table 5.3.48. 1986 NPDES Permit Number TN 0002950 Discharge Point 003[a]–Part 4

Month	Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av
	Cis-1,3-dichloropropene			*2-chloroethylvinylether*		
September	<0.005	<0.005	<0.005	<0.010	<0.010	<0.010
October	<0.005	<0.005	<0.005	<0.010	<0.010	<0.010
November	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Bromoform			*Chlorobenzene*		
September	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
October	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
November	<0.005	<0.005	<0.005	<0.010	<0.010	<0.010
December	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Titanium			*Antimony*		
September	<0.003	<0.003	<0.003	0.26	0.05	0.09
October	<0.003	<0.003	<0.003	0.081	<0.05	<0.053
November	<0.003	<0.003	<0.003	0.06	<0.05	<0.05
December	0.009	<0.003	<0.004	<0.05	<0.05	<0.05
Annual	0.009	<0.003	<0.0033	0.26	<0.05	<0.1883
	Arsenic			*Thallium*		
September	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
October	0.005	<0.005	<0.005	<0.01	<0.01	<0.01
November	0.007	<0.005	<0.005	0.01	0.01	0.01
December	0.007	<0.005	<0.006	<0.01	<0.01	<0.01
Annual	0.007	<0.005	<0.0053	0.01	<0.01	<0.01
	Uranium			*Phenols*		
September	0.960	0.698	0.893	0.040	0.008	0.024
October	1.40	0.04	0.53	0.004	0.001	0.002
November	0.16	0.05	0.10	0.004	<0.001	<0.002
December	0.043	0.027	0.037	<0.001	<0.001	<0.001
Annual	1.40	0.027	0.390	0.040	<0.001	<0.0075

[a]ORGDP.

Table 5.3.49. 1986 NPDES Permit Number TN 0002950
Discharge Point 003[a]–Part 5

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Cyanide			*TTO*			*Ethylbenzene*		
September	0.10	<0.002	<0.05	0.414	0.080	0.247	<0.005	<0.005	<0.005
October	0.003	<0.002	<0.002	0.386	0.060	0.177	<0.005	<0.005	<0.005
November	0.007	<0.002	<0.005	0.202	0.005	0.103	<0.005	<0.005	<0.005
December	0.006	<0.002	<0.005	0.105	0.055	0.082	<0.010	<0.010	<0.010
	PCB			*Trans-1,2-dichloroethane*			*Boron*		
September	<0.001	<0.001	<0.001	0.029	<0.005	<0.013	0.15	0.15	0.15
October	<0.001	<0.001	<0.001	0.018	0.009	0.012	0.120	0.84	0.106
November	<0.001	<0.001	<0.001	0.019	<0.005	<0.016	0.16	0.09	0.12
December	<0.001	<0.001	<0.001	0.014	<0.010	<0.010	0.16	0.07	0.11
	Chloroform			*Toluene*			*Acetone*		
September	0.008	<0.005	<0.007	0.008	<0.005	<0.005	1.2	<0.005	<0.35
October	0.008	0.005	0.006	<0.005	<0.005	<0.005	<0.180	0.006	0.031
November	0.010	<0.005	<0.008	<0.029	<0.005	<0.009	<0.010	<0.010	<0.010
December	0.007	<0.005	<0.005	<0.012	<0.005	<0.005	<0.227	<0.010	<0.037
	Trichloroethene[b]			*Tetrachloroethene*			*pH*		
September	0.056	<0.010	0.026	0.007	<0.005	<0.006	8.5	6.5	NA
October	0.045	0.018	0.028	0.020	<0.005	<0.008	8.4	6.3	NA
November	0.056	<0.005	<0.036	0.120	<0.005	<0.050	8.8	6.8	NA
December	0.045	<0.010	<0.029	0.043	0.006	0.017	9.0	6.2	NA
	1,1,2,2-tetrachloroethane								
September	0.006	<0.005	<0.005						
October	<0.005	<0.005	<0.005						
November	<0.005	<0.005	<0.005						
December	<0.010	<0.010	<0.010						

[a]ORGDP.
[b]Detection levels for several parameters varied in 1986.

Table 5.3.50. 1986 NPDES Permit Number TN 0002950 Discharge Point 003[a] (November)

Parameter	Concentration ($\mu g/L$)		
	Max	Min	Av
Trichlorofluoromethane	6	1	3
Acrolein	<100	<100	<100
Acrylonitrile	<100	<100	<100
Phenol	<10	<10	<10
bis(2-chloroethyl)ether	<10	<10	<10
2-chlorophenol	<10	<10	<10
1,3-dichlorobenzene	<10	<10	<10
1,4-dichlorobenzene	<10	<10	<10
1,2-dichlorobenzene	<10	<10	<10
bis(2-chloroisopropyl)ether	<10	<10	<10
N-nitroso-di-n-propylamine	<10	<10	<10
Hexachloroethane	<10	<10	<10
Nitrobenzene	<10	<10	<10
Isophorone	<10	<10	<10
2-nitrophenol	<10	<10	<10
2,4-dimethylphenol	<10	<10	<10
bis(2-chloroethoxy)methane	<10	<10	<10
2,4-dichlorophenol	<10	<10	<10
1,1,4-trichlorobenzene	<10	<10	<10
Naphthalene	<10	<10	<10
Hexachlorobutadiene	<10	<10	<10
4-chloro-3-methylphenol	<10	<10	<10
Hexachlorocyclopentadiene	<10	<10	<10
2,4,6-trichlorophenol	<10	<10	<10
2-chloronaphthalene	<10	<10	<10
Dimethylphthalate	<10	<10	<10
Acenaphthylene	<10	<10	<10
Benzidine	<80	<80	<80
1,2-diphenylhydrazine	<50	<50	<50
Acenaphthene	<10	<10	<10
2,4-dinitrophenol	<50	<50	<50
4-nitrophenol	<50	<50	<50
2,4-dinitrotoluene	<10	<10	<10
2,6-dinitrotoluene	<10	<10	<10
Diethylphthalate	<10	<10	<10
4-chlorophenylphenylether	<10	<10	<10
Fluorene	<10	<10	<10
4,6-dinitro-2-methylphenol	<50	<50	<50
N-nitrosodiphenylamine (1)	<10	<10	<10
4-bromophenylphenylether	<10	<10	<10
Hexachlorobenzene	<10	<10	<10
Pentachlorophenol	<50	<50	<50
Phenanthrene	<10	<10	<10
Anthracene	<10	<10	<10
Di-n-butylphthalate	<10	<10	<10
Fluoranthene	<10	<10	<10
Pyrene	<10	<10	<10
Butylbenzylphthalate	<10	<10	<10
3,3′-dichlorobenzidine	<20	<20	<20

Table 5.3.50 (continued)

Parameter	Concentration (μg/L)		
	Max	Min	Av
Benzo(a)anthracene	<10	<10	<10
bis(2-ethylhexyl)phthalate	<10	<10	<10
Chrysene	<10	<10	<10
Di-n-octylphthalate	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10
Indeno(1,2,3-cd)pyrene	<10	<10	<10
Dibenz(a,h)anthracene	<10	<10	<10
Benzo(g,h,i)perylene	<10	<10	<10
N-nitrosodiamethylamine	<10	<10	<10

[a]ORGDP.

Table 5.3.51. 1986 NPDES Permit Number TN 0002950 Discharge Point 003[a] (December)

Parameter	Concentration (μg/L)		
	Max	Min	Av
Trichlorofluoromethane	1	2.3	4
Acrolein	<100	<100	<100
Acrylonitrile	<100	<100	<100
Phenol	<10	<10	<10
bis(2-chloroethyl)ether	<10	<10	<10
2-chlorophenol	<10	<10	<10
1,3-dichlorobenzene	<10	<10	<10
1,4-dichlorobenzene	<10	<10	<10
1,2-dichlorobenzene	<10	<10	<10
bis(2-chloroisopropyl)ether	<10	<10	<10
N-nitroso-di-n-propylamine	<10	<10	<10
Hexachloroethane	<10	<10	<10
Nitrobenzene	<10	<10	<10
Isophorone	<10	<10	<10
2-nitrophenol	<10	<10	<10
2,4-dimethylphenol	<10	<10	<10
bis(2-chloroethoxy)methane	<10	<10	<10
2,4-dichlorophenol	<10	<10	<10
1,1,4-trichlorobenzene	<10	<10	<10
Naphthalene	<10	<10	<10
Hexachlorobutadiene	<10	<10	<10
4-chloro-3-methylphenol	<10	<10	<10
Hexachlorocyclopentadiene	<10	<10	<10
2,4,6-trichlorophenol	<10	<10	<10
2-chloronaphthalene	<10	<10	<10
Dimethylphthalate	<10	<10	<10
Acenaphthylene	<10	<10	<10
Benzidine	<80	<80	<80
1,2-diphenylhydrazine	<50	<50	<50
Acenaphthene	<10	<10	<10
2,4-dinitrophenol	<50	<50	<50
4-nitrophenol	<50	<50	<50
2,4-dinitrotoluene	<10	<10	<10
2,6-dinitrotoluene	<10	<10	<10
Diethylphthalate	<10	<10	<10
4-chlorophenylphenylether	<10	<10	<10
Fluorene	<10	<10	<10
4,6-dinitro-2-methylphenol	<50	<50	<50
N-nitrosodiphenylamine (1)	<10	<10	<10
4-bromophenylphenylether	<10	<10	<10
Hexachlorobenzene	<10	<10	<10
Pentachlorophenol	<50	<50	<50
Phenanthrene	<10	<10	<10
Anthracene	<10	<10	<10
Di-n-butylphthalate	<10	<10	<10
Fluoranthene	<10	<10	<10
Pyrene	<10	<10	<10
Butylbenzylphthalate	<10	<10	<10
3,3′-dichlorobenzidine	<20	<20	<20

Table 5.3.51 (continued)

Parameter	Concentration (μg/L)		
	Max	Min	Av
Benzo(a)anthracene	<10	<10	<10
bis(2-ethylhexyl)phthalate	510	<10	176
Chrysene	<10	<10	<10
Di-n-octylphthalate	<10	<10	<10
Benzo(b)fluoranthene	<10	<10	<10
Benzo(k)fluoranthene	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10
Indeno(1,2,3-cd)pyrene	<10	<10	<10
Dibenz(a,h)anthracene	<10	<10	<10
Benzo(g,h,i)perylene	<10	<10	<10
N-nitrosodiamethylamine	<10	<10	<10

[a]ORGDP.

Table 5.3.52. 1986 NPDES Permit Number TN 0002950
Discharge Point 005[a]–Part 1

Month	Concentration (mg/L) Max	Min	Av	Concentration (mg/L) Max	Min	Av
	Ammonia (N)			BOD_5		
January	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0
February	<0.2	<0.2	<0.2	8.0	<5.0	<5.3
March	1.1	<0.2	<0.3	<5.0	<5.0	<5.0
April	<0.2	<0.2	<0.2	17.0	<5.0	<6.1
May	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0
June	<0.2	<0.2	<0.2	8.0	<5.0	<5.3
July	0.2	<0.2	<0.2	<5.0	<5.0	<5.0
August	<0.2	<0.2	<0.2	6.0	<5.0	<5.3
September	<0.2	<0.2	<0.2	6.0	5.0	5.1
October	5.0	<0.2	<1.2	<5.0	<5.0	<5.0
November	1.1	<0.2	<0.5	<5.0	<5.0	<5.0
December	0.3	<0.2	<0.2	<5	<5	<5
	Fecal coliform bacteria (colonies/100 mL)			*Total suspended solids*		
January	200	4	87	94	4	19
February	>500	0	>221	47	9	15
March	2	0	1	43	7	19
April	3	0	1	34	6	18
May	5	0	1	35	1	14
June	18	0	4	18	3	8
July	6	0	0	42	3	11
August	2	0	1	16	6	11
September	6	0	2	28	1	11
October	7	0	2	30	1	11
November	2	1	1	17	4	10
December	>500	0	>59	29	4	15
	Beryllium			*Cadmium*		
January	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
February	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
March	<0.001	<0.001	<0.001	0.005	<0.002	<0.003
April	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
May	<0.001	<0.001	<0.001	0.003	<0.002	<0.002
June	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
July	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
August	<0.001	<0.001	<0.001	0.005	<0.002	<0.003
September	<0.001	<0.001	<0.001	0.006	<0.002	<0.003
October	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
November	<0.001	<0.001	<0.001	<0.002	<0.002	<0.002
December	<0.001	<0.001	<0.001	0.002	<0.002	<0.002

[a]ORGDP.

Table 5.3.53. 1986 National Pollution Discharge Elimination System (NPDES) Permit Number TN 0002950 Discharge Point 005[a]-Part 2

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
		Mercury			*Selenium*			*pH (units)*	
January	<0.0002	<0.0002	<0.0002	<0.005	<0.005	<0.005	8.2	7.7	NA
February	<0.0002	<0.0002	<0.0002	<0.05	<0.005	<0.005	8.1	7.4	NA
March	<0.0002	<0.0002	<0.0002	<0.005	<0.005	<0.005	8.2	7.1	NA
April	0.001	<0.0002	<0.0002	<0.005	<0.005	<0.005	8.9	6.8	NA
May	0.0006	<0.0002	<0.0003	<0.005	<0.005	<0.005	8.5	7.2	NA
June	0.0004	<0.0002	<0.0003	<0.005	<0.005	<0.005	8.8	7.2	NA
July	0.0002	<0.0002	<0.0002	0.005	<0.005	<0.005	9.0	7.2	NA
August	0.0004	<0.0002	<0.0002	<0.005	<0.005	<0.005	8.5	6.8	NA
September	<0.0002	<0.0002	<0.0002	<0.005	<0.005	<0.005	7.8	7.2	NA
October	<0.0002	<0.0002	<0.0002	<0.005	<0.005	<0.005	8.4	7.9	NA
November	0.0003	<0.0002	<0.0002	<0.005	<0.005	<0.005	7.5	6.7	NA
December	0.0006	0.0002	0.0004	<0.005	<0.005	<0.005	7.5	7.0	NA
		Silver			*Lead*			*Halomethanes*	
January	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004			
February	<0.01	<0.01	<0.01	<0.050	<0.004	<0.016			
March	<0.01	<0.01	<0.01	0.014	<0.004	<0.008	0.011	0.011	0.011
April	<0.01	<0.01	<0.01	0.010	0.008	0.009			
May	<0.01	<0.01	<0.01	0.028	<0.004	<0.012	<0.01	<0.01	<0.01
June	<0.01	<0.01	<0.01	0.011	0.004	0.007			
July	<0.01	<0.01	<0.01	0.010	0.004	0.007			
August	0.01	<0.01	<0.01	0.009	<0.004	<0.007	<0.01	<0.01	<0.01
September	<0.01	<0.01	<0.01	0.009	<0.004	<0.005			
October	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004			
November	<0.011	<0.01	<0.01	0.007	0.004	0.006	0.007	0.009	0.011
December	0.017	<0.01	<0.011	0.009	<0.004	<0.007			
		Zinc			*Perchloroethylene*				
January	0.30	0.03	0.11	<0.005	<0.005	<0.005			
February	0.05	0.03	0.04	<0.005	<0.005	<0.005			
March	0.07	<0.02	<0.04	0.007	<0.005	<0.005			
April	0.04	0.02	0.03	<0.005	<0.005	<0.005			
May	0.07	0.02	0.04	<0.005	<0.005	<0.005			
June	0.04	<0.02	<0.03	<0.005	<0.005	<0.005			
July	0.03	0.02	0.03	<0.005	<0.005	<0.005			
August	0.06	0.03	0.04	<0.005	<0.005	<0.005			
September	0.04	0.03	0.03	<0.005	<0.005	<0.005			
October	0.066	<0.02	<0.035	<0.005	<0.005	<0.005			
November	0.038	0.021	0.033	<0.005	<0.005	<0.005			
December	0.07	0.03	0.05	<0.005	<0.005	<0.005			

[a]ORGDP.

Table 5.3.54. 1986 NPDES Permit Number TN 0002950 Discharge Point 005[a]-Part 3

Month	Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av
		Trichloroethane			*Methylene chloride*	
January	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
February	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
March	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
April	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
May	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
June	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
July	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
August	<0.005	<0.005	<0.005	0.014	<0.005	<0.007
September	<0.005	<0.005	<0.005	0.005	<0.005	<0.003
October	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
November	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
December	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
		Trichloroethylene			*Residual chlorine*	
January	<0.005	<0.005	<0.005	0.22	0.17	0.20
February	<0.005	<0.005	<0.005	0.20	0.04	0.17
March	<0.005	<0.005	<0.005	0.13	0.02	0.07
April	<0.005	<0.005	<0.005	0.1	0.04	0.06
May	<0.005	<0.005	<0.005	0.11	0.04	0.07
June	<0.005	<0.005	<0.005	0.09	0.05	0.07
July	<0.005	<0.005	<0.005	0.09	0.06	0.07
August	<0.005	<0.005	<0.005	0.12	0.07	0.08
September	<0.005	<0.005	<0.005	0.08	0.06	0.07
October	<0.005	<0.005	<0.005	0.11	0.03	0.07
November	<0.005	<0.005	<0.005	0.07	0.03	0.04
December	<0.005	<0.005	<0.005	0.12	0.03	0.05
		Settleable solids			*Dissolved oxygen*	
January	<0.1	<0.1	<0.1	10.3	9.6	10.0
February	<0.1	<0.1	<0.1	11.0	9.8	10.4
March	0.5	0.1	0.1	11.4	9.3	10.6
April	<0.1	<0.1	<0.1	9.6	8.8	9.4
May	<0.1	<0.1	<0.1	8.9	8.2	8.5
June	0.3	<0.1	<0.1	8.8	7.8	8.2
July	0.3	0.1	0.1	8.4	6.5	7.8
August	<0.1	<0.1	<0.1	8.2	7.8	7.9
September	<0.1	<0.1	<0.1	8.8	7.9	8.3
October	<0.1	<0.1	<0.1	9.1	8.1	8.8
November	<0.1	<0.1	<0.1	9.7	8.8	9.2
December	1.0	<0.1	0.12	10.8	8.9	10.1

[a]ORGDP.

Table 5.3.55. 1986 NPDES Permit Number TN 0002950 Discharge Point 006[a]

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
		COD			*Total chromium*			*Oil and grease*	
January	17	<5	<11	0.02	0.01	0.01	12	<2	<3
February	34	<5	<12	0.02	<0.01	<0.01	12	<2	<5
March	14	<5	<8	<0.01	<0.01	<0.01	15	<2	<7
April	24	<5	<9	<0.01	<0.01	<0.01	7	<2	<3
May	17	<5	<10	<0.01	<0.01	<0.01	6	2	3
June	24	<5	<13	0.01	<0.01	<0.01	5	<2	<3
July	31	10	20	<0.01	<0.01	<0.01	2	<2	<2
August	27	<5	<18	<0.01	<0.01	<0.01	4	<2	<3
September	27	<5	<13	<0.01	<0.01	<0.01	3	<2	<2
October	44	5	13	0.014	<0.01	0.012	<2	<2	<2
November	27	<5	<14	<0.01	<0.01	<0.01	3	<2	<2
December	54	5	19	0.013	<0.01	0.01	3	<2	<2
		Fluoride			*Total suspended solids*			*Dissolved oxygen*	
January	0.15	<0.10	<0.11	12	<1	<5	15.8	13.8	14.7
February	<0.10	<0.10	<0.10	11	<1	<6.1	15.8	10.2	12.7
March	0.16	<0.10	<0.12	17	6	11	15.2	10.8	11.9
April	0.12	<0.10	<0.11	17	1	8	12.4	9.0	10.8
May	0.13	<0.10	<0.11	13	1	6	10.2	9.2	8.5
June	0.21	0.11	0.15	16	1	10	9.2	7.2	8.5
July	0.13	<0.10	<0.11	42	6	15	9.0	6.0	7.8
August	0.12	<0.10	<0.11	18	9	12	9.1	5.1	7.5
September	0.18	<0.10	<0.12	23	7	13	9.8	7.9	8.7
October	<0.1	<0.1	<0.1	27	9	18	9.8	6.9	8.8
November	<0.1	<0.1	<0.1	21	<1	<12	10.8	8.4	9.4
December	<0.1	<0.1	<0.1	22	5	12	14.8	9.6	11.4
		pH (units)							
January	9.50	7.97	NA[b]						
February	9.32	7.09	NA						
March	9.91	7.33	NA						
April	9.3	7.3	NA						
May	9.0	7.0	NA						
June	8.8	6.6	NA						
July	9.0	6.3	NA						
August	8.9	6.9	NA						
September	8.9	7.0	NA						
October	9.4	7.2	NA						
November	9.1	6.5	NA						
December	9.6	6.1	NA						

[a]ORGDP.
[b]NA = not applicable.

Table 5.3.56. 1986 NPDES Permit Number 0002950 Discharge Point 007[a]

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
	COD			*Total chromium*			*Oil and grease*		
January	13	<5	<7	0.03	0.01	0.02	2	0	1
February	10	<5	<6	0.03	<0.01	0.021	3	<2	<2
March	12	<5	<7	<0.01	<0.01	<0.01	12	<1	<5
April	27	<5	11	0.03	<0.01	0.02	5	<2	3
May	20	<5	<12	<0.086	<0.01	<0.03	2	1	2
June	19	<5	<13	0.04	<0.01	<0.02	<2	<2	<2
July	41	14	27	0.07	<0.01	0.02	3	1	2
August	31	17	22	0.08	0.01	0.04	2	<2	<2
September	20	<5	<12	0.03	0.02	0.02	4	<2	<3
October	44	<5	<17	0.038	0.022	0.030	<2	<2	<2
November	17	<5	<11	0.024	<0.01	<0.017	<2	<2	<2
December	57	<5	<18	0.044	<0.01	<0.018	2	<2	<2
	Fluoride			*Total suspended solids*			*Turbidity (NTU)*		
January	0.10	<0.10	0.10	17	1	7	4	2	3
February	<0.10	<0.10	<0.10	13	<1	5	34	3	13
March	0.13	<0.10	0.12	26	3	10	39	3	12
April	0.12	<0.10	0.10	24	6	13	22	3	14
May	0.26	<0.10	0.17	47	<1	<14	38	7	16
June	0.31	0.24	0.29	35	5	18	25	4	17
July	0.36	<0.10	0.23	48	4	20	116	11	29
August	0.23	0.15	0.18	37	20	29	54	17	40
September	0.20	0.10	0.14	44	15	29	52	22	34
October	0.13	0.10	0.12	32	25	28	41	23	31
November	<0.1	<0.1	<0.1	29	2	19	30	5	20
December	0.11	<0.1	<0.1	24	2	10	15	3	8
	Dissolved oxygen			*pH (units)*					
January	14.5	13.6	14.2	9.5	8.4	NA[b]			
February	14.4	6.1	9.8	9.0	6.7	NA			
March	13.8	9.9	12.0	9.1	7.6	NA			
April	10.5	8.9	9.6	9.2	7.9	NA			
May	14.0	7.1	9.1	8.9	6.8	NA			
June	8.6	5.8	7.1	8.7	6.8	NA			
July	8.0	6.0	6.9	8.9	6.8	NA			
August	7.1	5.1	5.9	9.0	7.9	NA			
September	9.3	5.5	7.8	8.9	7.6	NA			
October	8.7	5.8	7.4	8.9	7.4	NA			
November	10.4	7.8	8.7	9.6	7.7	NA			
December	12.6	7.8	10.1	8.5	7.4	NA			

[a]ORGDP.
[b]NA = not applicable.

Table 5.3.57. 1986 NPDES Permit Number 0002950
Discharge Point 009[a]

Month	Concentration (mg/L)			Concentration (mg/L)			Concentration (mg/L)		
	Max	Min	Av	Max	Min	Av	Max	Min	Av
	Total suspended solids			*Aluminum*			*Sulfate*		
January	7	1	3	0.38	0.11	0.22	29	26	27
February	8	<1	<4	0.55	0.27	0.42	26	10	19
March	9	1	4	0.61	0.29	0.40	22	19	21
April	13	1	8	0.55	0.30	0.42	24	21	23
May	8	<2	<4	0.47	0.28	0.38	26	22	24
June	6	<2	<4	0.39	0.14	0.26	29	27	28
July	13	5	9	0.39	0.10	0.27	30	28	29
August	9	6	7	0.67	0.47	0.55	28	25	26
September	11	5	7	0.41	0.12	0.25	28	24	26
October	13	4	9	0.42	0.21	0.28	26	22	24
November	14	6	10	0.45	0.17	0.30	26	20	23
December	5	<1	<3	0.7	0.2	0.4	21	10	18
	COD			*pH (units)*					
January	7	<5	<6	7.7	7.1	NA[b]			
February	7	<5	<6	7.3	6.6	NA			
March	5	5	5	7.8	6.9	NA			
April	5	<5	<5	8.0	7.4	NA			
May	14	<5	<7	7.7	7.2	NA			
June	24	<5	<15	8.1	7.9	NA			
July	17	10	14	7.8	7.4	NA			
August	20	14	7	8.1	8.7	NA			
September	7	5	6	8.1	7.3	NA			
October	17	<5	<8	8	7.2	NA			
November	7	<5	<6	8	7.4	NA			
December	37	<5	<12	7.9	7.0	NA			

[a]ORGDP.
[b]NA = not applicable.

6. GROUNDWATER

6.1 GROUNDWATER USE

The major portion of industrial and drinking water supply in the Oak Ridge area is taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by public water supply systems. As in most of East Tennessee, groundwater on the ORR and in areas adjacent to the ORR occurs primarily in fractures in the rocks. Other than those adjacent to the City of Oak Ridge, most of the residential wells in the immediate area are south of the Clinch River. The characteristics of some domestic wells and springs in areas adjacent to the City of Oak Ridge and the ORR are given in Table 6.1.1. Wells shown are those for which the Tennessee Department of Water Resources keeps logs of location, elevation, and depth. Additional wells exist within the region, but they either have not been reported to the state or were incompletely reported. More than 100 water supply wells and springs are located within 16 km of the ORR. Studies indicate that the incised meander of the river in bedrock represents a major topographic feature that prevents any groundwater flow from passing beneath the river (Boyle, 1982).

Several industrial groundwater supplies exist within about 32 km of the ORR (McMaster, 1967), as indicated by the data in Table 6.1.2. Three of these supplies are about 15 km south-southeast of the ORR, the nearest at Charles H. Bacon company in Lenoir City, Tennessee. An estimated average of 320 m^3 is obtained daily from this supply (Exxon Nuclear Company, 1976), which is located about 15 km south-southeast of the ORR. A daily average of about 38 m^3 is obtained from the well supplying the Lenoir City Car Works, which is about 15 km south of the ORR, as well as the one supplying the Ralph Rogers Company, which is approximately 15 km northeast of the ORR. Other industrial groundwater supplies are farther from the ORR.

Seventeen public groundwater supplies are located within a 35-km radius of the ORR. Their sources, and distances from the ORR are given in Table 6.1.3. Of these sources, the closest to the ORR is the Allen Fine Spring, which supplies the Dixie-Lee Utility District in Loudon County. This groundwater source located about 11 km southeast of the ORR, serves approximately 6700 people with an average of about 1500 m^3/d. The well that serves Edgewood Center in Roane County is about 12 km southwest of the ORR, and the spring that supplies the Cumberland Utility District of Roane and Morgan counties is approximately 13 km west of the ORR.

The possibility of connections between off-site and on-site aquifers groundwater sources are being investigated by the U.S. Geological Survey (USGS). Because of the stratigraphic and structural control of groundwater flow in the region, groundwater beneath the ORR is expected to migrate along strike and discharge to surface water bodies, rather than migrating from the ORR to off-site wells.

The importance of the Knox Group as a regional aquifer is apparent from its wide use among the public and industry. The mean Knox spring and well yields estimated from water use figures included in Tables 6.1.1 and 6.1.2 are about 0.017 m^3/s. Reliable estimates of the mean yield to domestic wells in the Knox Group are not available. Yields are expected to vary widely depending on the size and extent of cavity systems encountered by individual wells. Water from the Chickamauga Group is also used by Energy Systems installations on the ORR.

Table 6.1.1. Characteristics of some domestic wells and springs near the City of Oak Ridge and south of the Clinch River in the vicinity of the ORR

County	Distance to nearest post office (km)	Topographic position	Altitude (m)	Depth (m)	Geological material	Yield (m^3/s)
Anderson	Oak Ridge[a]					
	4.8 N	Valley	259	S[b]	Shale	0.00063
	2.4 NW	Valley	258	31	Shale	U[c]
	3.2 NE	Slope	308	92	Dolomite	U
	2.4 E	Slope	250	62	Limestone	U
	5.6 NE	Slope	259	16	Shale	U
	6.4 E	Slope	259	16	Shale	U
	2.4 W	Valley	249	6	Shale	U
Knox	Byington					
	6.4 W	Slope	259	19	Shale	U
	6.4 W	Valley	262	S	Dolomite	0.028
	8.0 W	Slope	256	20	Dolomite	0.00038
	8.0 W	Valley	235	S	Dolomite	0.032
	11.3 W	Valley	236	S	Dolomite	0.019
	Martel					
	9.7 N	Slope	274	56	Dolomite	U
	Oak Ridge[a]					
	8.0 SW	Valley	256	18	Shale	U
Loudon	Martel					
	8.9 NW	Ridge	233	19	Dolomite	0.00013
	Lenoir City					
	10.5 NW	Slope	294	31	Dolomite	U
Roane	Lenoir City					
	14.5 NW	Valley	236	7	Shale	U
	12.9 NW	Hilltop	348	79	Dolomite	U
	12.1 NW	Slope	247	20	Shale	U
	10.5 NW	Slope	282	24	Dolomite	U
	10.5 NW	Slope	252	4	Dolomite	U
	9.7 NW	Valley	267	S	Dolomite	0.063
	Kingston					
	11.3 E	Slope	235	13	Shale	U
	11.3 E	Valley	261	6	Shale	U

[a]Jackson Square.
[b]S = spring.
[c]U = unknown.

Table 6.1.2. Industrial groundwater supplies within about 32 km of the ORR

Industrial water user	Yield (m^3/s)	Source	Probable water-bearing formation	Distance from ORR (km)
Charles H. Bacon Co. (Lenoir City)	0.0037	Well	Knox	14.5 SSE
Lenoir City Car Works	0.00044	Well	Chickamauga	15.0 S
Ralph Rogers Co.	0.00044	Well	Conasauga	15.1 NE
Charles H. Bacon Co. (Loudon)	0.015	Spring[a]	Knox	20.4 S
Envirodyne Industry, Inc. (Loudon)	0.14	Spring[b]	Chickamauga	21.2 S
John J. Craig Co.	0.00057	Well Spring	Knox	24.9 SSE
Tennessee Forging Steel	0.001	Well Pond	Knox	30.6 W
Morgan Apparel Co.		Well	Knox	30.7 NW
Stone and Webster		Well	Conasauga	0.016 NW
TVA		Well	Knox	0.016 WNW

[a]Primary source.
[b]Secondary source.

Table 6.1.3. Public groundwater supplies within about 35 km of the ORR[a]

Public water user	People served	Yield (m^3/s)	Source	Probable water-bearing formation	Distance from ORR (km)
Oliver Springs	4,000	0.013	Spring	Knox	16.9 NNE
Dutch Valley Elementary School	140	0.00012	Well	Rome	22.5 NNE
First Utility District of Anderson County	3,600	0.012	Spring	Conasauga	21.4 NE
West Knox Utility District	15,000	0.057	Well[b]	Knox	22.5 E
Dixie-Lee Utility District	6,700[c]	0.018	Spring	Knox	10.9 SE
Piney Utility District	2,000	0.003	Spring	Knox	23.2 S
Loudon	5,200	0.025	Spring[d]	Knox	23.5 SSW
Philadelphia	300	0.00026	Well	Knox	28.2 SSW
Edgewood Center	100	0.00017	Well	Knox	12.2 SW
Paint Rock Elementary School	250	0.00022	Well	Rome	26.9 SW
Midway High School	500	0.00057	Spring	Chickamauga	27.0 SW
Kingston	5,000	0.014	Spring[e]	Conasauga	18.8 WSW
Rockwood	10,000	0.062	Spring[e]	Knox	34.6 WSW
Cumberland Utility District of Rome and Morgan Cos.	4,300	0.0078	Spring[e]	Knox	12.9 W
Midtown	2,500	0.0047	Well	Rome	26.4 W
Brushy Mountain State Honor Farm	200	0.0000088	Well		27.7 NW
Plateau Utility District	2,300	0.0090	Well		28.2 NW

[a]*Source*: J. W. Boyle et al., *Environmental Analysis of the Operation of Oak Ridge National Laboratory (X-10 Site)*, ORNL-5870, Oak Ridge, Tenn., 1982.
[b]Secondary source.
[c]Includes Martel Utility District.
[d]Half supply.
[e]Primary source.

6.2 GROUNDWATER MONITORING

Groundwater monitoring data required by EPA (EPA, 1974, 1976, and 1984) and the State of Tennessee (TN, 1982) fall into three categories: (1) parameters for safe drinking water standards (As, Ba, Cd, Cr, F, Pb, Hg, NO_3, Se, Ag, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP silvex, Ra, gross alpha, gross beta, ^{60}Co, ^{137}Cs, and fecal coliform); (2) water quality parameters (Cl, Fe, Mn, phenols, Na, and SO_4); and (3) groundwater contamination indicators (pH, specific conductance, total organic carbon, and total organic halides).

The Oak Ridge Task Force (ORTF, 1985) is attempting, with the USGS, to determine whether a significant potential exists for off-site groundwater contamination from the ORR. The deep geologic flow structure is such that the preferred orientation of groundwater flow is likely to be in a northeasterly or southwesterly direction (along strike). The Clinch River and other streams and valleys are discharge areas for water in the ORR burial grounds and are believed to be barriers to deep groundwater flow as well. If the deepest water crosses these divides, it should have a long flow path and a slow rate, which would reduce the likelihood of radionuclides being present.

EPA regulations in 40 CFR Pt. 265, Subpart F, require that owners/operators of hazardous waste facilities monitor groundwater beneath their facilities. Additional monitoring is required by Interim Status Regulations (40 CFR Pt. 264) and during Sect. 3004 (u) (EPA, 1984) and CERCLA (EPA, 1980) investigations.

6.2.1. Oak Ridge Y-12 Plant Monitoring

Each waste disposal facility operated by the Oak Ridge Y-12 Plant has a network of groundwater monitoring wells that consists of at least one well hydraulically upgradient and three downgradient from the facility. Water samples are collected from these wells and analyzed each quarter. Analytical results are compared with EPA (EPA, 1976) and TDHE (TN, 1980) constituents. Several Oak Ridge Y-12 Plant wells installed before 1986 are used for characterization studies and monitoring. In addition four coreholes, 11 soil borings, and 55 groundwater wells were installed during the period August 15 through December 20, 1985: at the Beta-4 Security Pit, the Chestnut Ridge Security Pits, Kerr Hollow Quarry, New Hope Pond, the 9712 Ravine Disposal Site, Rogers Quarry, the Sludge Disposal Basin, the United Nuclear Site, a site on Chestnut Ridge south of the Oak Ridge Y-12 Plant Burial Grounds, and a site on Pine Ridge north of the Oak Ridge Y-12 Plant Burial Grounds. Investigations and drilling at the latter two sites were conducted in cooperation with the USGS (Haase, Gillis, and King, 1987). Well numbers, plant coordinates, elevations, and total depths are given in Table 6.2.1. Figure 6.2.1 is the location map for groundwater well groupings around and within Oak Ridge Y-12 Plant.

The purposes of this program are compliance monitoring at the currently permitted sites and characterization studies at sites that have been used in the past.

The principal consideration in siting boreholes was to locate them so that maximum geological and hydrological data could be obtained from each well. Borehole locations were based on site topography, available geologic and hydrologic data, and knowledge gained from previous investigations at geohydrologically similar sites. At each site major features of subsurface geology were identified and core holes and groundwater investigation wells were installed to study hydrogeologic significance of such features. Wells were designed to provide data on subsurface geology, hydrostatic heads, and water quality for shallow-flow regimes in soils and upper weathered-bedrock zones and for deeper-flow regimes in unweathered bedrock.

Groundwater investigation wells finished in unconsolidated materials or in the uppermost weathered portions of bedrock were installed using sand filter packs and spiral-wound screens. Well-screen and casing material was either stainless steel or polyvinyl chloride (PVC), depending on anticipated groundwater chemistry

Table 6.2.1. Borehole location summary[a]

Well No.	N (m)[b]	E (m)[b]	Elevation (m)[b]	T.D. (m)[b]
		Beta-4 Security Pit		
GW-191	9,381.7	16,544.2	307.0	18.4
GW-192	9,379.3	16,543.6	306.6	5.3
GW-194	9,321.7	16,525.6	302.5	3.8
GW-195	9,318.7	16,486.3	304.9	7.0
GW-196	9,396.7	16,430.5	315.3	8.2
GW-197	9,367.7	16,485.7	305.3	5.2
		Chestnut Ridge Security Pits		
GW-173	8,617.0	18,127.1	339.2	50.3
GW-174	8,596.9	18,048.7	339.6	44.2
GW-176	8,624.0	17,815.6	342.0	44.2
GW-177	8,681.6	17,525.1	352.2	44.2
GW-179	8,693.5	17,851.8	342.7	35.7
		Kerr Hollow Quarry		
CH-143	7,392.6	19,358.5	277.6	182.9
GW-142	7,474.9	19,516.3	295.1	90.0
GW-143	7,393.5	19,361.5	277.7	77.1
GW-144	7,392.9	19,355.4	277.5	59.4
GW-145	7,449.6	19,283.5	255.2	33.5
GW-146	7,446.9	19,285.3	255.1	67.1
GW-147	7,538.0	19,332.9	258.6	21.0
GW-231	7,536.2	19,327.4	258.1	10.7
		New Hope Pond		
GW-148	8,900.8	19,451.4	275.7	3.4
GW-149	8,900.5	19,453.6	275.8	15.4
GW-150	8,826.7	19,574.9	278.2	3.6
GW-151	8,826.4	19,577.9	278.3	29.4
GW-152	8,721.5	19,421.2	279.9	5.3
GW-153	8,721.2	19,424.3	280.9	18.3
GW-154	8,835.2	19,307.9	276.9	3.4
GW-220	8,823.7	19,575.8	278.2	13.8
GW-222	8,825.2	19,301.2	277.0	7.6
GW-223	8,820.3	19,297.2	277.1	27.6
GW-240	8,718.5	19,423.7	280.3	9.0
		Ravine Disposal Site		
GW-198	9,282.7	19,039.6	293.1	8.1
GW-199	9,230.3	19,039.0	292.0	6.9
GW-200	9,257.7	18,868.9	294.5	17.5
GW-201	9,259.2	18,871.4	294.4	6.4
GW-202	9,326.0	18,893.6	293.9	6.1
		Rogers Quarry		
CH-185	7,129.3	17,344.6	252.6	256.6
CH-189	7,349.6	17,308.7	267.4	232.6
GW-184	7,289.3	17,518.7	281.8	39.6
GW-185	7,129.9	17,350.4	252.9	143.7
GW-186	7,128.7	17,331.5	252.5	52.1
GW-187	7,130.2	17,062.7	253.5	49.4
GW-188	7,212.5	17,121.8	254.3	20.7
GW-199	7,129.0	17,338.9	252.5	64.0
GW-224	7,129.9	17,056.3	253.7	38.4

Table 6.2.1 (continued)

Well No.	N (m)[b]	E (m)[b]	Elevation (m)[b]	T.D. (m)[b]
		Sludge Disposal Basin		
CH-157	8,365.8	19,528.2	314.5	164.6
GW-155	8,449.7	19,608.7	322.7	53.9
GW-156	8,420.4	19,513.3	319.1	48.0
GW-157	8,375.0	19,474.3	318.5	44.2
GW-158	8,250.6	19,398.4	299.1	134.4
GW-159	8,462.5	19,353.6	319.7	47.9
GW-241	8,250.6	19,403.3	298.9	31.4
		United Nuclear Site		
GW-203	8,642.9	16,517.1	336.1	47.5
GW-205	8,645.3	16,461.6	335.8	50.0
GW-221	8,643.8	16,577.5	336.4	48.2
		USGS-1N/Y-12 Burial Grounds		
GW-162	9,549.7	13,558.4	315.9	38.1
GW-163	9,550.6	13,557.8	316.1	68.6
GW-164	9,548.8	13,554.5	315.9	123.4
		USGS-1S/Chestnut Ridge		
GW-165	8,475.6	13,577.9	332.4	99.1
GW-166	8,484.1	13,573.0	332.8	117.3

[a]*Source:* C. S. Haase, G. A. Gillis, and H. L. King, 1987. *Fiscal Year 1985 Groundwater Investigation Drilling Program at the Y-12 Plant, Oak Ridge, Tennessee*, ORNL/TM-9999, Oak Ridge, Tenn.

[b]N and E are Y-12 Plant coordinates. Elevation is for ground surface measured with respect to mean sea level. Total depth (T.D.) is with respect to ground surface.

at a particular site. A schematic diagram of a typical screened well is illustrated in Fig. 6.2.2 (Haase, Gillis, and King, 1987).

Rotary-drilled, open groundwater investigation wells range from 61 to 122 m deep. These wells were installed to investigate hydrologic behavior of unweathered bedrock that was sufficiently competent so that installation of a screen was not required. A schematic diagram of a typical open groundwater investigation well is shown in Fig. 6.2.3 (Haase, Gillis, and King, 1987).

Summaries of the geological formations, fractures, and cavities penetrated by a particular well are presented in Tables 6.2.2 and 6.2.3. Monitoring of each of the major disposal sites is detailed below.

Chestnut Ridge Security Pits. The Chestnut Ridge Security Pits are located on the crest of

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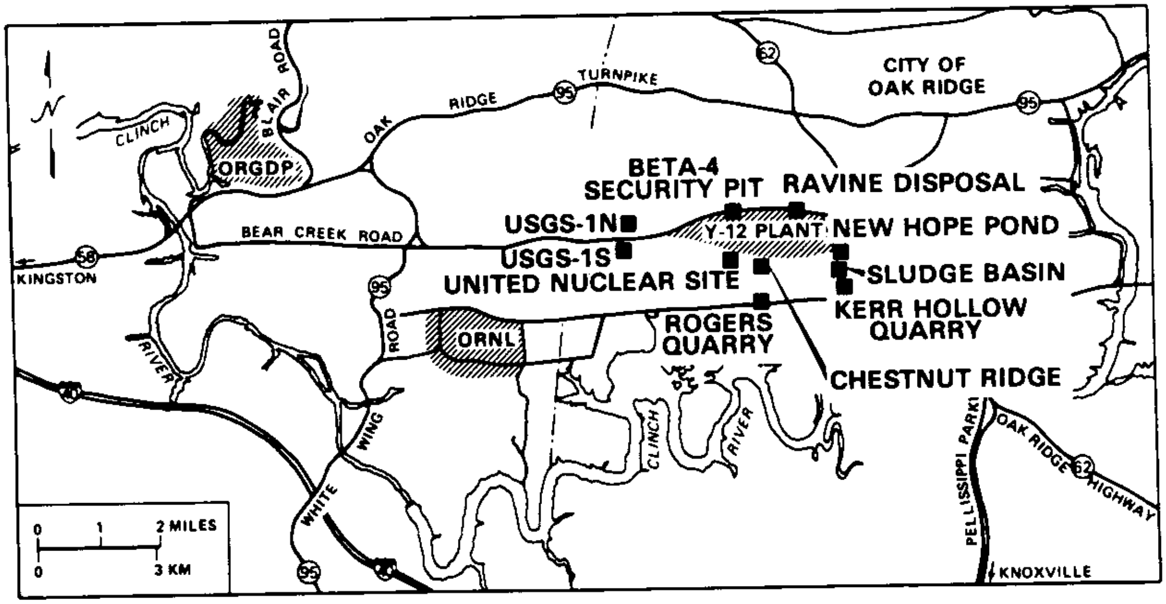

Fig. 6.2.1. Index map of Oak Ridge Y-12 Plant groundwater investigation program.

Chestnut Ridge immediately south of the central portion of the Oak Ridge Y-12 Plant complex (Fig. 6.2.1). Disposal of classified materials at the site is conducted in trenches and auger holes. Details of disposal operations and general inventories of materials disposed of are summarized elsewhere (Production Optimization Department, Oak Ridge Y-12 Plant, 1984).

The security pits are located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. The soil and residuum contain abundant chert and rubble-rich horizons that occur at the top of bedrock and are dispersed irregularly throughout the soil column. Depth to bedrock at the site varies from 15 to 27 m (Haase, Gillis, and King, 1987).

Available information on site hydrology is summarized by Geraghty and Miller (1985b). Hydrology of the Knox Group is not well understood. Groundwater flow directions in the shallow subsurface (61 m) have not been determined but are thought to be controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the security pits. The location of the groundwater divide would influence whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley. Work elsewhere along Chestnut Ridge by Ketelle and Huff (1984) indicates that joints, fractures, and solutional features developed within the upper bedrock can exert substantial local influence on groundwater flow directions. Analysis of joint and fracture patterns suggests that preferred groundwater flow directions within the upper bedrock are parallel and perpendicular to the ridge crest (Law Engineering, 1983b).

Initial plans for monitoring well installation at the Chestnut Ridge Security Pits site were developed by Geraghty and Miller (1985b). These wells were intended to monitor groundwater occurring at the top of water table, which typically corresponds to the soil/bedrock interface. Because of the complexity of the site hydrology, original well installation plans were modified to address the hydrologic issues. Locations of the five groundwater investigation wells completed at this site are shown in Fig. 6.2.4.

Of the twelve borings made at this location, five (SB-173, SB-174, SB-176, SB-177, and SB-179) are auger/split-spoon soil borings obtained

ORNL-DWG 87-8232

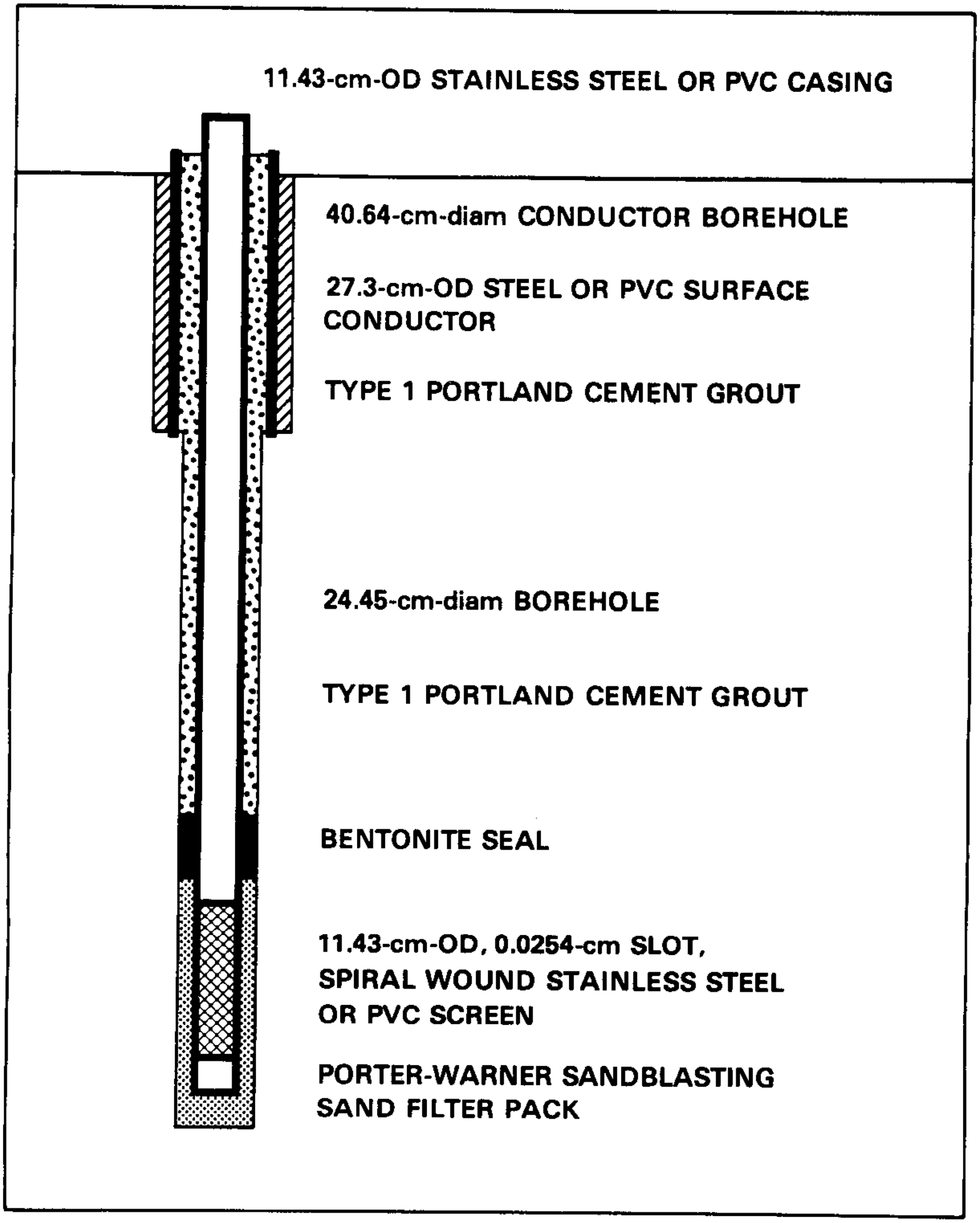

Fig. 6.2.2. Screened groundwater well.

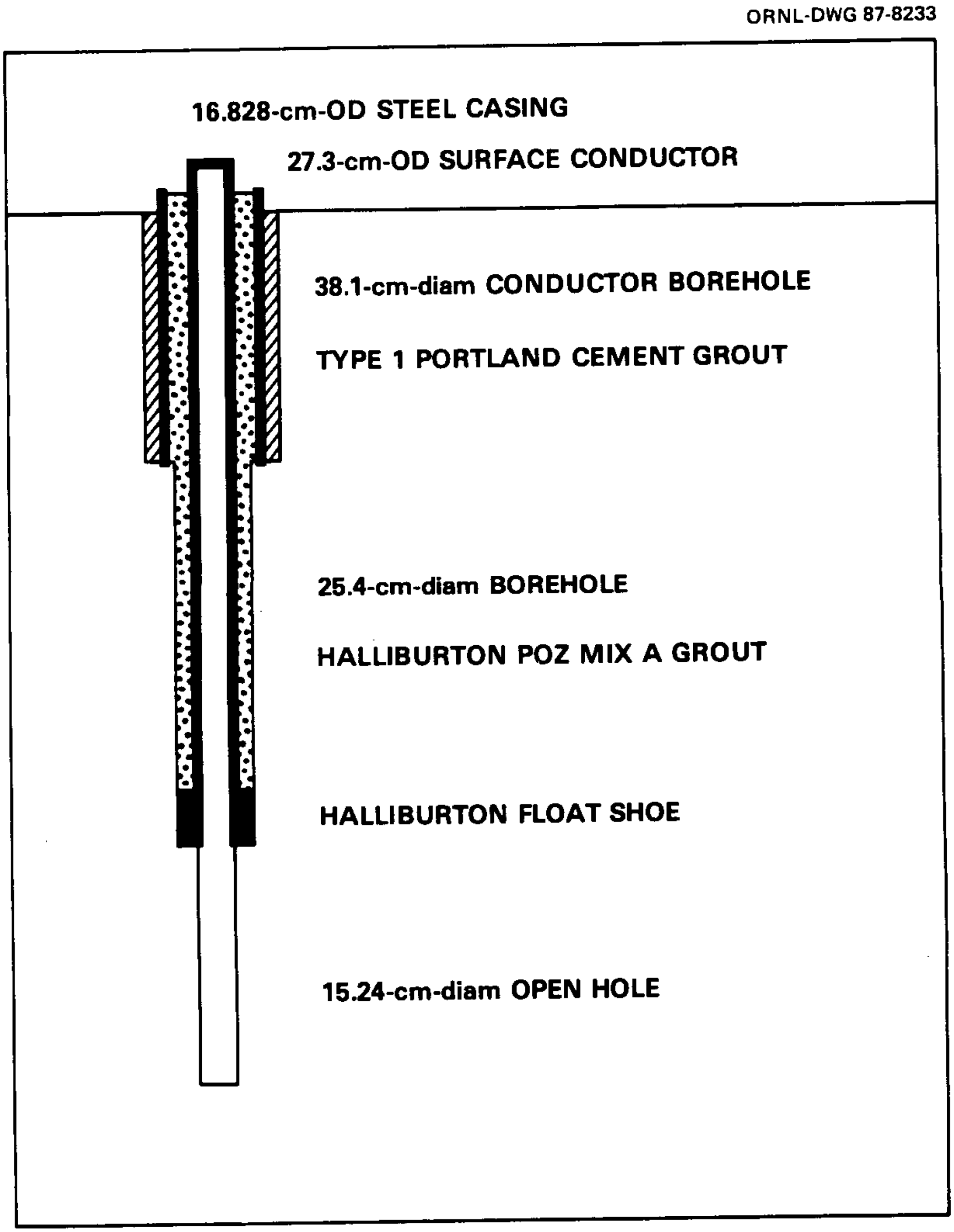

Fig. 6.2.3. Open groundwater well.

Table 6.2.2. Borehole geology summary[a]

Well number	Rock formations(s) and downhole footages[b]
CH-143	CHICK: A 0-177/KNOX 177 TD
CH-157	KNOX
CH-185	CHICK: E 0-123/D 123-183/C 183-379/B 379-680/A 680 TD
CH-189	CHICK: B 0-268/A 268-578/KNOX 578 TD
GW-142	CHICK: A 0-220/KNOX 220 TD
GW-143	CHICK: A 0-177/KNOX 177 TD
GW-144	CHICK: A 0-177/KNOX 177 TD
GW-145	KNOX
GW-146	KNOX
GW-147	KNOX
GW-148	CON: Maynardville
GW-149	CON: Maynardville
GW-150	CON: Maynardville
GW-151	CON: Maynardville
GW-152	CON: Maynardville
GW-153	CON: Maynardville
GW-154	CON: Maynardville
GW-155	KNOX
GW-156	KNOX
GW-157	KNOX
GW-158	KNOX
GW-159	KNOX
GW-162	CON: Pumpkin Valley
GW-163	CON: Pumpkin Valley 0-204/ROME 204 TD
GW-164	CON: Pumpkin Valley 0-197/ROME 197 TD
GW-165	KNOX
GW-166	KNOX
GW-173	KNOX
GW-174	KNOX
GW-176	KNOX
GW-177	KNOX
GW-179	KNOX
GW-184	CHICK: C
GW-185	CHICK: B
GW-186	CHICK: C
GW-187	CHICK: E
GW-188	CHICK: D
GW-189	CHICK: C
GW-191	CON: Maryville
GW-192	CON: Maryville
GW-194	CON: Maryville
GW-195	CON: Maryville
GW-196	CON: Maryville
GW-197	CON: Maryville
GW-198	CON: Rutledge
GW-199	CON: Rogersville
GW-200	CON: Rogersville
GW-201	CON: Rogersville
GW-202	CON: Rutledge
GW-203	KNOX
GW-205	KNOX
GW-220	CON: Maynardville
GW-221	KNOX
GW-222	CON: Maynardville
GW-223	CON: Maynardville
GW-224	CHICK: E
GW-231	KNOX

Table 6.2.2 (continued)

Well number	Rock formations(s) and downhole footages[b]
GW-240	CON: Maynardville
GW-241	KNOX

[a]*Source*: C. S. Haase, G. A. Gillis, and H. L. King, 1987. *Fiscal Year 1985 Groundwater Investigation Drilling Program at the Y-12 Plant, Oak Ridge, Tennessee*, ORNL/TM-9999, Oak Ridge, Tenn.

[b]A, B, C, D, and E—units of the Chickamauga Group as defined by Stockdale (1951); CHICK—Chickamauga Group; CON—Conasauga Group; KNOX—Knox Group; ROME—Rome Formation; TD—total depth.

to provide samples of unconsolidated material for chemical analysis. These borings are not illustrated in Fig. 6.2.4 but are immediately adjacent to groundwater investigation wells with the same designation. Additional soil borings (SB-178 and SB-180) not associated with groundwater investigation wells, and located immediately adjacent to the northwest and northeast corners of the disposal area are illustrated in Fig. 6.2.4. All soil borings at the Chestnut Ridge Security Pits site are nominally 18.3 m deep and were augered to refusal. In all cases, the soil borings bottomed in zones of chert gravel dispersed within the soil and did not reach to the top of bedrock (as determined by subsequent drilling of groundwater observation wells). Split-spoon samples were taken during the augering at 1.5-m intervals for chemical study (Haase, Gillis, and King, 1987).

Wells GW-173, GW-174, GW-176, GW-177, and GW-179 are screened and finished in the top of bedrock. During the installation of the surface conductor for these wells, zones of cavity formation and solutional alteration were encountered within 3 to 7.6 m of the top of bedrock. The vertical extent of such cavities ranged from 0.3 to 5 m. In all cases, the surface conductor was advanced 0.3 to 1.5 m past the bottom of the first significant cavity encountered below the top of bedrock. Such practice prevents potential intercavity migration of surface waters.

Wells GW-177 and GW-173 were installed to the west and to the east of the active and proposed burial areas to monitor possible migration along strike of material from the disposal area, with GW-177 occupying the highest topographic location and thus serving as an upgradient well. Wells GW-176 and GW-174, in conjunction with existing well 1080, were placed south of the active site to monitor potential movement of material away from the site perpendicular to strike. Well GW-179, installed north of the active disposal area, monitors potential movement of material perpendicular to strike northward. Analysis and comparison of hydrologic data from these wells should permit identification of the groundwater divide and resolution of its significance to groundwater flow behavior at the site, (Haase, Gillis, and King, 1987).

The 1986 concentrations of parameters at Chestnut Ridge Security Pits are given in Tables 6.2.4 through 6.2.8.

Kerr Hollow Quarry. Kerr Hollow Quarry, located on a low ridge running along the north side of Bethel Valley (Fig. 6.2.1), was active in the 1940s and was abandoned sometime in the late 1940s. Since the early 1950s, the quarry has been used for the disposal of reactive materials from the Oak Ridge Y-12 Plant and from ORNL. Generalized details of the material disposed of and disposal operations conducted at the quarry were presented by Geraghty and Miller (1985d).

Kerr Hollow Quarry is at the contact between the Newala Formation of the Knox Dolomite and Unit A of the Chickamauga Group (Stockdale, 1951).

The contact is a nonconformity that exhibits approximately 15 to 30 m of topographic relief.

Table 6.2.3. Summary of major fractures and solution cavities encountered during drilling operations[a]

Well Number	Fracture or solution cavity, depth, and approximate water yield[b]
GW-144	Frac @ 170 (W, 20-30 gpm[c])
GW-147	Frac @ 10-12.5(w), 19(w), 20-21(w), 24-25, 32.5-33(M), 46.5 to 47.5(W), 59.5 to 60.5
GW-149	Water @ 4.0 / (W) @ 25-28
GW-151	Frac @ 26(w)
GW-153	Frac @ 29-30
GW-154	Water @ 5.0
GW-155	Frac @ 130-136, 165-177(mW)
GW-156	Cav @ 92-93, 101-103, 106-112 / Frac @ 150
GW-157	Water @ 74 / Frac @ 114-116.5, 140(w)
GW-158	Frac @ 98(foam), 180(W, sul), 220-230, 250-260(mW, >25 gpm)
GW-159	Cav @ 112-117 / Water @ 130
GW-162	Water @ 118
GW-164	Frac @ 150(w), 197(w), 280, 392(w)
GW-165	Cav @ 103-113, 314-317(mW, >100 gpm) / Frac @ 92-96, 100-102
GW-166	Frac @ 287-290, 320-323, 358-363(W, >300 gpm)
GW-173	Frac @ 103.6 / Cav @ 108.9, 140-141
GW-174	Frac @ 143 / Cav @ 63-79.6, 91, 140
GW-177	Cav @ 68-73, 96-97.5 / Frac @ 130-133
GW-179	Cav @ 53-73 / Frac @ 112
GW-184	Frac @ 115(w), 126-130(w)
GW-185	Frac @ 73(W, 20-30 gpm), 170(w), 366(W, gas)
GW-186	Frac @ 25(w), 164-169(W)
GW-187	Frac @ 92(w), 115-121(w), 134-135(W, >25 gpm), 159-160(W, >25 gpm)
GW-188	Cav(mW) @ 27-29 / Frac @ 47-48, 55-58.5, 60-68. Lost circulation @ 60-68
GW-189	Frac @ 44(w), 143-145(W), 164-165(W), 170(W), 200(W)
GW-198	Water @ 22
GW-199	Water @ 18
GW-200	Frac @ 52(w)
GW-201	Water @ 21
GW-202	Water @ 17
GW-220	Water @ 11.0
GW-221	Frac @ 36-80, 153
GW-222	Fractured zone-cavity @ 19.0
GW-223	Cav(M) @ 57-59 / Frac @ 17-18, 27.5-29, 34-34.5, 36-36.5, 37-37.5, 38-39, 66-67, 68.5-69.5
GW-224	Frac @ 115-120(W, sul)
GW-231	Frac @ 15-16.5, 17-17.5(w), 19-20.5(w), 23-24, 25-27, 28-29
GW-240	Frac @ 29 to 30
GW-241	Cav @ 78-89 / Frac @ 89-94.6

[a]*Source*: C. S. Haase, G. A. Gillis, aand H. L. King, 1987. *Fiscal Year 1985 Groundwater Investigation Drilling Program at the Y-12 Plant, Oak Ridge, Tennessee*, ORNL/TM-9999, Oak Ridge, Tenn.

[b]Cav—cavity; Frac—fracture or fracture interval; Water—depth at which the water table was encountered, not necessarily associated with a fracture or cavity; (M)—mud, or thick extremely muddy water; (mW)—muddy water; (sul)—sulfurous smell to water; (w)—small flow of water <5 gpm; (W)—large flow of water, >5 gpm. Yields cited are based on drillers, estimates of surface discharge during drilling.

[c]1 gpm = 3.7 L/min.

The uppermost Knox Group at this site consists of medium-bedded to massive dolostone with locally abundant nodular to bedded chert throughout. The basal portion of the Chickamauga Group consists of abundant thin- to medium-bedded maroon and gray siltstones, thin-bedded limestones, and less-abundant-to-rare nodular-to-bedded chert. A schematic cross section of the quarry site is presented in Fig. 6.2.5. As with other strata in the Oak Ridge

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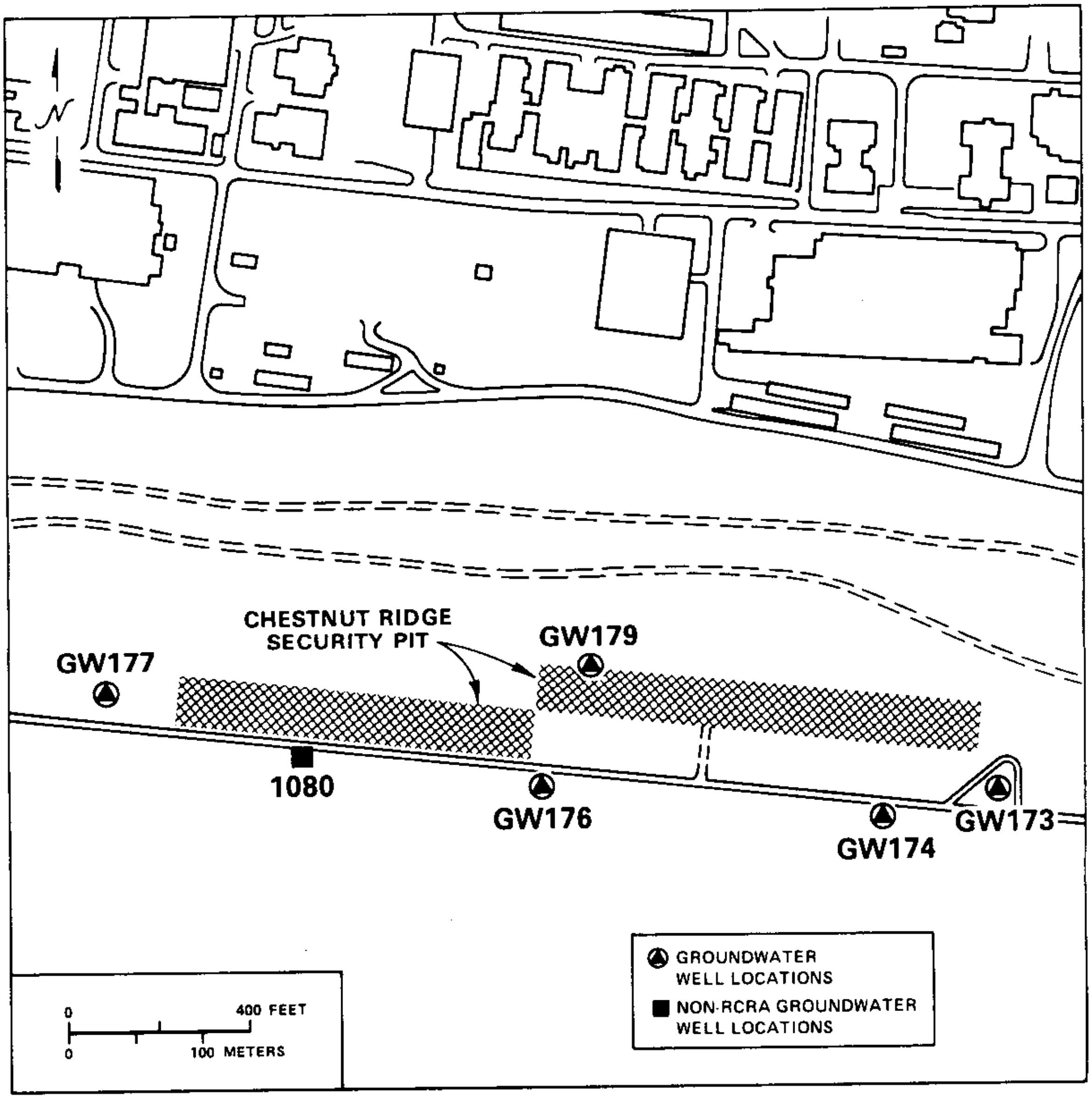

Fig. 6.2.4. Locations of groundwater wells around Chestnut Ridge Security Pit.

vicinity, both the upper Knox Group and the basal Chickamauga Group are pervasively jointed, with predominant joint directions parallel and perpendicular to geological strike, which is approximately parallel to the ridge crests (Haase, Gillis and King, 1987). In the vicinity of Kerr Hollow Quarry, an additional joint set that trends approximately north-south is also noted (Law Engineering, 1983b).

Porosity and density geophysical logs from the site suggest that most of the strata are "tight," with low porosity (0 to 5%) and, by inference, low permeability. Examination of drill cores demonstrates, however, that significant major fractures and fractured intervals occur throughout the bedrock to depths of 183 m. Such fractured zones generally correspond to pronounced anomalies on the single point

Table 6.2.4. 1986 concentrations of parameters in downgradient well GW-173[a] at Chestnut Ridge Security Pits

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/4/86)	2nd Qtr. (4/15/86)	3rd Qtr. (7/29/86)	4th Qtr. (10/20/86)
Drinking water				
Arsenic	0.006	<0.005	<0.005	<0.005
Barium	0.021	0.017	0.0069	0.0074
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.032	<0.01	0.013	<0.01
Lead	0.073	0.016	0.011	0.019
Mercury	0.0004	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.18	<0.1	0.2	0.1
Nitrate nitrogen	3.4	1.11	1.06	1.0
Endrin	<0.00005	<0.0001	<0.0001	<0.0001
Lindane	<0.00001	<0.00002	<0.00002	<0.00002
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00008
Toxaphene	<0.001	<0.002	<0.002	<0.002
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	73	<1	2	<2
Gross beta (pCi/L)	135	2.93	4	<2
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	<1	2.2	3.1	3.7
Iron	43	1.3	4.7	7.5
Manganese	0.13	0.015	0.031	0.033
Phenols	0.003	0.002	0.007	0.006
Sodium	2.4	1.4	1.6	1.6
Sulfate	9.3	5.7	5.9	7.6
Indicators				
pH (units)	7.8	7.7	7.8	8.3
	7.7	7.7	7.8	8.2
	7.7	7.7	7.8	8.2
	7.1	7.9	7.8	8.2
Specific conductance (μmhos/cm)	316	332	386	377
	326	333	384	375
	325	334	385	374
Total organic carbon	13	49	58	56
	12	50	57	57
	15	49	55	55
	14	49	47	59
Total organic halogen	0.024	0.007	0.083	<0.010
	0.026	0.01	0.119	<0.010
	0.024	0.012	0.086	<0.010
	0.026	<0.010	0.111	<0.010

[a]See Fig. 6.2.4.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.5. 1986 concentrations of parameters in downgradient well GW-174[a] at Chestnut Ridge Security Pits

Parameter	Concentration (mg/L)			
	1st Qtr. (2/4/86)	2nd Qtr. b	3rd Qtr. c	4th Qtr. d
Drinking water				
Arsenic	0.021			
Barium	0.14			
Cadmium	<0.003			
Chromium	0.074			
Lead	0.065			
Mercury	<0.0002			
Selenium	<0.005			
Silver	<0.006			
Fluoride	0.14			
Nitrate nitrogen	0.16			
Endrin	<0.00005			
Lindane	<0.00001			
Methoxychlor	<0.00004			
Toxaphene	<0.001			
2,4-D	<0.001			
Silvex	<0.0001			
Radium (pCi/L)	10.8			
Gross alpha (pCi/L)	51			
Gross beta (pCi/L)	108			
Total coliform (Ct/100 mL)	NF[e]			
Groundwater quality				
Chloride	<1			
Iron	110			
Manganese	0.42			
Phenols	0.01			
Sodium	10			
Sulfate	9.8			
Indicators				
pH (units)	7.9			
	7.8			
	7.9			
	7.8			
Specific conductance (μmhos/cm)	320			
	325			
	320			
	334			
Total organic carbon	35			
	37			
	38			
	38			
Total organic halogen	0.009			
	0.008			
	0.009			
	0.011			

[a]See Fig. 6.2.4.
[b]Well did not recover sufficiently after purging and could not be sampled.
[c]Pump stuck in well. No sample could be obtained.
[d]Well was dry; no sample could be obtained.
[e]NF = not found.

Table 6.2.6. 1986 concentrations of parameters in downgradient well GW-176[a] at Chestnut Ridge Security Pits

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/4/86)	2nd Qtr. (4/14/86)	3rd Qtr. (7/29/86)	4th Qtr. (10/15/86)
Drinking water				
Arsenic	0.108	<0.005	<0.005	<0.005
Barium	0.11	0.013	0.011	0.012
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.036	<0.01	<0.01	0.013
Lead	0.219	0.013	0.006	0.005
Mercury	0.0006	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.1	<0.1	0.1	<0.1
Nitrate nitrogen	0.27	0.41	0.43	1.7
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	6.48	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	76	14.05	2	<3
Gross beta (pCi/L)	83	22.52	3	5
Total coliform (Ct/100 mL)	NF[c]	NF	NF	1
Groundwater quality				
Chloride	<1	1.7	1.5	1.8
Iron	97	1.6	1.2	0.064
Manganese	2.7	0.074	0.055	0.0049
Phenols	0.004	<0.001	0.005	0.016
Sodium	0.65	0.5	0.62	0.75
Sulfate	1	<1	1.3	<1
Indicators				
pH (units)	7.1	7.6	7.2	6.9
	7.1	7.2	7.2	6.9
	7.1	7.2	7.2	6.9
	7.3	7.6	7.2	6.9
Specific conductance (μmhos/cm)	464	415	480	376
	458	415	482	374
	456	414	482	376
	457	413	479	375
Total organic carbon	62	72	55	83
	57	71	43	85
	58	72	46	87
	59	71	41	87
Total organic halogen	0.031	0.027	0.14	<0.010
	0.03	0.015	0.12	<0.010
	0.029	0.019	0.11	<0.010
	0.03	0.018	0.14	<0.010

[a]See Fig. 6.2.4.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.7. 1986 concentrations of parameters in upgradient well GW-177[a] at Chestnut Ridge Security Pits

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/4/86)	2nd Qtr. (4/17/86)	3rd Qtr. (7/29/86)	4th Qtr. (10/13/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.0062	0.0056	0.037	0.012
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	0.034	0.013
Lead	0.031	0.039	0.016	0.014
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.15	0.2	0.2	<0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	0.16
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	2.37	1.6	4	2
Gross beta (pCi/L)	18.5	8.29	8	4
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	1.8	8.4	6.4	3.0
Iron	4.9	7.5	4.3	0.19
Manganese	0.15	0.16	0.098	0.033
Phenols	0.013	0.008	0.011	0.003
Sodium	3.4	4.2	5.9	1.3
Sulfate	24	24	24	10.2
Indicators				
pH (units)	7.5	7.4	7.8	7.6
	7.4	7.5	7.8	7.6
	7.4	7.5	7.8	7.6
	7.4	7.5	7.8	7.8
Specific conductance (μmhos/cm)	446	402	479	420
	478	425	478	424
	474	429	479	422
	486	427	478	423
Total organic carbon	52	59	47	68
	54	59	49	68
	57	60	43	70
	57	59	47	68
Total organic halogen	0.51	0.006	0.038	<0.010
	0.48	0.195	0.04	<0.010
	0.53	0.166	0.041	0.016
	0.51	0.248	0.042	<0.010

[a]See Fig. 6.2.4.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.8. 1986 concentrations of parameters in downgradient well GW-179[a] at Chestnut Ridge Security Pits

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/10/86)	2nd Qtr. (4/23/86)	3rd Qtr. (8/05/86)	4th Qtr. (10/20/86)
Drinking water				
Arsenic	0.013	<0.005	<0.005	<0.005
Barium	0.011	0.02	0.016	0.019
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.22	<0.01	0.012	<0.01
Lead	0.069	0.022	0.007	0.015
Mercury	0.003	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.09	0.1	0.1	<0.1
Nitrate nitrogen	<0.11	<0.11	0.14	<0.11
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00005
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	4.05	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	6.8	<3	4	<2
Gross beta (pCi/L)	216	<7	4	<2
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	1.4	1.8	1.4	1.5
Iron	38	0.52	1.1	1.1
Manganese	0.99	0.042	0.072	0.047
Phenols	0.003	0.002	0.004	0.005
Sodium	1.3	1.3	1.7	1.5
Sulfate	12	17	11	9.8
Indicators				
pH (units)	7.7	8	7.9	8.0
	7.7	8	7.9	7.9
	7.8	8	7.9	7.9
	7.8	7.9	7.8	8.1
Specific conductance (μmhos/cm)	380	476	452	492
	393	492	463	427
	433	492	464	491
	330	491	460	492
Total organic carbon	95	71	85	73
	120	74	86	72
	80	72	89	100
	158	73	87	99
Total organic halogen	0.131	0.07	0.16	<0.010
	0.121	0.069	0.17	<0.010
	0.126	0.069	0.18	<0.010
	0.129	0.069	0.18	0.015

[a]See Fig. 6.2.4.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

ORNL-DWG 87-8240

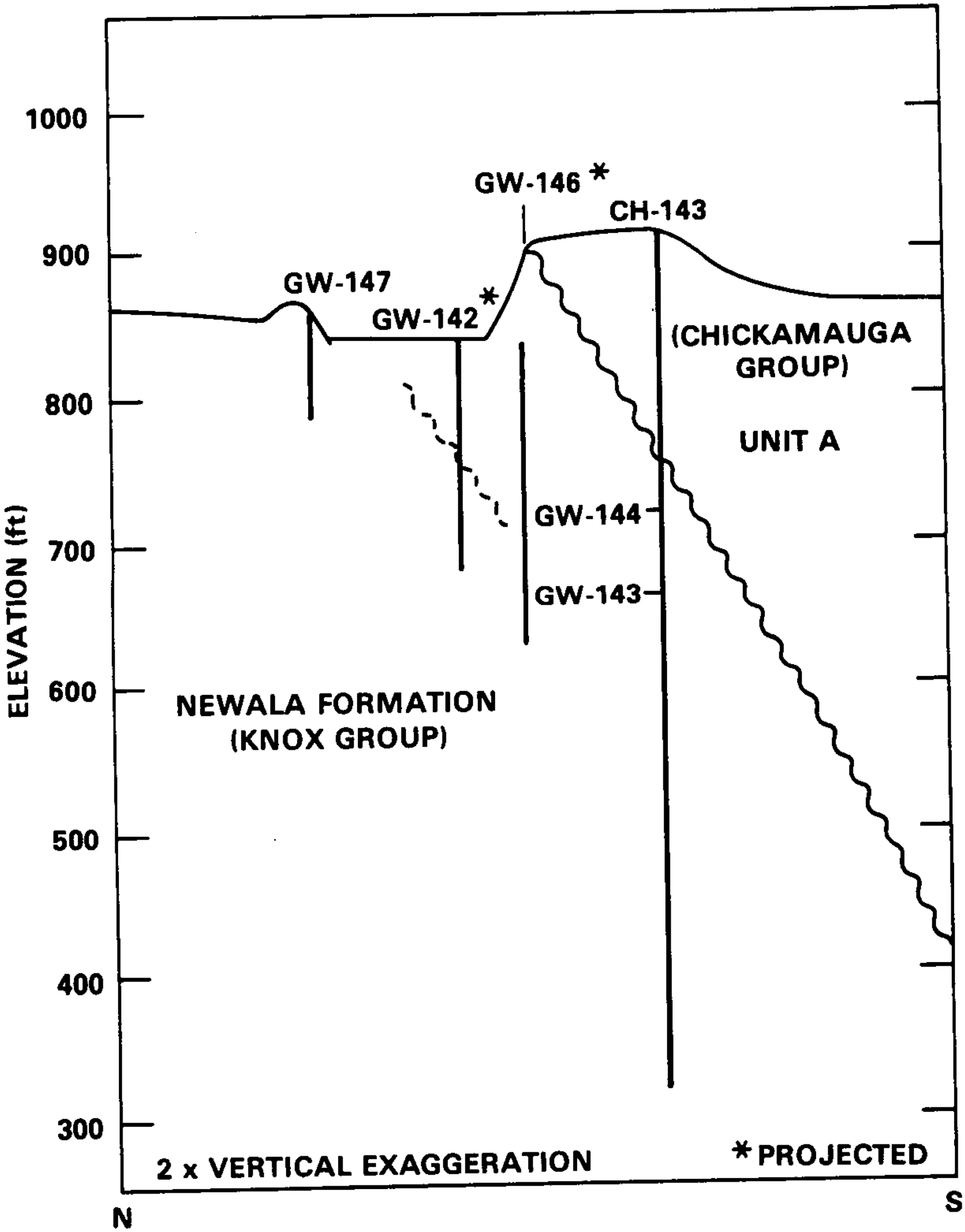

Fig. 6.2.5. Schematic cross section of Kerr Hollow Quarry.

resistance and spontaneous potential geophysical logs. Taken together, the drill core and geophysical log data suggest that there are thin (0.3–0.9-m), relatively permeable, water-bearing zones associated with most fractured zones occurring throughout the bedrock (Haase and King, in press). It is probable, therefore, that groundwater movement within the bedrock is based on fractures and fracture systems rather than being restricted within stratigraphic units. To understand the hydrologic behavior in the vicinity of the quarry it is necessary to understand the spacing, density, and orientations of fracture systems.

Plans for monitoring well installations at Kerr Hollow Quarry, presented by Geraghty and Miller (1985d), were modified to allow more complete characterization of subsurface geohydrologic conditions and to intercept hydrologic targets identified during initial core-drilling. Locations of the eight borings are shown in Fig 6.2.6.

ORNL-DWG 87-7631

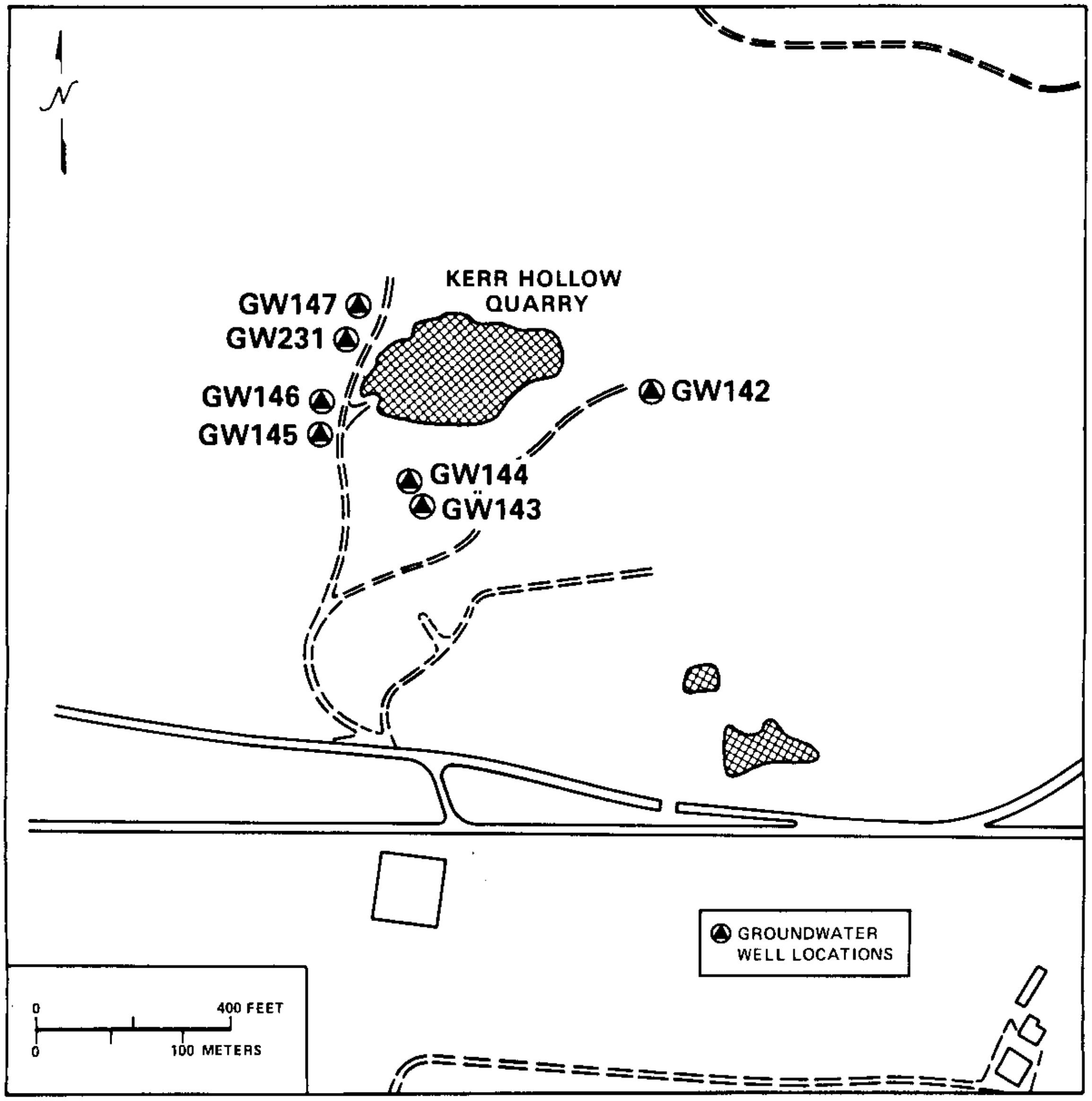

Fig. 6.2.6. Locations of groundwater wells around Kerr Hollow Quarry.

Boring CH-143 is a 183-m-deep core hole that was collared in the lower portion of Unit A of the Chickamauga Group. The core hole, which penetrates the contact with the Newala Dolomite of the Knox Group and continues approximately 122 m into the Newala, provides a detailed map of the stratigraphy and structural character of the strata surrounding Kerr Hollow Quarry. Those data were used to select target depths for the other groundwater observation wells at the site (Fig 6.2.5). Because of the hydrologic importance of fractures and fractured zones, much of the drilling was aimed at such features. Because of their spacing and frequency, however, wells in this initial stage of investigation were finished to study several closely spaced fractures or groups of fractured zones. Depending on the results of chemical analyses and hydrologic data, additional wells, finished to specific fractures, may be required (Haase, Gillis, and King, 1987).

Well GW-142, an open well with the highest topographic elevation, was installed as a potential upgradient, background well completed in unweathered bedrock. During the drilling of GW-142, only trace quantities of water were encountered in the bedrock down to depths of 61 m. Casing was installed to a depth of 76 m, after several water-bearing fractured intervals had been encountered. Subsequent drilling of the open hole portion of the well below 76 m indicates that the strata remain relatively tight and contain only small quantities of water also associated with fractured zones (Haase, Gillis, and King, 1987).

Wells GW-143 and GW-144 form a piezometer cluster designed to investigate possible hydrostatic head differences between the uppermost Knox Group and lowermost Chickamauga Group. Both wells are finished in bedrock. These wells also intersect the downdip projection of all strata that crop out in the quarry and serve to monitor potential downdip migration of material out of the quarry. Both wells intersect several apparent bedding-plane-parallel fracture systems that occur within the stratigraphic interval of interest (Haase, Gillis, and King, 1987).

Wells GW-145 and GW-146 and wells GW-147 and GW-231 form two piezometer clusters along the western edge of the quarry. These wells are designed to investigate potential head differences between various stratigraphic units cropping out within the quarry and to monitor for potential strike-parallel movement of material out of the quarry. Well GW-146 is an open well finished in unweathered bedrock. Wells GW-145, GW-147, and GW-231 are screened wells finished in unweathered bedrock. The 1986 concentrations of parameters at Kerr Hollow Quarry are given in Tables 6.2.9 through 6.2.14.

New Hope Pond. New Hope Pond, located on the east end of the Oak Ridge Y-12 Plant (Fig. 6.2.1), is a man-made impoundment on East Fork Poplar Creek that serves as a settling basin for creek waters before they are discharged into the natural channel and flow off Oak Ridge Y-12 Plant property.

New Hope Pond is located on soils and residuum developed on the Maynardville Limestone of the Conasauga Group. The trace of the contact between the Maynardville Limestone and the underlying Nolichucky Shale roughly coincides with the Oak Ridge Y-12 Plant access road (Second Street) that passes immediately north of the pond. Depth to bedrock ranges from 3 to 4.6 m throughout the site. As is typical of the Conasauga Group, joints and fractures may have significant influence on groundwater flow directions. Principal joint directions at the New Hope Pond site are parallel and perpendicular to geological strike, and it is anticipated that those orientations would be preferred groundwater flow directions. At other sites, approximately 610 to 1219 m east of New Hope Pond, the Maynardville Limestone has been demonstrated to exhibit solution cavities and other solutional alteration features (Rothschild et al., 1984a). Such features can profoundly influence groundwater movement, although the impact of such features cannot be predicted as easily as that of regionally systematic joints and fractures. Although several fracture zones within the Maynardville Limestone were encountered during drilling at this site, only one significant solution cavity was encountered in well GW-153 (Haase, Gillis, and King, 1987).

Table 6.2.9. 1986 concentrations of parameters in upgradient well GW-142[a] at Kerr Hollow Quarry

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/27/86)	2nd Qtr. (4/23/86)	3rd Qtr. (8/21/86)	4th Qtr. (12/02/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.14	0.13	0.1	0.19
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	0.011
Lead	0.027	0.016	0.004	0.005
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.39	0.5	0.1	0.3
Nitrate nitrogen	0.27	0.23	<0.11	0.33
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	7.56	<2.7
Gross alpha (pCi/L)	4	<1	<1	13
Gross beta (pCi/L)	5	4.01	6	16
Total coliform (Ct/100 mL)	NF[c]	NF	3100	NF
Groundwater quality				
Chloride	4.2	3.9	3.7	2.5
Iron	10	8.5	4.1	9.7
Manganese	0.077	0.1	0.046	0.11
Phenols	<0.001	<0.001	0.004	0.004
Sodium	1.4	2.3	1.3	1.1
Sulfate	6.2	5.2	4.3	4.1
Indicators				
pH (units)	8.3	7.9	8.7	7.4
	8.6	7.9	8.7	7.5
	8.6	7.9	8.7	7.7
	8.6	7.9	8.7	7.7
Specific conductance (μmhos/cm)	322	331	299	540
	304	345	303	420
	301	349	307	370
	329	350	302	450
Total organic carbon	39	49	32	55
	44	47	33	46
	38	47	28	52
	38	45	32	50
Total organic halogen	0.014	0.019	0.343	<0.010
	0.011	0.016	0.375	<0.010
	0.012	0.016	0.429	<0.010
	0.01	0.016	0.398	<0.010

[a]See Fig. 6.2.6.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.10. 1986 concentrations of parameters in well GW-143 at Kerr Hollow Quarry

Parameter	Concentration (mg/L)			
	1st Qtr. (2/6/86)	2nd Qtr. (4/16/86)	3rd Qtr. (7/8/86)	4th Qtr. (10/3/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	<0.05			<0.05
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	0.03	0.013	0.005	0.04
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.1	<0.1	0.1	<0.1
Nitrate nitrogen	<0.11	0.16	0.16	0.2
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	0.054	<2.7
Gross alpha (pCi/L)	16.8	4.08	<1	2
Gross beta (pCi/L)	16	3.78	<2	3
Total coliform (counts/100 mL)	*a*	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	<1	<1	<1	<1
Iron	6.5	3.3	0.076	4
Manganese	0.15	0.17	0.16	0.13
Phenols	0.007	<0.001	0.004	0.002
Sodium	2.5	0.73	0.57	0.78
Sulfate	8	4.6	3.9	3.3
Indicators				
pH (units)	7.7	7.8	7.7	8.1
	7.7	7.8	7.7	8.0
	7.6	8.1	7.8	8.3
	7.8	7.9	7.8	8.1
Specific conductance (μmhos/cm)	278	247	273	273
	294	260	273	272
	294	262	274	274
	299	262	274	273
Total organic carbon	12	44	39	60
	10	45	39	50
	12	45	38	55
	20	43	39	68
Total organic chloride	11	357	16	50
	9	<5	17	54
	10	7	19	45
	19	217	14	63

[a]No colonies observed.

Table 6.2.11. 1986 concentrations of parameters in downgradient well GW-144[a] at Kerr Hollow Quarry

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/03/86)	2nd Qtr. (4/28/86)	3rd Qtr. (8/14/86)	4th Qtr. (11/10/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.034	0.035	0.039	0.039
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.010
Lead	<0.004	0.011	0.007	0.017
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.15	0.1	0.1	0.1
Nitrate nitrogen	0.59	0.47	0.28	0.41
Endrin	<0.00005	<0.00005	<0.0001	<0.00005
Lindane	<0.00001	<0.00001	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00004	<0.00008	<0.00004
Toxaphene	<0.001	<0.001	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	2	<1	5	10
Gross beta (pCi/L)	3	<2	9	12
Total coliform (Ct/100 mL)	NF[c]	2	NF	1
Groundwater quality				
Chloride	9.0	8.2	4.7	8.2
Iron	0.27	0.049	0.039	0.070
Manganese	0.0022	<0.001	0.0067	0.0011
Phenols	0.001	0.002	0.003	0.041
Sodium	3.1	2.8	2.9	2.8
Sulfate	7.7	7	4	7.1
Indicators				
pH (units)	7.9	8.1	7.9	8.0
	8.0	8.1	7.9	8.0
	8.0	7.9	7.9	8.0
	7.9	7.8	7.9	8.0
Specific conductance (μmhos/cm)	335	348	347	428
	341	355	344	437
	343	355	342	429
	342	356	344	441
Total organic carbon	34	40	42	3
	34	40	46	35
	34	42	47	3
	33	42	43	28
Total organic halogen	0.015	0.41	0.08	0.043
	0.014	0.43	0.08	0.075
	0.011	0.39	0.09	0.082
	0.014	0.37	0.08	0.076

[a]See Fig. 6.2.6.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.12. 1986 concentrations of parameters in downgradient well GW-145[a] at Kerr Hollow Quarry

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/5/86)	2nd Qtr. (4/24/86)	3rd Qtr. (8/20/86)	4th Qtr. (11/13/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.0024	0.0081	0.073	0.098
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	0.011
Lead	<0.004	0.008	0.004	0.009
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	0.006	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	1.5	2	1.4	1.9
Nitrate nitrogen	0.14	0.11	0.25	0.29
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	3.9	2.16	8	15
Gross beta (pCi/L)	92.4	41.71	65	48
Total coliform (Ct/100 mL)	NF[c]	NF	NF	5
Groundwater quality				
Chloride	30	13.7	24	19.5
Iron	0.074	2.8	0.2	0.20
Manganese	0.0016	0.012	0.008	0.011
Phenols	0.013	0.001	<0.001	0.002
Sodium	25	14	40	51
Sulfate	26	35	56	65
Indicators				
pH (units)	10.6	9.1	7.9	7.8
	10.6	9.1	7.9	7.9
	10.7	9.1	7.9	8.1
	10.7	9.1	7.9	8.1
Specific conductance (μmhos/cm)	564	485	540	620
	579	501	554	610
	578	504	552	610
	582	504	551	610
Total organic carbon	20	38	57	55
	20	35	54	35
	20	35	54	30
	19	38	55	35
Total organic halogen	0.026	0.022	0.15	0.176
	0.028	0.024	0.13	0.250
	0.028	0.024	0.12	0.184
	0.027	0.023	0.11	0.259

[a]See Fig. 6.2.6.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.13. 1986 concentrations of parameters in well GW-146 at Kerr Hollow Quarry

Parameter	Concentration (mg/L)			
	1st Qtr. (3/5/86)	2nd Qtr. (4/24/86)	3rd Qtr. (8/20/86)	4th Qtr. (11/25/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.077	0.065	0.019	0.035
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	<0.004	0.017	0.023	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	0.009	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	1.87	1.9	2.0	1.8
Nitrate nitrogen	0.11	<0.11	<0.11	<0.11
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	14.58	<2.7
Gross alpha (pCi/L)	2	2.46	18	4
Gross beta (pCi/L)	150	61.13	44	43
Total coliform (counts/100 mL)	*a*	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	24	29	12	9.5
Iron	0.11	0.38	14	10
Manganese	0.01	0.024	0.077	0.06
Phenols	0.041	0.002	0.007	0.008
Sodium	13	37	17	11
Sulfate	50	79	40	37
Indicators				
pH (units)	8.5	8.5	9.4	9.2
	9	8.6	9.4	9.3
	8.5	8.5	9.5	9.3
	8.5	8.6	9.4	9.3
Specific conductance (μmhos/cm)	587	607	445	390
	599	643	453	383
	604	644	455	384
	603	690	456	362
Total organic carbon	42	53	41	25
	43	45	42	75
	42	46	42	15
	150	53	43	20
Total organic chloride	25	22	160	<10
	16	23	150	<10
	<5	22	140	<10
	181	21	140	<10

[a]No colonies observed.

Table 6.2.14. 1986 concentrations of parameters in downgradient well GW-231[a] at Kerr Hollow Quarry

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/7/86)	2nd Qtr. (4/25/86)	3rd Qtr. (8/21/86)	4th Qtr. (11/10/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.08	0.094	0.12	0.15
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	<0.004	0.011	0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.094	<0.1	<0.11	<0.1
Nitrate nitrogen	0.21	0.16	<0.11	<0.11
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	13.77	<2.7
Gross alpha (pCi/L)	<0.1	<1	<2	12
Gross beta (pCi/L)	3.5	4.14	2	19
Total coliform (Ct/100 mL)	1	1	1	22
Groundwater quality				
Chloride	1.9	1.2	1.1	1.2
Iron	0.026	0.015	0.0052	0.0089
Manganese	0.028	<0.001	0.0058	0.0046
Phenols	0.009	<0.001	0.002	0.006
Sodium	0.76	0.48	0.82	0.75
Sulfate	3.6	3.4	3.1	3.4
Indicators				
pH (units)	8.1	7.7	7.6	7.7
	8.0	7.6	7.7	8.0
	8.0	7.9	7.7	8.0
	8.1	7.9	7.7	8.0
Specific conductance (μmhos/cm)	245	317	364	394
	245	331	363	397
	244	334	361	397
	241	334	360	400
Total organic carbon	35	48	46	35
	31	45	46	35
	34	45	46	35
	38	46	48	40
Total organic halogen	0.016	1.7	0.044	<0.010
	0.019	1.9	0.029	<0.010
	0.018	1.7	0.032	<0.010
	0.013	1.7	0.043	<0.010

[a]See Fig. 6.2.6.
[b]During 1986 detection levels for several parameters varied.

To characterize the geohydrological setting of the New Hope Pond site, 11 borings were completed (Fig. 6.2.7). A plan for monitor well installation was presented by Geraghty and Miller (1985b), and the present drilling program is an implementation of that plan, with the addition of several borings to investigate site hydrology more completely (Haase, Gillis, and King, 1987).

All groundwater investigation wells at New Hope Pond are screened. They were installed in piezometer clusters such that data on both lateral and vertical groundwater flow components could be obtained. Two clusters, one to the east and one to the west of the pond, were installed to monitor potential strike-parallel groundwater movement (Haase, Gillis, and King, 1987).

To the east, well GW-150 is finished in unconsolidated soil and residuum developed on the Maynardville Limestone. Well GW-220 is completed in the lower Maynardville Limestone to a depth of 14 m, and well GW-151 is completed in the basal Maynardville Limestone, in a transition zone characterized by alternating layers of shale and limestone, to a depth of 29.4 m. To the west, well GW-154 is finished in the unconsolidated residuum. Well GW-222 is finished in the lower Maynardville Limestone to a

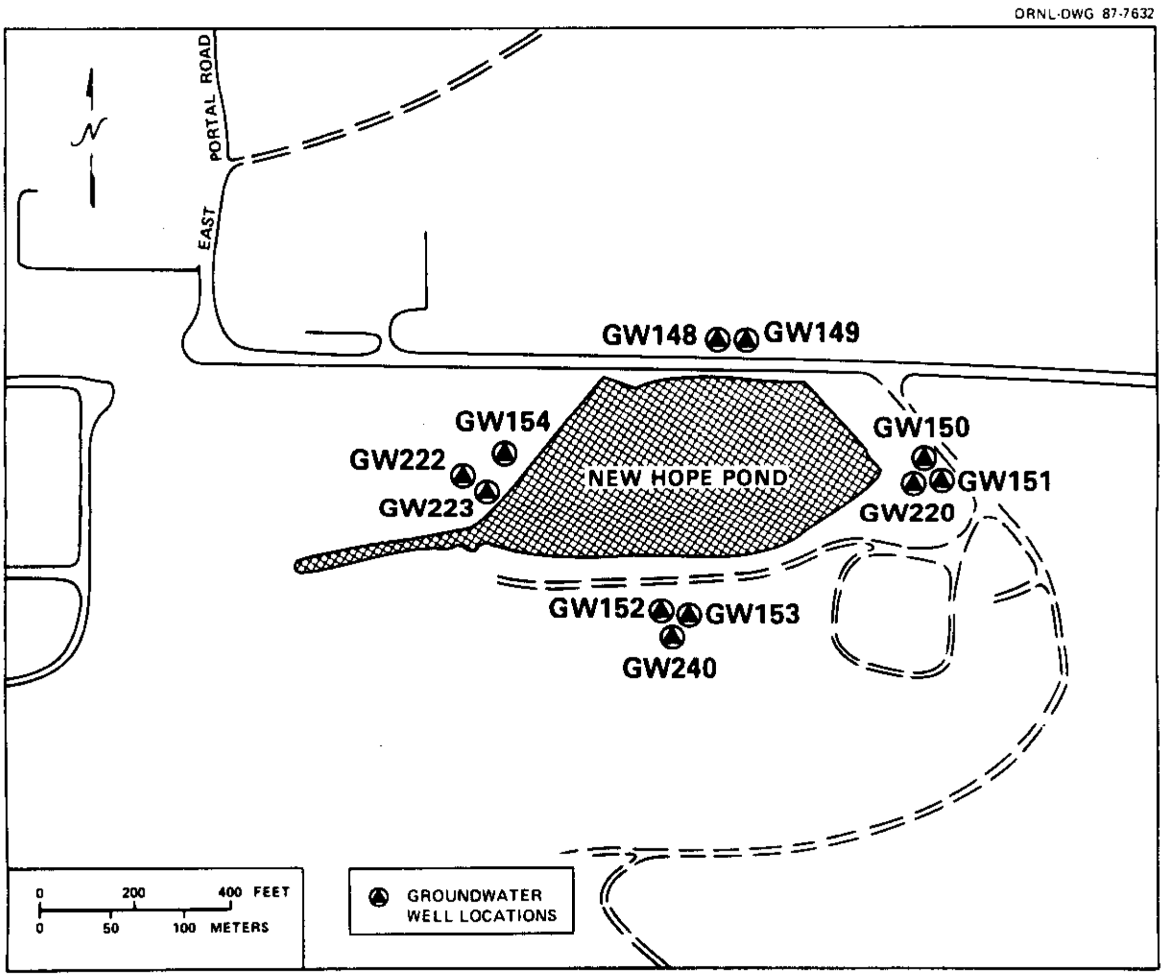

Fig. 6.2.7. Locations of groundwater wells around New Hope Pond.

depth of 7.6 m, and well GW-223 is finished in the shale/limestone transition zone at the base of the Maynardville Limestone to a depth of 27.6 m.

To the north of the site, well GW-148 is complete to a total depth of 3.4 m in residuum developed at the contact between the Maynardville Limestone and the Nolichucky Shale. Well GW-149 is finished in the basal Maynardville Limestone to a depth of 15.4 m.

The wells in the cluster south of the site are topographically the highest. The shallowest well in the cluster (GW-152) should serve as an upgradient well, at least for flow in the unconsolidated zone. Well GW-152 is completed in Maynardville Limestone residuum to a depth of 5.3 m. Wells GW-153, completed to a depth of 18.3 m, and GW-240, completed to a depth of 9 m, are both finished in the upper Maynardville Limestone.

The 1986 concentrations of parameters in groundwater wells around New Hope Pond are given in Tables 6.2.15 through 6.2.24.

Sludge Disposal Basin. The Sludge Disposal Basin, located on the northern crest of Chestnut Ridge approximately 305 m due south of New Hope Pond (Fig. 6.2.1), has been used to dispose of sediments and sludge removed from periodic dredging of New Hope Pond. A summary of analytical results and groundwater quality data from the disposal site before 1986 are presented by Geraghty and Miller (1985b). Monitoring wells 1095 and 1096 were already in existence.

The Sludge Disposal Basin is located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. A schematic cross section of the site is shown in Fig. 6.2.8. The soil and residuum locally contain abundant chert and rubble-rich horizons that occur at the top of bedrock and are dispersed irregularly throughout the soil column. Depth to bedrock ranges from 15 to 27 m (Haase, Gillis, and King, 1987).

The Copper Ridge Dolomite at the site consists of thinly to thickly bedded, dark gray to buff dolostones ranging from massive bedded, without significant bedding structure, to having faint, planar laminations. Locally, dolostones contain intervals exhibiting wavy to planar cryptalgal laminations. Such intervals are typically interbedded with intraformational breccias and micrite-rich beds containing disseminated rip-up clasts. Intervals of bedded to nodular chert occur throughout the portion of the Copper Ridge Dolomite penetrated by core hole CH-157 (Haase, Gillis, and King, 1987).

The Copper Ridge Dolomite at the Sludge Disposal Basin has a uniform dip to the southeast of 35 to 45 m. The strata exhibit joints and fractures, with the density and lateral continuity of such features varying from bed to bed. Most fractures appear to be filled with secondary calcite mineralization, although open fractures occur throughout. Thin (<0.3- 6-m) chert-rich intervals typically have the highest fracture density, followed by thin dolostone intervals. Locally, many stratigraphic intervals exhibit solutionally widened bedding, joint, or fracture surfaces although no discrete solution cavities were noted. Locally, generally bedding-plane-parallel fractures are concentrated into fracture zones from <0.3 to 1 m in thickness. Numerous high-angle fractures are also noted throughout the strata penetrated by core hole CH-157 (Haase, Gillis, and King, 1987).

Little is known about subsurface hydrology at the Sludge Disposal Basin. Available information on shallow subsurface hydrology of the site has been summarized by Geraghty and Miller (1985b). Groundwater flow direction in the shallow subsurface (<61 m) have not been determined but are probably generally controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the security pits. The location of the groundwater divide would influence a general control as to whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley. Work by Ketelle and Huff (1984) elsewhere along Chestnut Ridge indicates that joints, fractures, and solutional features developed within the upper bedrock exert substantial local influence on groundwater flow directions. Analysis of joint and fracture patterns suggests that preferred groundwater flow directions within the upper bedrock are parallel

Table 6.2.15. 1986 concentrations of parameters in downgradient well GW-148[a] at New Hope Pond

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/23/86)	2nd Qtr. (4/22/86)	3rd Qtr. (8/01/86)	4th Qtr. (11/04/86)
Drinking water				
Arsenic	0.012	<0.005	<0.005	0.005
Barium	0.69	0.34	0.38	0.42
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.088	0.023	0.043	0.016
Lead	0.077	0.013	0.01	0.015
Mercury	0.0005	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.13	0.4	0.2	<0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	0.25
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	32	1.63	3	7
Gross beta (pCi/L)	66	<3.5	5	9
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	31	29	23	29
Iron	59	17	10	17
Manganese	2.7	0.85	1.1	0.65
Phenols	<0.001	<0.001	0.012	0.003
Sodium	6.6	6.3	6.6	7.3
Sulfate	13	15	12	11
Indicators				
pH (units)	6.9	6.9	6.9	6.9
	6.9	6.8	7.0	6.9
	6.9	6.7	7.2	6.9
	6.8	6.7	7.1	6.9
Specific conductance (μmhos/cm)	774	720	773	864
	799	777	769	859
	799	784	772	852
	798	786	780	856
Total organic carbon	116	132	107	140
	117	136	109	145
	128	128	107	145
	121	140	110	140
Total organic halogen	0.014	0.029	0.09	0.025
	0.014	0.026	0.08	0.030
	0.014	0.025	0.09	0.037
	0.014	0.03	0.08	0.028

[a]See Fig. 6.2.7.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.16. 1986 concentrations of parameters in well GW-149 at New Hope Pond

Parameter	Concentration (mg/L)			
	1st Qtr. (2/23/86)	2nd Qtr. (4/22/86)	3rd Qtr. (7/30/86)	4th Qtr. (11/3/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.42	0.47	0.37	0.4
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	0.008	0.007	0.005	0.034
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.36	0.5	0.5	0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	5.6	<1	4	10
Gross beta (pCi/L)	8.3	2.48	10	14
Total coliform (counts/100 mL)	*a*	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	5.3	10.3	11	11
Iron	0.31	0.41	0.52	0.91
Manganese	0.12	0.11	0.093	0.099
Phenols	0.01	<0.001	0.002	0.011
Sodium	59	53	56	77
Sulfate	5.6	5.8	6	5
Indicators				
pH (units)	7.6	7.5	7.5	8.1
	7.6	7.6	7.6	8.1
	7.6	7.6	7.6	8.2
	7.6	7.6	7.6	8.2
Specific conductance (μmhos/cm)	506	486	538	547
	530	509	541	542
	539	510	538	539
	541	510	537	539
Total organic carbon	40	75	61	80
	45	76	60	80
	50	74	63	80
	65	74	61	75
Total organic chloride	<5	61	860	53
	<5	23	900	38
	15	22	870	14
	15	21	850	70

[a]No colonies observed.

Table 6.2.17. 1986 concentrations of parameters in downgradient well GW-150[a] at New Hope Pond

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/20/86)	2nd Qtr. (4/21/86)	3rd Qtr. (8/01/86)	4th Qtr. (11/06/86)
Drinking water				
Arsenic	0.036	<0.005	<0.005	<0.005
Barium	0.37	0.25	0.1	0.047
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.13	0.067	0.028	<0.010
Lead	0.37	0.018	0.018	<0.004
Mercury	<0.0002	0.0003	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.082	0.1	0.1	<0.1
Nitrate nitrogen	0.79	0.97	0.5	0.38
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	9.18	9.99	3.51	<2.7
Gross alpha (pCi/L)	117	1.74	13	<2
Gross beta (pCi/L)	252	3.83	14	5
Total coliform (Ct/100 mL)	2	NF[c]	1	NF
Groundwater quality				
Chloride	4.8	5	8	11
Iron	170	78	13	1.1
Manganese	5.3	3.7	0.83	0.061
Phenols	<0.001	<0.001	0.004	0.015
Sodium	3.5	2.8	4.1	4.8
Sulfate	23	23.8	21	20
Indicators				
pH (units)	7	7	6.9	7.8
	7	6.9	7	7.8
	7.1	7	7	8.0
	7.4	6.9	7	7.7
Specific conductance (μmhos/cm)	391	464	504	514
	398	478	504	516
	408	478	505	514
	411	480	505	515
Total organic carbon	53	65	65	45
	51	63	66	60
	53	62	67	55
	48	64	70	45
Total organic halogen	0.028	0.191	0.09	<0.010
	0.032	0.024	0.09	<0.010
	0.027	0.026	0.08	<0.010
	0.03	0.197	0.08	<0.010

[a]See Fig. 6.2.7.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.18. 1986 concentrations of parameters in well GW-151 at New Hope Pond

Parameter	Concentration (mg/L)			
	1st Qtr. (2/20/86)	2nd Qtr. (4/21/86)	3rd Qtr. (7/31/86)	4th Qtr. (11/5/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.15	0.15	0.15	0.16
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	<0.004	<0.004	<0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.07	0.1	0.1	0.1
Nitrate nitrogen	<0.11	0.15	<0.11	<0.11
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	0.46	<1	<1	<2
Gross beta (pCi/L)	0.72	<2	3	<2
Total coliform (counts/100 mL)	*a*	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	1.3	3.2	3.2	3.8
Iron	0.025	0.035	0.014	0.0094
Manganese	0.009	<0.001	0.0069	0.0062
Phenols	0.005	0.002	<0.001	0.017
Sodium	5.9	4.8	5	5.3
Sulfate	4.5	5.6	5.6	5.2
Indicators				
pH (units)	7.2	7.2	7.5	7.6
	7.2	7.2	7.5	7.6
	7.2	7.2	7.5	7.6
	7.8	7.2	7.5	7.5
Specific conductance (μmhos/cm)	436	470	484	467
	442	504	486	473
	458	509	488	473
	461	510	482	474
Total organic carbon	665	73	64	60
	87	76	66	50
	99	75	65	55
	45	75	66	55
Total organic chloride	17	38	60	15
	9	39	100	13
	31	39	80	15
	19	36	70	15

[a]No colonies observed.

Table 6.2.19. 1986 concentrations of parameters in upgradient well GW-152[a] at New Hope Pond

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/25/86)	2nd Qtr. (4/21/86)	3rd Qtr. (8/01/86)	4th Qtr. (11/14/86)
Drinking water				
Arsenic	0.02	<0.005	<0.005	<0.005
Barium	0.055	0.055	0.022	0.018
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.015	0.02	0.01	0.031
Lead	2.21	0.3	0.064	0.024
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.07	0.1	0.1	<0.1
Nitrate nitrogen	0.68	0.88	1.67	1.78
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	20	0.8	31	4
Gross beta (pCi/L)	23	3.74	13	7
Total coliform (Ct/100 mL)	7	2	2	NF[c]
Groundwater quality				
Chloride	2.2	10.9	41	78
Iron	26	24	1.9	0.33
Manganese	0.93	0.91	0.11	0.024
Phenols	<0.001	<0.001	0.03	0.006
Sodium	2.6	4.5	11	15
Sulfate	3.5	4.4	11	9.8
Indicators				
pH (units)	7.7	7.5	7.6	8.1
	7.7	7.7	7.6	7.9
	7.7	7.5	7.6	8.1
	7.7	7.6	7.6	8.2
Specific conductance	311	321	485	580
(μmhos/cm)	341	334	484	620
	315	338	480	570
	320	342	484	600
Total organic carbon	39	41	45	29
	39	44	42	16
	40	45	43	36
	39	43	42	15
Total organic halogen	0.019	0.011	0.08	0.203
	0.017	0.006	0.07	0.205
	0.015	<0.005	0.06	0.226
	0.017	0.028	0.08	0.218

[a]See Fig. 6.2.7.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.20. 1986 concentrations of parameters in upgradient well GW-153[a] at New Hope Pond

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/25/86)	2nd Qtr. (4/21/86)	3rd Qtr. (7/31/86)	4th Qtr. (11/20/86)
Drinking water				
Arsenic	0.016	<0.005	<0.005	<0.005
Barium	0.03	0.017	0.028	0.034
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.021	0.019	0.013	0.015
Lead	0.004	0.013	0.004	0.007
Mercury	<0.0002	0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	0.012
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.19	0.3	0.2	0.1
Nitrate nitrogen	0.47	1179	1.2	1.8
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	2	1.11	2	3
Gross beta (pCi/L)	23	19.64	8	9
Total coliform (Ct/100 mL)	NF[b]	NF	6	NF
Groundwater quality				
Chloride	5.2	11.2	34	100
Iron	1.3	1.1	0.49	0.15
Manganese	0.084	0.062	0.035	0.014
Phenols	0.003	<0.001	0.001	0.003
Sodium	15	15	18	54
Sulfate	20	34.8	21	24
Indicators				
pH (units)	11	1.5	9	8.1
	11	10.4	9	8.1
	11.1	9.8	9	8.1
	11.1	10	9	8.1
Specific conductance (μmhos/cm)	597	30600	374	557
	697	249	375	570
	666	301	372	460
	675	519	377	565
Total organic carbon	15	6	25	9
	12	7	27	11
	30	6	25	9
	25	7	26	10
Total organic halogen	0.048	0.254	0.12	0.199
	0.055	0.214	0.1	0.227
	0.110	0.256	0.09	0.235
	0.048	0.158	0.09	<0.010

[a]See Fig. 6.2.7.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.21. 1986 concentrations of parameters in downgradient well GW-154[a] at New Hope Pond

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/23/86)	2nd Qtr. (4/23/86)	3rd Qtr. (8/5/86)	4th Qtr. (11/7/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.077	0.22	0.086	0.054
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	0.022	0.011	<0.010
Lead	0.027	0.038	0.006	<0.004
Mercury	0.0022	0.0152	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.12	0.2	0.2	0.1
Nitrate nitrogen	0.75	0.47	0.41	<0.11
Endrin	*c*	<0.0001	<0.0001	<0.00005
Lindane	*c*	<0.00002	<0.00002	<0.00001
Methoxychlor	*c*	<0.00008	<0.00008	<0.00004
Toxaphene	*c*	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	31	8.99	27	59
Gross beta (pCi/L)	13	7.39	15	21
Total coliform (Ct/100 mL)	NF[d]	NF	NF	NF
Groundwater quality				
Chloride	28	19.4	17	17
Iron	5.1	25	1.3	0.051
Manganese	1.9	5.5	1.9	1.1
Phenols	<0.001	<0.001	<0.001	0.018
Sodium	15	15	15	14
Sulfate	80	97	88	90
Indicators				
pH (units)	7.2	7.1	7.3	7.3
	7.2	7.1	7.3	7.4
	7.2	7.1	7.2	7.3
	7.0	7.2	7.2	7.3
Specific conductance (μmhos/cm)	589	592	601	662
	598	617	602	680
	598	620	608	687
	607	602	591	695
Total organic carbon	52	66	62	30
	51	64	65	60
	53	60	61	55
	51	63	60	55
Total organic halogen	0.073	0.052	0.16	0.072
	0.073	0.046	0.09	0.072
	0.075	0.05	0.11	0.077
	0.072	0.048	0.04	0.086

[a]See Fig. 6.2.7.
[b]During 1986 detection levels for several parameters varied.
[c]Sample lost during analysis.
[d]NF = not found.

Table 6.2.22. 1986 concentrations of parameters in well GW-222 at New Hope Pond

Parameter	Concentration (mg/L) 1st Qtr. (2/23/86)	2nd Qtr. (4/23/86)	3rd Qtr. (7/30/86)	4th Qtr. (11/4/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.056	0.056	0.04	0.049
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	0.005	0.009	0.005	<0.004
Mercury	0.0002	0.0003	0.0004	0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	0.24	<0.006	<0.006	<0.006
Fluoride	0.74	1	1	0.5
Nitrate nitrogen	5.31	3.27	3.1	2.6
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	20.5	9.89	9	27
Gross beta (pCi/L)	8.7	8.2	8	24
Total coliform (counts/100 mL)	66	57	2	[a]
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	32.5	24.7	16	14
Iron	0.22	0.051	0.019	0.13
Manganese	0.027	0.0029	0.0079	0.0073
Phenols	0.004	0.001	0.003	0.01
Sodium	5.9	4.8	5	5.3
Sulfate	43	95	35	70
Indicators				
pH (units)	7.3	7.5	7.8	8.3
	7.4	7.5	7.7	8.2
	7.5	7.5	7.7	8.1
	7.5	7.6	7.7	8.0
Specific conductance (μmhos/cm)	421	493	405	472
	427	518	401	445
	436	522	398	445
	444	519	396	440
Total organic carbon	15	33	27	30
	40	34	27	30
	54	35	27	30
	32	35	25	30
Total organic chloride	79	44	740	61
	66	48	720	59
	79	47	760	61
	73	45	760	63

[a]No colonies observed.

Table 6.2.23. 1986 concentrations of parameters in well GW-223 at New Hope Pond

Parameter	Concentration (mg/L)			
	1st Qtr. (2/25/86)	2nd Qtr. (4/18/86)	3rd Qtr. (8/1/86)	4th Qtr. (11/4/86)
Drinking water				
Arsenic	0.013	<0.005	<0.005	<0.005
Barium	0.24	0.19	0.17	0.21
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	0.11	<0.01
Lead	0.008	<0.004	<0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.26	0.5	0.6	0.1
Nitrate nitrogen	1.15	1.8	2.1	1.4
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<2	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	5	4.49	7	11
Gross beta (pCi/L)	8	5	8	11
Total coliform counts/100 mL)	6	26	13	*a*
Silvex	<0.2	<0.2	<0.2	<0.1
Groundwater				
Chloride	24	17.6	14	14
Iron	0.35	0.15	0.1	0.097
Manganese	0.46	0.27	0.19	0.28
Phenols	0.013	<0.002	0.008	0.004
Sodium	16	15	12	18
Sulfate	32	51	35	49
Indicators				
pH (units)	7.0	7.1	8.0	7.6
	7.0	7.0	7.6	7.6
	7.0	7.0	7.3	7.5
	7.0	7.0	7.5	7.5
Specific conductance (μmhos/cm)	611	493	459	507
	652	502	450	506
	661	504	461	507
	660	504	459	507
Total organic carbon	84	57	46	55
	102	48	55	
	120	61	46	50
	84	54	45	55
Total organic chloride	82	67	110	82
	95	120	69	
	95	130	61	
	97	100	74	

[a]No colonies observed.

Table 6.2.24. 1986 concentrations of parameters in well GW-240 at New Hope Pond

Parameter	Concentration (mg/L)			
	1st Qtr. (2/25/86)	2nd Qtr. (4/21/86)	3rd Qtr. (7/30/86)	4th Qtr. (11/13/86)
Drinking water				
Arsenic	0.016	<0.005	<0.005	<0.005
Barium	0.025	0.023	0.034	0.057
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	0.014
Lead	0.007	0.012	0.004	0.007
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.13	0.2	0.3	0.1
Nitrate nitrogen	0.9	0.88	1.8	2.05
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	2	2.99	3	102
Gross beta (pCi/L)	4	3.15	5	33
Total coliform (counts/100 mL)	1	19	20	7
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	29	14.3	57	138
Iron	0.094	0.053	0.13	0.034
Manganese	0.078	0.0025	0.024	0.07
Phenols	<0.001	<0.001	0.002	0.008
Sodium	13	8.4	18	50
Sulfate	4.4	10.2	15	20
Indicators				
pH (units)	7.6	7.3	7.4	7.6
	7.6	7.2	7.5	7.8
	7.5	7.2	7.4	7.7
		7.3	7.5	7.7
Specific conductance (μmhos/cm)	456	388	556	890
	460	399	554	900
	460	401	551	900
		402	552	890
Total organic carbon	63	53	45	45
	24	55	43	45
	85	53	46	45
	43	53	46	45
Total organic chloride	6	50	450	478
	10	97	400	461
	14	98	400	440
	33	104	430	367

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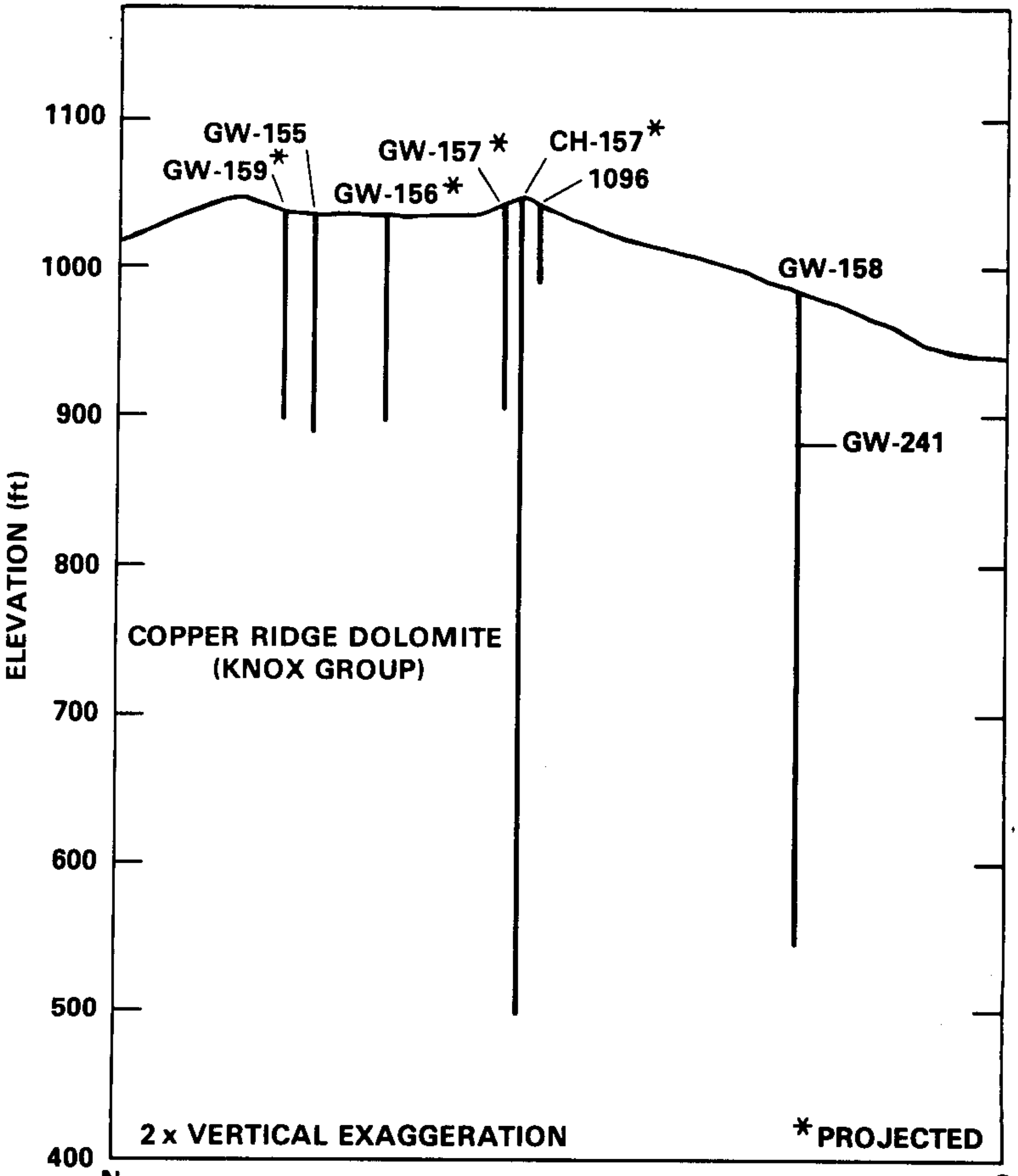

Fig. 6.2.8. Schematic cross section of Sludge Disposal Basin.

and perpendicular to the ridge crest (Haase, Gillis, and King, 1987).

For the generally unweathered bedrock in the deeper subsurface (>61 m), porosity and density geophysical logs for core hole CH-157 suggest that most of the strata are "tight," with low porosity (0 to 5%) and, by inference, low permeability. Several anomalies noted on the electric logs suggest that there are thin (<0.3–1-m), relatively permeable, water-bearing zones occurring throughout the section. The data suggest that water movement within the deeper bedrock probably occurs principally within fractures and fracture systems. To understand the hydrologic behavior in the vicinity of the Sludge Disposal Basin, one must understand the spacing, density, and orientations of fracture systems (Haase, Gillis, and King, 1987).

Initial plans for monitoring well installation at the Sludge Disposal Basin (Geraghty and Miller, 1985b) were modified to address these hydrologic issues. Locations of the seven borings conducted at the site are shown in Fig. 6.2.9.

CH-157 is a 165-m-deep core hole collared in the lower portion of the Copper Ridge Dolomite. The core hole provided data for a detailed map of the stratigraphy and structural character of the strata underlying the Sludge Disposal Basin (Haase, Gillis, and King, 1987).

Screened wells were installed along the immediate perimeter of the site and at some distance from it to monitor groundwater

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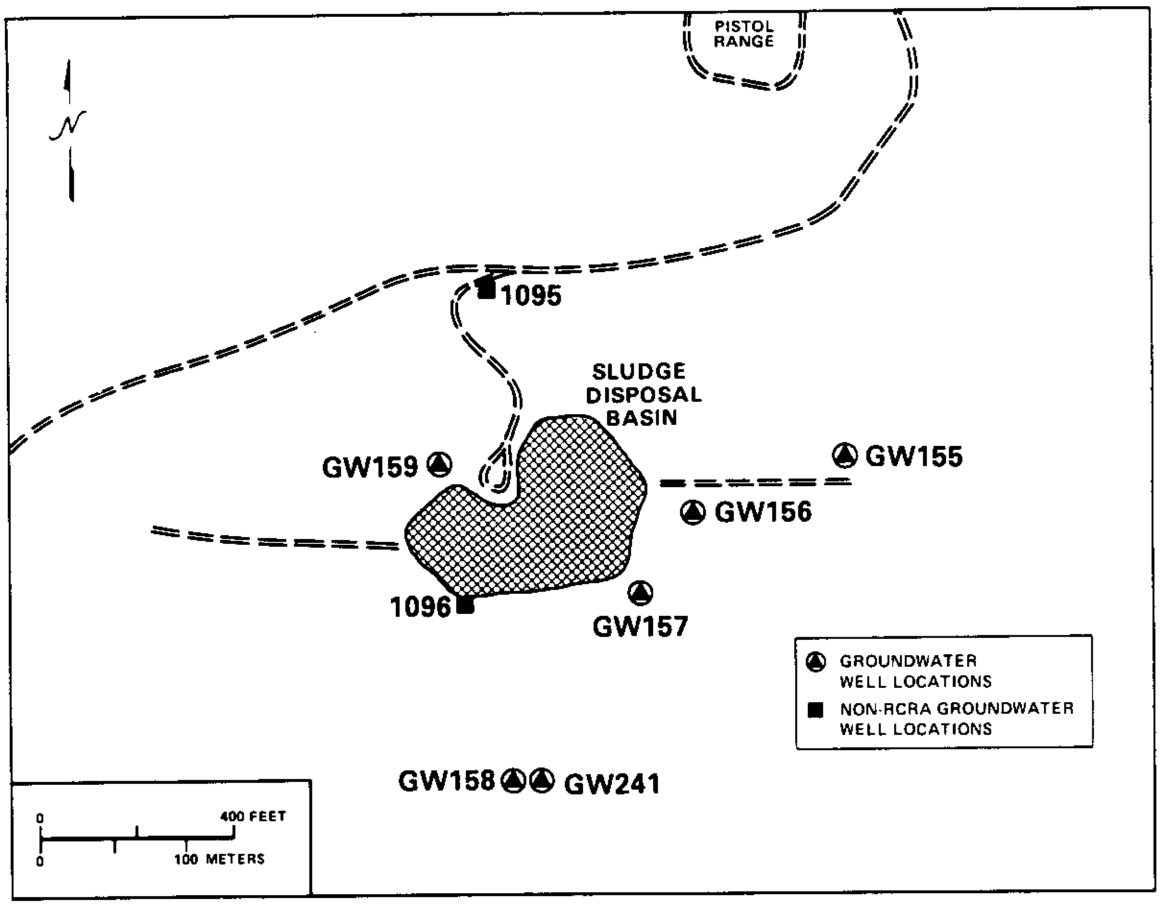

Fig. 6.2.9. Locations of groundwater wells around Sludge Disposal Basin.

occurring at the top of the water table, which typically corresponds to the soil/bedrock interface. Analysis and comparison of hydrologic data from all wells at the site should permit identification of the groundwater divide and resolution of its significance to groundwater flow behavior at the site. During the installation of the surface conductor for these wells, zones of cavity formation and solutional alteration were encountered within 3 to 7.5 m of the top of bedrock. The vertical extent of such cavities ranged from 0.3 to 1.5 m. In all cases, the surface conductor was advanced 1 to 5 m past the bottom of the first significant cavity encountered below the top of bedrock (Haase, Gillis, and King, 1987).

Wells GW-156 and GW-159 were installed to the west and to the east of the active and proposed burial areas to monitor possible migration along strike of material from the disposal area. Both wells are 48 m deep and are completed in the uppermost weathered bedrock.

These wells, together with existing well No. 1095, which is also screened in the interval at the top of bedrock, are north of the disposal area and will serve to investigate movement of material perpendicular to strike northward from the site. Comparison of hydrologic data from both groups of wells should also permit identification of the groundwater divide at the site (Haase, Gillis, and King, 1987).

Well GW-155, which occupies the highest topographic location and serves as an upgradient, background well for the site, is 54 m deep and is also completed in weathered bedrock immediately below the top of rock. Well GW-157, in conjunction with existing well No. 1096, was placed south of the active site to monitor potential movement of material away from the site southward and perpendicular to strike. Well GW-157 is 44 m deep and, like well No. 1096, is completed in weathered bedrock just below the top of rock. Wells GW-158 and GW-241 form a piezometer cluster that was placed approximately 90 m south of the site. Well GW-241 is a 31-m-deep screened well completed at the top of bedrock. Well GW-158 is a 134-m-deep open well completed in a fractured interval. These wells will allow the vertical component of groundwater flow south of the site to be investigated and the potential, along-fracture, downdip movement of material away from the site to be monitored (Haase, Gillis, and King, 1987).

Other sites. The 1986 concentrations of parameters in groundwater wells from around Chestnut Ridge Sludge Disposal Basin are given in Tables 6.2.25 through 6.2.30.

The United Nuclear Corporation (UNC) Site, located on the northern crest of Chestnut Ridge, immediately south of the western end of Oak Ridge Y-12 Plant (Fig. 6.2.1), is used to dispose of waste from the Rhode Island-based company. Materials disposed of are low-level radioactive wastes and contaminated equipment packaged in 0.02-m^3 drums and in boxes. A summary of site disposal activities and groundwater chemistry is presented by Geraghty and Miller (1985b).

The UNC is located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. The soil and residuum locally contain abundant chert and rubble-rich horizons that occur at the top of bedrock and are dispersed irregularly throughout the soil column. Depth to bedrock at the site ranges from 15 to 27 m (Haase, Gillis, and King, 1987).

The geohydrologic setting of the UNC site is similar to those of the Chestnut Ridge Security Pit and the Sludge Disposal Basin. Groundwater flow directions have not been determined but, as at the other sites mentioned, are thought to be controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the site. The location of the groundwater divide would influence a general control as to whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley (Haase, Gillis, and King, 1987).

The locations of the three borings completed at this site are given in Fig. 6.2.10. All borings at the site are screened wells finished in the top of bedrock. These wells were constructed to monitor groundwater occurring at the top of the water table, which typically corresponds to the

Table 6.2.25. 1986 concentrations of parameters in upgradient well GW-155[a] at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/19/86)	2nd Qtr. (5/5/86)	3rd Qtr. (9/08/86)	4th Qtr. (12/4/86)
Drinking water				
Arsenic	0.038	<0.005	0.005	<0.005
Barium	0.0051	0.01	0.013	0.0075
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.026	<0.01	<0.01	0.021
Lead	0.052	0.011	0.016	0.01
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.07	0.1	<0.1	<0.1
Nitrate nitrogen	<0.11	0.32	0.23	0.18
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	5.67	<2.7
Gross alpha (pCi/L)	20	<1	<1	7
Gross beta (pCi/L)	12	<2	<1	9
Total coliform (Ct/100 mL)	2	NF[c]	NF	NF
Groundwater quality				
Chloride	<1	<1	<1	<1
Iron	17	2.4	2.8	1.6
Manganese	0.34	0.034	0.081	0.032
Phenols	<0.001	0.008	0.011	0.002
Sodium	1.2	0.53	0.46	0.53
Sulfate	2.6	1.6	2.3	1.1
Indicators				
pH (units)	7.9	7.7	8.1	7.5
	7.9	7.7	8.1	7.5
	8.0	7.7	8.1	7.5
	8.1	7.8	8.1	7.5
Specific conductance (μmhos/cm)	237	247	260	250
	256	248	262	260
	241	249	262	220
	266	249	262	260
Total organic carbon	3.5	39	41	27
	1.6	41	42	28
	1.7	40	43	26
	1.6	39	40	28
Total organic halogen	0.015	0.09	0.05	0.010
	0.02	0.084	0.052	<0.010
	0.023	0.086	0.044	<0.010
	0.014	0.09	0.059	<0.010

[a]See Fig. 6.2.9.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.26. 1986 concentrations of parameters in upgradient well GW-156[a] at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/22/86)	2nd Qtr. (4/18/86)	3rd Qtr. (8/19/86)	4th Qtr. (12/8/86)
Drinking water				
Arsenic	0.008	<0.005	<0.005	<0.005
Barium	0.017	0.0066	0.015	0.015
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.012	0.012
Lead	0.005	0.004	0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.18	0.2	<0.1	<0.1
Nitrate nitrogen	<0.11	<0.11	<0.5	0.17
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	0.52	2.08	<2	8
Gross beta (pCi/L)	120	53.29	44	557
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	27	15.4	7.6	3.7
Iron	0.5	0.032	0.14	0.57
Manganese	0.022	0.0051	0.022	0.017
Phenols	0.016	0.002	0.007	0.001
Sodium	15	8.6	5.6	3.5
Sulfate	117	55	29	18
Indicators				
pH (units)	9.7	7.7	7.7	8.3
	8.1	7.8	7.7	8.3
	9.3	7.5	7.7	8.2
	8.5	7.7	7.7	8.1
Specific conductance (μmhos/cm)	899	726	678	620
	1236	755	678	630
	1361	758	673	670
	1197	769	677	620
Total organic carbon	69	90	81	10
	70	86	86	9
	69	88	83	6
	72	90	86	7
Total organic halogen	0.1	0.011	0.4	<0.010
	0.097	0.065	0.32	<0.010
	0.095	0.076	0.35	<0.010
	0.103	0.076	0.32	<0.010

[a]See Fig. 6.2.9.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.27. 1986 concentrations of parameters in downgradient well GW-157[a] at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/21/86)	2nd Qtr. (4/30/86)	3rd Qtr. (8/25/86)	4th Qtr. (12/08/86)
Drinking water				
Arsenic	<0.005	0.006	0.007	<0.005
Barium	0.022	0.022	0.025	0.025
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	0.01	0.026
Lead	0.007	0.029	0.027	0.008
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	0.045	<0.006	<0.006	<0.006
Fluoride	0.09	0.1	1.4	<0.1
Nitrate nitrogen	0.32	0.25	0.25	0.25
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	5.4	<2.7
Gross alpha (pCi/L)	1.9	<1	30	9
Gross beta (pCi/L)	3.1	3.29	<1	536
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	2	3	2.4	2.9
Iron	0.12	10	9.6	4.9
Manganese	0.042	0.36	0.4	0.15
Phenols	0.006	<0.002	0.004	<0.001
Sodium	1.3	0.98	1.2	1.6
Sulfate	23	19	25	33
Indicators				
pH (units)	7.5	7.5	7.8	8.1
	7.5	7.6	7.8	8.0
	7.5	7.6	7.8	8.0
	7.5	7.6	7.8	8.0
Specific conductance (μmhos/cm)	481	367	449	510
	466	371	448	510
	464	370	446	500
	463	374	443	510
Total organic carbon	65	54	38	37
	62	55	23	41
	61	54	44	38
	61	51	46	36
Total organic halogen	0.04	0.25	0.027	0.016
	0.041	0.25	0.045	0.017
	0.043	0.25	0.033	0.016
	0.036	0.24	0.025	0.015

[a]See Fig. 6.2.9.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.28. 1986 concentrations of parameters in well GW-158 at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)			
	1st Qtr. (2/28/86)	2nd Qtr. (4/18/86)	3rd Qtr. (Not available)	4th Qtr. (Not available)
Drinking water				
Arsenic	<0.005	<0.005		
Barium	0.0059	0.0032		
Cadmium	<0.003	<0.003		
Chromium	<0.01	<0.01		
Lead	<0.004	0.007		
Mercury	<0.0002	<0.0002		
Selenium	<0.005	<0.005		
Silver	<0.006	<0.006		
Fluoride	0.05	0.1		
Nitrate nitrogen	<0.11	0.16		
Endrin	<0.05	<0.1		
Lindane	<0.01	<0.02		
Methoxychlor	<0.04	<0.08		
Toxaphene	<1	<2		
2,4-D	<1	<2		
Radium (pCi/L)	<2.7	<2.7		
Gross alpha (pCi/L)	2	0.38		
Gross beta (pCi/L)	<2	0.86		
Total coliform (counts/100 mL)	12	*a*		
Silvex	<0.1	<0.2		
Groundwater				
Chloride	1.9	2.3		
Iron	5.2	8.7		
Manganese	0.063	0.089		
Phenols	0.003	<0.002		
Sodium	1	1.3		
Sulfate	11	13		
Indicators				
pH (units)	8.6	8.6		
	8.7	8.3		
	8.7	8.6		
	8.7	8.7		
Specific conductance (μmhos/cm)	240	181		
	227	185		
	226	185		
	221	186		
Total organic carbon	31	24		
	30	21		
	30	22		
	31	20		
Total organic chloride	14	730		
	14	25		
	13	42		
	15	134		

[a]No colonies observed.

Table 6.2.29. 1986 concentrations of parameters in downgradient well GW-159[a] at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (2/19/86)	2nd Qtr. (4/22/86)	3rd Qtr. (8/19/86)	4th Qtr. (12/08/86)
Drinking water				
Arsenic	0.007	0.007	<0.005	0.008
Barium	0.019	0.0027	0.0049	0.015
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	0.031	<0.01	<0.01	0.019
Lead	0.013	0.007	<0.004	<0.004
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	0.015	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.125	0.2	0.1	<0.1
Nitrate nitrogen	0.2	0.23	0.25	0.25
Endrin	<0.00005	<0.0001	<0.0001	<0.00005
Lindane	<0.00001	<0.00002	<0.00002	<0.00001
Methoxychlor	<0.00004	<0.00008	<0.00008	<0.00004
Toxaphene	<0.001	<0.002	<0.002	<0.001
2,4-D	<0.001	<0.002	<0.002	<0.001
Silvex	<0.0001	<0.0002	<0.0002	<0.0001
Radium (pCi/L)	<2.7	<2.7	<2.7	<2.7
Gross alpha (pCi/L)	17.3	1.52	8	5
Gross beta (pCi/L)	392	34.19	55	29
Total coliform (Ct/100 mL)	NF[c]	NF	NF	NF
Groundwater quality				
Chloride	26.8	10	7.7	2.9
Iron	2.9	1.4	0.1	4.8
Manganese	0.12	0.078	0.013	0.20
Phenols	0.003	<0.001	0.002	<0.001
Sodium	10	2.6	3.8	3.2
Sulfate	158	66	35	20
Indicators				
pH (units)	11.1	9	8.5	8.6
	11.1	9.4	8.2	8.6
	11.1	9.1	8.4	8.5
	10.4	8.3	8.3	8.7
Specific conductance (μmhos/cm)	753	529	403	370
	3000	527	423	370
	3000	666	412	340
	2860	453	403	370
Total organic carbon	64	29	44	22
	44	29	39	76
	160	29	38	58
	75	30	42	50
Total organic halogen	0.9	0.063	0.18	0.011
	0.91	0.061	0.19	0.010
	0.91	0.054	0.17	<0.010
	0.87	0.063	0.2	<0.010

[a]See Fig. 6.2.9.
[b]During 1986 detection levels for several parameters varied.
[c]NF = not found.

Table 6.2.30. 1986 concentrations of parameters in well GW-241 at Chestnut Ridge Sludge Disposal Basin

Parameter	Concentration (mg/L)			
	1st Qtr. (2/28/86)	2nd Qtr. (4/18/86)	3rd Qtr. (Not available)	4th Qtr. (Not available)
Drinking water				
Arsenic	0.005	<0.005		
Barium	0.042	0.031		
Cadmium	<0.003	<0.003		
Chromium	<0.01	<0.01		
Lead	0.02	0.01		
Mercury	<0.0002	<0.0002		
Selenium	<0.005	<0.005		
Silver	<0.006	<0.006		
Fluoride	0.08	0.1		
Nitrate nitrogen	<0.11	<0.11		
Endrin	<0.05	<0.1		
Lindane	<0.01	<0.02		
Methoxychlor	<0.04	<0.08		
Toxaphene	<1	<2		
2,4-D	<1	<2		
Radium (pCi/L)	<2.7	<2.7		
Gross alpha (pCi/L)	17	0.71		
Gross beta (pCi/L)	11	1.71		
Total coliform (counts/100 mL)	4	3		
Silvex	<0.1	<0.2		
Groundwater				
Chloride	1.6	<1		
Iron	13	7.8		
Manganese	0.6	0.61		
Phenols	0.002	<0.002		
Sodium	0.78	0.56		
Sulfate	2.3	1.5		
Indicators				
pH (units)	7.6	7.5		
	7.6	7.5		
	7.6	7.4		
	7.6	7.5		
Specific conductance (μmhos/cm)	298	274		
	300	280		
	303	282		
	303	282		
Total organic carbon	47	46		
	47	46		
	47	47		
	38	45		
Total organic chloride	27			
	22	11		
	23	30		
	22	27		

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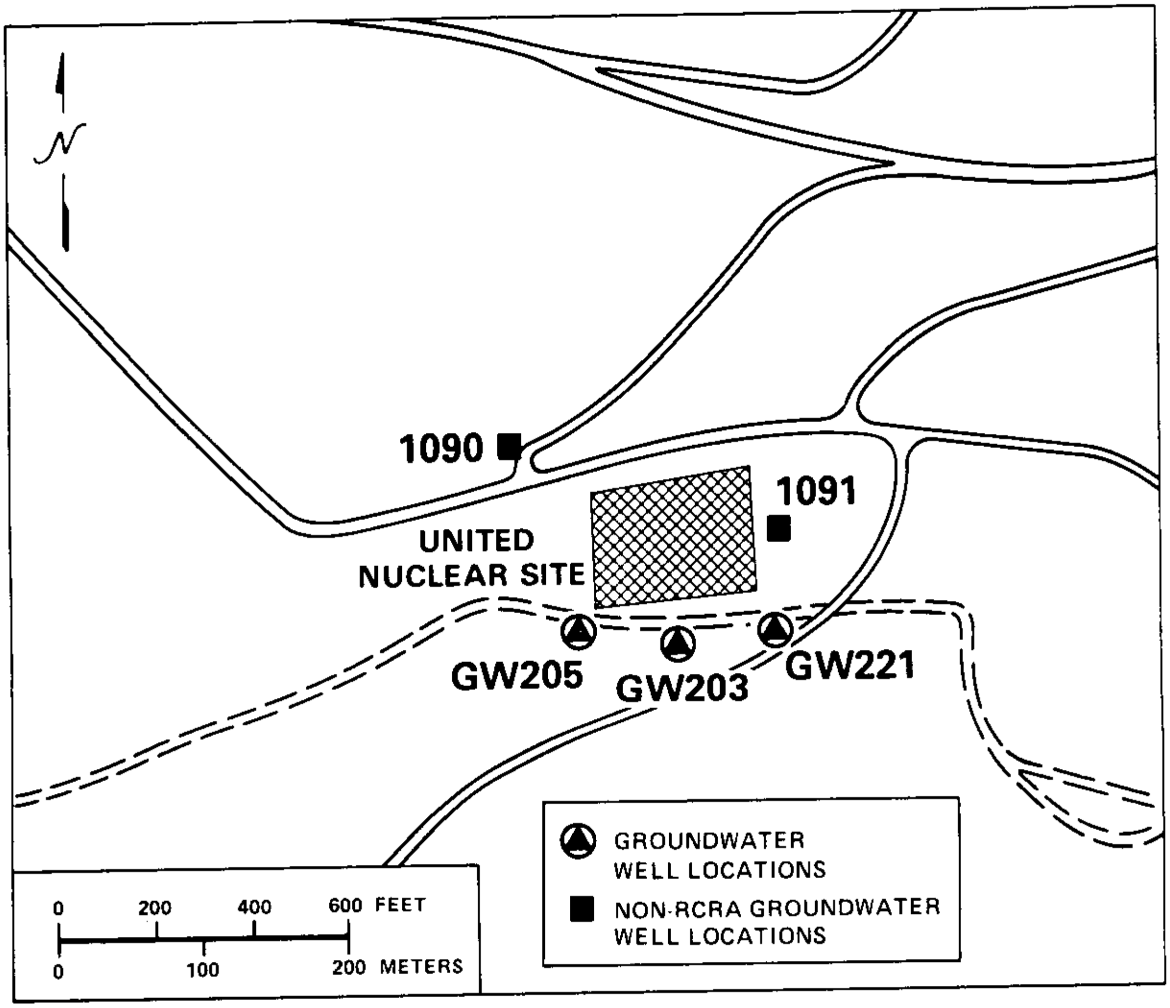

Fig. 6.2.10. Locations of groundwater wells around United Nuclear Site.

soil/bedrock interface. During the installation of the surface conductors, zones of cavity formation and solutional alteration were encountered within 3 to 7.6 m of the top of bedrock. The vertical extent of such cavities ranged from 0.3 to 3 m. In all cases, the surface conductor was advanced 0.3 to 1.5 m past the bottom of the first significant cavity encountered below the top of bedrock (Haase, Gillis, and King, 1987).

Wells GW-203, GW-205, and GW-221 were placed south of the active site to monitor movement of material away from the site in a direction perpendicular to strike. The wells are 47.5, 50, and 48.1 m deep, respectively. Existing wells at the site, Nos. 1090 and 1091, are also screened in the interval at the top of bedrock. Well 1090 is northwest of the disposal area and serves to investigate movement of material perpendicular to strike northward from the site. Well 1091, east of the site, serves to monitor potential contaminant movement parallel to strike. Comparison of hydrologic data from all wells should permit identification of the groundwater divide and resolution of its significance to groundwater flow at the site (Haase, Gillis, and King, 1987).

The 1986 concentrations of parameters in groundwater from the United Nuclear Corporation site are given in Table 6.2.31 and 6.2.35.

Table 6.2.31. 1986 concentrations of parameters from well Y-GMW-24[a] at the United Nuclear Corporation site

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/18/86)	2nd Qtr. (4/17/86)	3rd Qtr. (7/10/86)	4th Qtr. (10/8/86)
Drinking water				
Arsenic	<0.06	<0.005	<0.005	<0.005
Barium	<0.2	0.021	0.020	0.020
Cadmium	<0.002	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	<0.01	0.014
Lead	0.2	0.004	0.006	0.008
Mercury	<0.0005	<0.0002	<0.0002	<0.0002
Selenium	<0.002	<0.005	<0.005	<0.005
Silver	<0.01	<0.006	<0.006	<0.006
Fluoride	0.11	0.1	0.1	0.1
Nitrate nitrogen	2.6	2.03	1.65	1.25
Endrin	*c*	*c*	<0.0001	<0.00005
Lindane	*c*	*c*	<0.00002	<0.00001
Methoxychlor	*c*	*c*	<0.00008	<0.00004
Toxaphene	*c*	*c*	<0.002	<0.001
2,4-D	*c*	*c*	<0.002	<0.001
Silvex	*c*	*c*	<0.0002	<0.0001
Radium (pCi/L)	<3.1	<2.7	0.97	<2.7
Gross alpha (pCi/L)	<1.0	52	<1.0	<1.0
Gross beta (pCi/L)	16	27	<4.0	4.0
Total coliform (Ct/100 mL)	<1	2	NF[d]	NF
Groundwater quality				
Chloride	29	36.8	26	17.7
Iron	6.6	0.085	0.024	0.16
Manganese	0.30	0.008	0.0080	0.0095
Phenols	<0.001	0.016	0.012	0.003
Sodium	7.7	11	10	7.9
Sulfate	<10	3.4	2.6	1.8
Indicators				
pH (units)	7.3	7.2	7.4	7.7
		7.2	7.4	7.7
		7.2	7.4	7.7
		7.2	7.4	7.7
Specific conductance (μmhos/cm)	570	534	517	486
		555	518	489
		557	518	489
		558	518	490
Total organic carbon	3.0	76	61	72
		58	60	73
		66	60	77
		10	58	78
Total organic halogen	0.187	0.044	0.010	<0.010
	0.191	0.044	0.011	<0.010
	0.173	0.097	0.011	<0.010
	0.193	0.148	0.012	<0.010

[a]See Fig. 6.2.10.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.
[d]NF = not found.

Table 6.2.32. 1986 concentrations of parameters from well Y-GMW-25[a] at the United Nuclear Corporation site

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/19/86)	2nd Qtr. (4/17/86)	3rd Qtr. (7/11/86)	4th Qtr. (10/06/86)
Drinking water				
Arsenic	<0.06	<0.005	<0.005	<0.005
Barium	<0.2	0.0031	0.10	0.0069
Cadmium	<0.002	<0.003	<0.0042	<0.003
Chromium	<0.01	<0.01	<0.031	<0.010
Lead	0.2	<0.004	0.016	<0.05
Mercury	<0.0005	<0.0002	0.0003	<0.0002
Selenium	<0.002	<0.005	<0.005	<0.005
Silver	<0.01	<0.006	<0.006	<0.006
Fluoride	0.10	0.1	0.1	<0.1
Nitrate nitrogen	0.40	0.41	0.33	0.29
Endrin	*c*	*c*	<0.0001	<0.00005
Lindane	*c*	*c*	<0.00002	<0.00002
Methoxychlor	*c*	*c*	<0.00008	<0.00004
Toxaphene	*c*	*c*	<0.002	<0.001
2,4-D	*c*	*c*	<0.002	<0.001
Silvex	*c*	*c*	<0.0002	<0.0001
Radium (pCi/L)	<3.1	<2.7	3.5	<2.7
Gross alpha (pCi/L)	3.6	0.51	8.5	<1.0
Gross beta (pCi/L)	150	3.06	12.0	3.0
Total coliform (Ct/100 mL)	<1	NF[d]	NF	NF
Groundwater quality				
Chloride	7	1.1	1.0	<1
Iron	0.68	0.013	25	0.26
Manganese	0.02	12	1.4	0.016
Phenols	<0.001	0.003	0.002	0.002
Sodium	2.6	1.7	2.2	2
Sulfate	<10	1.2	1.5	1.5
Indicators				
pH (units)	9.0	7.9	8.6	7.9
		7.9	8.6	7.8
		7.9	8.6	7.8
		7.9	8.6	7.9
Specific conductance (μmhos/cm)	160	214	172	255
		220	179	253
		221	178	252
		223	176	252
Total organic carbon	2.0	30	26	38
		28	24	39
		29	24	34
		24	22	37
Total organic halogen	0.164	0.075	0.011	<0.010
	0.161	0.031	0.011	<0.010
	0.162	0.060	0.012	<0.010
	0.169	0.070	0.010	0.079

[a]See Fig. 6.2.10.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.
[d]NF = not found.

Table 6.2.33. 1986 concentrations of parameters from well 205 at the United Nuclear Corporation site

Parameter	Concentration (mg/L)			
	1st Qtr. (2/6/86)	2nd Qtr. (4/16/86)	3rd Qtr. (7/8/86)	4th Qtr. (10/3/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	<0.05		<0.05	<0.05
Cadmium	0.029	<0.004	0.014	0.024
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	0.03	0.013	0.005	0.04
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.1	<0.1	0.1	<0.1
Nitrate nitrogen	<0.11	0.16	0.16	0.2
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	0.324	<2.7
Gross alpha (pCi/L)	16.8	4.08	<1	2
Gross beta (pCi/L)	16	3.78	<2	3
Total coliform (counts/100 mL)	*a*	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	<1	<1	<1	<1
Iron	6.5	3.3	0.076	4
Manganese	0.15	0.17	0.016	0.13
Phenols	0.007	<0.001	0.004	0.002
Sodium	2.5	0.73	0.57	0.78
Sulfate	8	4.6	3.9	3.3
Indicators				
pH (units)	7.7	7.8	7.7	8.1
	7.7	7.8	7.7	8.0
	7.6	8.1	7.8	8.3
	7.8	7.9	7.8	8.1
Specific conductance (umhos/cm)	278	247	273	273
	294	260	273	272
	294	262	274	274
	299	262	274	273
Total organic carbon	12	44	39	60
	10	45	39	50
	12	45	38	55
	10	43	39	68
Total organic chloride	11	357	16	50
	9	<5	17	54
	10	7	19	45
	10	217	14	63

[a]No colonies observed.

Table 6.2.34. 1986 concentrations of parameters from well 203 at the United Nuclear Corporation site

Parameter	Concentration (mg/L)			
	1st Qtr. (2/6/86)	2nd Qtr. (4/16/86)	3rd Qtr. (7/9/86)	4th Qtr. (10/6/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	<0.05		<0.05	<0.05
Cadmium	<0.004	<0.004	0.013	0.03
Chromium	<0.01	<0.01	<0.01	<0.01
Lead	0.004	<0.004	0.005	0.006
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.1016	<0.1	0.1	<0.1
Nitrate nitrogen	0.59	0.7	0.68	0.75
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	0.432	<2.7
Gross alpha (pCi/L)	1.35	0.92	<1	2
Gross beta (pCi/L)	5.29	6.04	<2	1
Total coliform (counts/100 mL)	4	*a*	*a*	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	0.5	1	1.2	1.2
Iron	0.026	0.01	0.0074	0.55
Manganese	0.0035	0.0027	0.0015	0.024
Phenols	0.003	<0.001	<0.001	0.002
Sodium	1.2	0.82	0.7	0.69
Sulfate	2.1	1.2	1	<1
Indicators				
pH (units)	7.7	8.9	9	8.4
	7.7	8.9	9	8.3
	7.6	9	9	8.4
	7.8	9	9.1	8.4
Specific conductance (μmhos/cm)	151	142	149	196
	158	136	154	174
	160	137	151	175
	160	136	152	180
Total organic carbon	12	22	24	24
	25	22	25	29
	35	23	23	28
	12	22	24	27
Total organic chloride	16	<5	10	22
	15	11	10	32
	13	6	10	<10
	14	190	10	<10

[a]No colonies observed.

Table 6.2.35. 1986 concentrations of parameters from well 221 at the United Nuclear Corporation site

Parameter	Concentration (mg/L)			
	1st Qtr. (2/7/86)	2nd Qtr. (4/17/86)	3rd Qtr. (7/9/86)	4th Qtr. (10/7/86)
Drinking water				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.0013	0.0042	0.0037	0.0077
Cadmium	<0.003	<0.003	<0.003	<0.003
Chromium	<0.01	<0.01	0.014	0.031
Lead	0.006	0.004	0.01	0.009
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.006	<0.006	<0.006	<0.006
Fluoride	0.07	0.2	0.1	0.1
Nitrate nitrogen	0.25	0.41	0.36	0.36
Endrin	<0.05	<0.1	<0.1	<0.05
Lindane	<0.01	<0.02	<0.02	<0.01
Methoxychlor	<0.04	<0.08	<0.08	<0.04
Toxaphene	<1	<2	<2	<1
2,4-D	<1	<2	<2	<1
Radium (pCi/L)	<2.7	<2.7	0.378	7.56
Gross alpha (pCi/L)	0.77	10.28	<1	<1
Gross beta (pCi/L)	<1	4.64	<2	<1
Total coliform (counts/100 mL)	*a*	*a*	1	*a*
Silvex	<0.1	<0.2	<0.2	<0.1
Groundwater				
Chloride	<0.1	1.1	1.1	1.1
Iron	0.14	0.11	0.18	0.086
Manganese	0.0049	0.0036	0.0095	0.0021
Phenols	<0.001	<0.002	0.003	0.009
Sodium	0.41	0.38	0.66	0.56
Sulfate	<1	1.3	1	<1
Indicators				
pH (units)	7.6	7.4	7.8	7.8
	7.5	7.4	7.7	7.8
	7.5	7.4	7.7	7.8
	7.5	7.4	7.7	7.8
Specific conductance (μmhos/cm)	253	257	270	278
	280	266	272	279
	286	266	273	277
	287	266	273	278
Total organic carbon	15	39	38	47
	13	38	37	42
	13	39	37	47
	20	39	37	44
Total organic chloride	1	<5	9	17
	1	<5	10	<10
	1	<5	9	39
	1	<5	10	<10

[a]No colonies observed.

The Centralized Sanitary Landfill II is located on a small hill on the southern slope of Chestnut Ridge. The facility receives industrial sanitary waste from all three DOE Oak Ridge installations. It is surrounded by three wells that are monitored quarterly along with the other disposal facility wells. Above-normal levels of gross alpha, gross beta, and coliform bacteria were detected in one set of samples during 1986. The data for this facility are reported in Tables 6.2.36 through 6.2.38.

The Bear Creek Valley Waste Disposal Area (BCVWDA) is located on the southern flank of Pine Ridge approximately 3.2 km west of the Oak Ridge Y-12 Plant. The area consists of several principal sites, many of which are no longer used for waste disposal, including the S-3 Ponds, the Oil Land Farm, and the Burial Grounds. Topography suggests that the general direction of flow is southwesterly toward Bear Creek. Water level measurements (Fig. 6.2.11) indicate that there are upward components of groundwater flow in most of the BCVWDA area.

Investigations by Geraghty & Miller (1985) show that contaminants entered surface water and groundwater from each of the three principal waste disposal areas in the BCVWDA. The main contaminants found were volatile organic compounds, nitrates, oils, heavy metals, and radioactive substances. Plumes of groundwater contamination have been defined at all three principal disposal sites. Generally, the contaminated groundwater extends only a few tens of meters away from the waste sources. The 1986 concentrations of parameters from wells at Bear Creek Valley Waste Disposal Area are given in Tables 6.2.39 through 6.2.57.

6.2.2 ORNL Monitoring

Solid and liquid wastes have been disposed of at a number of ORNL sites that are now being characterized. These sites are possible sources of leakage to groundwater. Wells are being installed for those requiring groundwater monitoring. Active and inactive waste management sites are shown in Fig. 6.2.12.

Active sites. The equalization basin was constructed as two 1.137-million-liter ponds to provide for emergency holding when the low-level waste stream flow was too great for the collection tanks to provide sufficient time for radioactive decay. The basin, identified as Area 3524 is

ORNL–DWG 87-8685

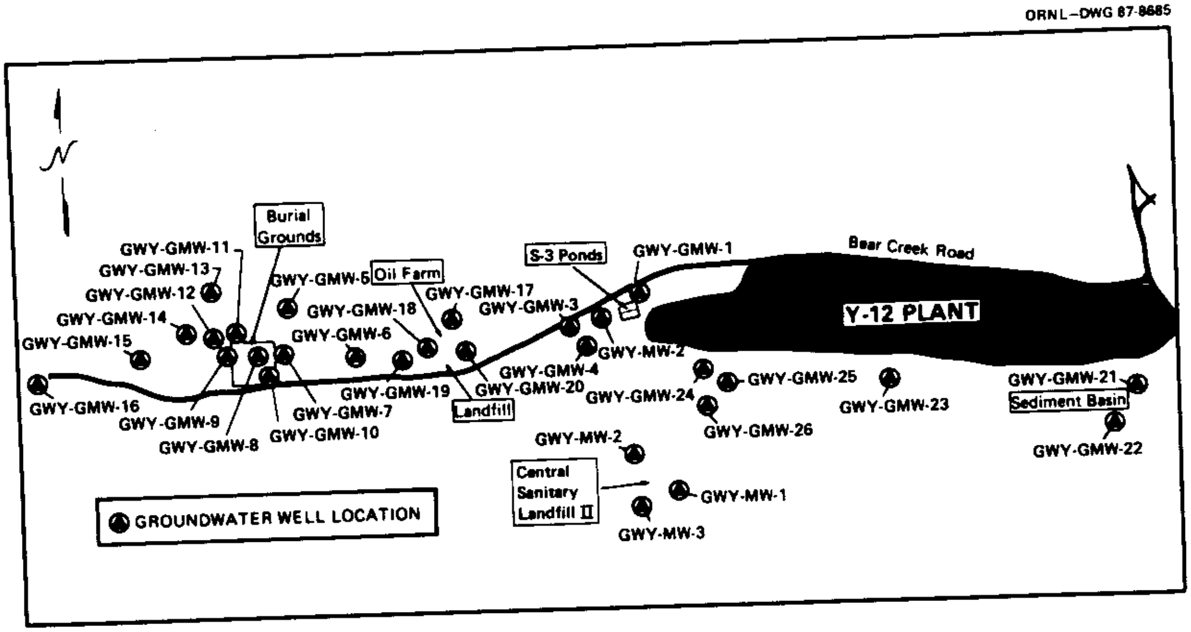

Fig. 6.2.11. Locations of some of the groundwater wells near waste areas.

ORNL-DWG 87-8744

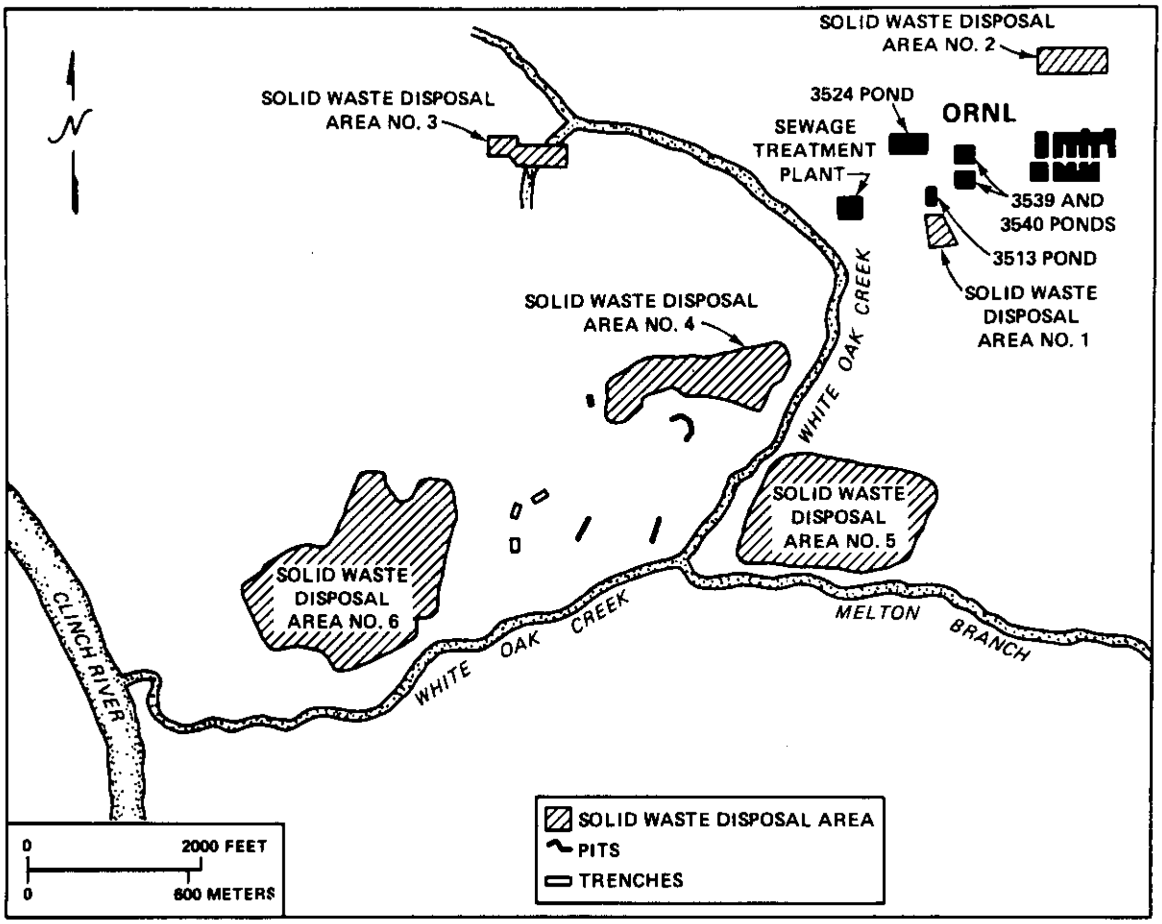

Fig. 6.2.12. General locations of active and inactive waste sites at ORNL.

shown in Fig. 6.2.13. After the waste pits were constructed in 1952, the ponds were no longer needed, and 1953 the earthen divider between the ponds was removed to create the existing equalization basin, which is currently used as the surge and flow equalization basin for the process wastewater treatment plant (3524). This basin is approximately 91.44 by 91.44 m.

Holding basins 3539 and 3540 receive process wastewater from the 4500 complex. The basins located just north of White Oak Creek adjacent to basins 3524 and 3513 have top dimensions of approximately 18.3 by 7.6 m. Holding basins 3539 and 3540 are still in operation, holding the water for determination of radioactive contamination.

Basin 7905 was installed in conjunction with basin 7906 to handle process wastewater drainage from HFIR. Both basins are located at the south end of the HFIR facility in Melton Valley. Wastewater from these basins is monitored for radioactive contamination and then released into the headwaters of Melton Branch. Top dimensions of 7905 and 7906 basins are approximately 15.2 by 30.5 m and 38.1 by 30.5 m, respectively.

Basins 7907 and 7908 were installed to handle process wastewater drainage from the transuranic processing facility. Both basins are located adjacent to the HFIR facility basins (7905 and 7906) at the south end of the HFIR facility in Melton Valley. Wastewater from these basins is

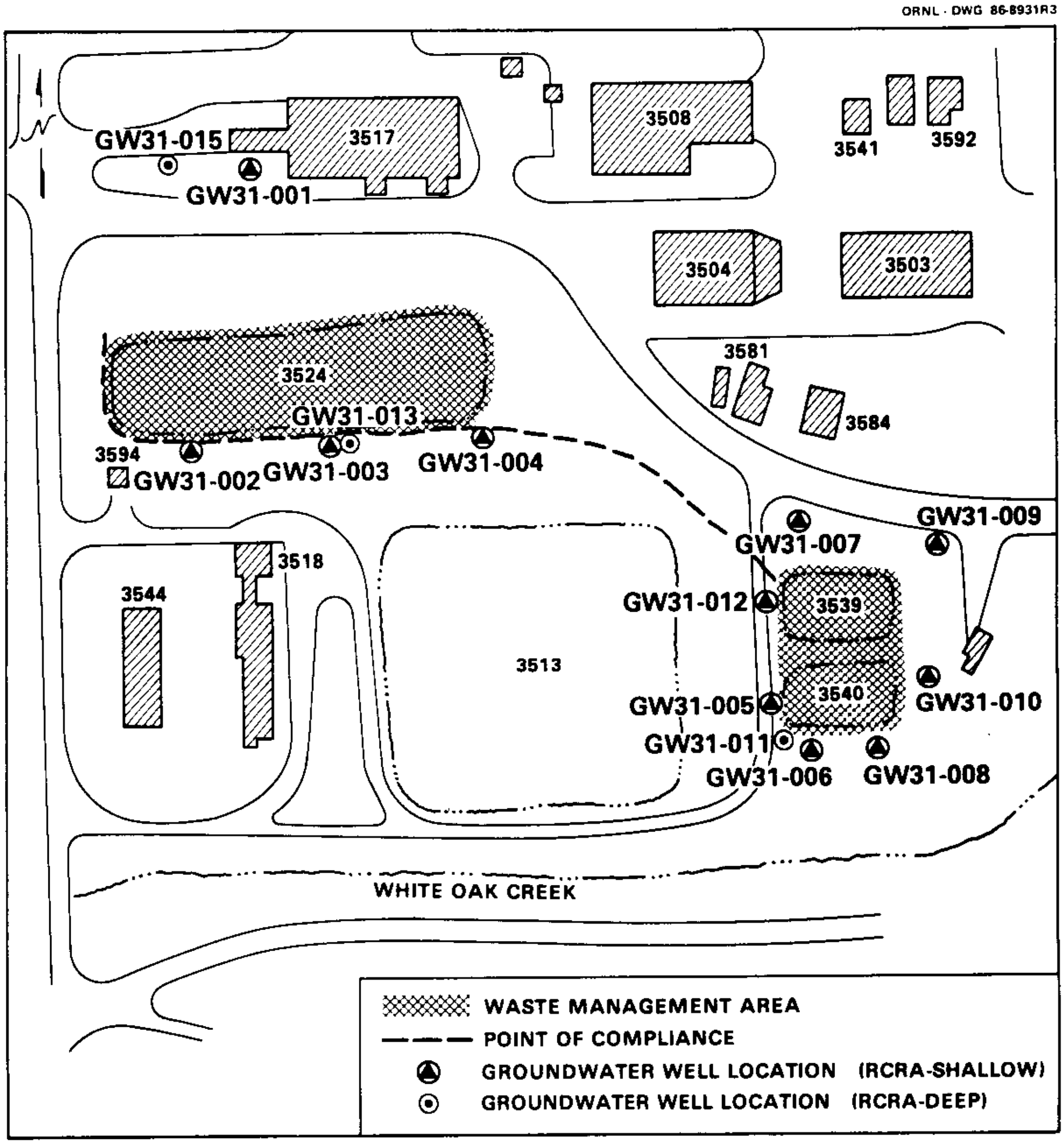

Fig. 6.2.13. Locations of groundwater wells around ponds 3524, 3539, and 3540.

monitored for radioactive contamination and then released into the headwaters of Melton Branch. Top dimensions of each basin are approximately 13.7 by 22.9 m.

The SWSA 6 site was selected based on topography, soil, lack of surface flooding, and depth to the groundwater table. SWSA 6 is located in Melton Valley immediately northwest of White Oak Lake and southeast of Lagoon Road and Haw Ridge and bounded by White Oak Dam. In 1980, ORNL made a concerted effort to ensure that no hazardous waste was handled at SWSA 6. Information available on waste buried is limited to the solid radioactive waste category (e.g., ^{233}U/TRU waste, ^{235}U waste, or general radioactive waste), the type of

Table 6.2.36. 1986 concentrations of parameters from well Y-MW-1[a] at Centralized Sanitary Landfill II

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/17/86)	2nd Qtr. (6/24/86)	3rd Qtr. (8/20/86)	4th Qtr. (10/23/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	<0.2	<0.2	0.0285
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	<0.01	<0.01	<0.006
Lead	<0.01	<0.01	0.01	<0.02
Mercury	<0.0005	<0.0005	<0.0005	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	<0.1	<0.1	<0.1	<0.1
Nitrate nitrogen	0.6	0.4	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	<3.3	<3.3	<5	<5.3
Gross alpha (pCi/L)	<1	<1	15	4.4
Gross beta (pCi/L)	<4	27	67	16
Total coliform (Ct/100 mL)	1	<1	<1	10
Groundwater quality				
Chloride	23	16	16	18
Iron	0.51	0.97	0.93	0.34
Manganese	0.03	0.03	0.04	0.322
Phenols	<0.001	<0.001	<0.001	0.001
Sodium	8.9	8.3	8.1	8.28
Sulfate	12	<10	<10	<10
Indicators				
pH (units)	7.1	7.2	7.2	6.9
Specific conductance (μmhos/cm)	580	570	580	730
Total organic carbon	3.4	3.0	2.4	3.2
Total organic halogen	0.230	0.270	0.043	0.050
	0.200	0.240	0.064	0.054
	0.170	0.250	0.069	0.033
	0.190	0.220	0.066	0.046

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.37. 1986 concentrations of parameters from well Y-MW-2[a] at Centralized Sanitary Landfill II

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/17/86)	2nd Qtr. (5/12/86)	3rd Qtr. (8/20/86)	4th Qtr. (10/23/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	<0.2	<0.2	0.2	0.0318
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	<0.02	<0.01	<0.006
Lead	<0.01	<0.01	<0.01	<0.02
Mercury	<0.0005	<0.0005	<0.0005	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.11	<0.4	<0.1	<0.1
Nitrate nitrogen	0.8	1.0	1.0	0.3
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	<3.3	<3.1	<3.1	<3.2
Gross alpha (pCi/L)	4.6	13	7.7	13
Gross beta (pCi/L)	<4	77	<4.0	<4.0
Total coliform (Ct/100 mL)	<1	<1	20	<1
Groundwater quality				
Chloride	3	3	5	5
Iron	12	5.4	0.95	0.93
Manganese	0.27	0.12	0.03	0.015
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	<10	11	<10	13
Sulfate	<10	<11	<10	<13
Indicators				
pH (units)	7.7	7.7	7.5	7.6
Specific conductance (μmhos/cm)	340	350	360	320
Total organic carbon	22	2.0	2.0	<2.0
Total organic halogen	0.030	0.135	<0.078	<0.010
	c	0.150	0.069	<0.010
	c	0.140	0.080	<0.010
	c	0.120	0.082	<0.010

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.38. 1986 concentrations of parameters from well Y-MW-3[a] at Centralized Sanitary Landfill II

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/17/86)	2nd Qtr. (6/23/86)	3rd Qtr. (9/29/86)	4th Qtr. (10/23/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	<0.2	<0.2	0.245	0.269
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	<0.02
Mercury	<0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.13	<0.1	<0.1	<0.1
Nitrate nitrogen	0.2	0.4	<0.1	0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	<3.3	<6.5	<5.0	<5.0
Gross alpha (pCi/L)	<1	<1.0	7.1	13
Gross beta (pCi/L)	54	<4.0	19	12
Total coliform (Ct/100 mL)	10	22	<1	<1
Groundwater quality				
Chloride	13	<2	2	4
Iron	1.1	0.37	0.56	0.31
Manganese	0.04	0.02	0.029	0.013
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	0.5	0.6	0.55	0.54
Sulfate	<10	<10	<10	<10
Indicators				
pH (units)	7.2	7.2	7.2	7.2
Specific conductance (μmhos/cm)	550	480	600	570
Total organic carbon	3.6	2.6	8.2	4.4
Total organic halogen	0.009	0.260	0.072	<0.010
	c	0.470	0.053	<0.010
	c	0.420	0.089	0.031
	c	0.460	0.051	0.017

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.39. 1986 concentrations of parameters from well GW-115[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (1/15/86)	2nd Qtr. *c*	3rd Qtr. (9/3/86)	4th Qtr. (12/15/86)
Drinking water				
Arsenic	<0.5		<0.5	<0.04
Barium	<0.5		<0.5	0.324
Cadmium	<0.5		<0.5	<0.003
Chromium	<0.5		<0.5	<0.006
Lead	<0.005		<0.005	<0.02
Mercury	*d*		0.0002	<0.0002
Selenium	<0.005		<0.5	<0.002
Silver	<0.5		<0.5	<0.004
Fluoride	*d*		*d*	0.1
Nitrate nitrogen	*d*		*d*	*d*
Endrin	*d*		*d*	*d*
Lindane	*d*		*d*	*d*
Methoxychlor	*d*		*d*	*d*
Toxaphene	*d*		*d*	*d*
2,4-D	*d*		*d*	*d*
Silvex	*d*		*d*	*d*
Radium (pCi/L)	*d*		*d*	<3.9
Gross alpha (pCi/L)	<2		<5	<1.0
Gross beta (pCi/L)	<4		<3	<4.0
Total coliform (Ct/100 mL)	*d*		*d*	<1
Groundwater quality				
Chloride	<5		2.8	7
Iron	1.9		<0.5	0.40
Manganese	<0.5		<0.5	0.206
Phenols	*d*		*d*	<0.001
Sodium	8.3		9.1	7.50
Sulfate	14		8.4	15
Indicators				
pH (units)	7.4		*d*	7.5
Specific conductance (μmhos/cm)	300		*d*	430
Total organic carbon	0.64		1.9	4.0
Total organic halogen	*d*		0.008	<0.010
	d		*d*	<0.010
	d		*d*	0.033
	d		*d*	0.018

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not sampled.
[d]Not measured.

Table 6.2.40. 1986 concentrations of parameters from well Y-GMW-2[a] Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/6/86)	2nd Qtr. (4/14/86)	3rd Qtr. (7/24/86)	4th Qtr. (10/27/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	5.5	5.2	6.8
Cadmium	<0.002	<0.002	0.002	<0.003
Chromium	<0.01	0.04	0.03	0.053
Lead	<0.01	0.01	0.04	0.05
Mercury	0.0027	<0.0005	<0.0005	0.0003
Selenium	<0.002	<0.002	<0.002	0.003
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.6	<0.1	<0.1	<0.1
Nitrate nitrogen	10.4	1200	1000	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<6.0	4.0	<5.7
Gross alpha (pCi/L)	94	68	69	25
Gross beta (pCi/L)	53	920	76	22
Total coliform (Ct/100 mL)	110	100	<1	<1
Groundwater quality				
Chloride	31	36	31	31
Iron	0.71	24	20	49.8
Manganese	0.22	1.7	1.3	1.72
Phenols	<0.001	0.005	0.004	<0.001
Sodium	20	22	24	18.6
Sulfate	78	12	11	13
Indicators				
pH (units)	7.1	6.6	6.8	6.7
Specific conductance (μmhos/cm)	960	810	7.4	10000
Total organic carbon	4.8	25	14	7.0
Total organic halogen	0.037	0.260	0.019	<0.010
	c	0.230	*c*	0.045
	c	0.240	*c*	0.030
	c	0.245	*c*	0.028

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.41. 1986 concentrations of parameters from well Y-GMW-3[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/6/86)	2nd Qtr. (4/14/86)	3rd Qtr. (7/24/86)	4th Qtr. (10/27/86)
Drinking water				
Arsenic	<0.3	<0.06	<0.06	<0.04
Barium	2.0	2.1	2.0	2.00
Cadmium	0.049	0.048	0.049	0.049
Chromium	0.061	0.02	<0.01	<0.006
Lead	<0.1	0.07	0.27	0.54
Mercury	0.0005	<0.0005	<0.0005	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.02	<0.01	<0.01	<0.004
Fluoride	4.9	5.1	5	5.2
Nitrate nitrogen	682	640	470	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	8.4	8.5	<3.7
Gross alpha (pCi/L)	150	67	120	230
Gross beta (pCi/L)	730	600	650	500
Total coliform (Ct/100 mL)	<1	100	<1	<1
Groundwater quality				
Chloride	65	62	46	41
Iron	19	8.1	2.4	0.85
Manganese	14	12	12	13.8
Phenols	<0.001	<0.001	0.005	<0.001
Sodium	80	75	75	63.3
Sulfate	22	10	10	<10
Indicators				
pH (units)	5.2	5.0	4.8	4.1
Specific conductance (μmhos/cm)	4.9	4.6	3400	4000
Total organic carbon	12	25	17	8.2
Total organic halogen	0.011	0.330	0.021	<0.010
	c	0.330	0.019	0.040
	c	0.330	0.022	0.023
	c	0.330	0.018	0.024

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.42. 1986 concentrations of parameters from well Y-GMW-4[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/6/86)	2nd Qtr. (4/15/86)	3rd Qtr. (7/24/86)	4th Qtr. (10/27/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	<0.2	<0.2	0.134
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	<0.01	<0.01	<0.006
Lead	<0.01	<0.01	<0.01	<0.02
Mercury	<0.0005	<0.0005	<0.0005	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.1	0.5	0.4	0.5
Nitrate nitrogen	96	26	28	17
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.2	<4.0	<3.1
Gross alpha (pCi/L)	180	54	170	240
Gross beta (pCi/L)	160	72	97	110
Total coliform (Ct/100 mL)	<1	2	<1	80
Groundwater quality				
Chloride	25	110	49	37
Iron	0.57	0.15	0.32	0.04
Manganese	0.30	0.31	0.98	0.365
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	34	39	44	38.3
Sulfate	18	120	120	130
Indicators				
pH (units)	6.6	7.0	7.0	7.0
Specific conductance (μmhos/cm)	1000	1300	1100	1200
Total organic carbon	16	11	10	8.5
Total organic halogen	0.120	0.280	0.020	0.281
	0.130	*c*	*c*	0.275
	0.110	*c*	*c*	0.213
	0.110	*c*	*c*	0.256

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.43. 1986 concentrations of parameters from well Y-GMW-5[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/10/86)	2nd Qtr. (4/29/86)	3rd Qtr. (8/19/86)	4th Qtr. (11/10/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	<0.02	<0.2	0.130
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	<0.01	<0.01	0.007
Lead	<0.01	<0.01	<0.01	<0.02
Mercury	0.0006	0.0008	<0.0005	0.0003
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.27	0.16	0.12	0.2
Nitrate nitrogen	0.5	0.3	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.2	<2.9	<5.5
Gross alpha (pCi/L)	5.1	14	<1.0	<1.0
Gross beta (pCi/L)	<4.0	63	17	<4.0
Total coliform (Ct/100 mL)	90	<1	<1	7
Groundwater quality				
Chloride	4.0	3.9	4.0	4.0
Iron	2.8	5.5	2.9	7.65
Manganese	0.10	0.31	0.46	1.87
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	8.6	9.6	10	10.7
Sulfate	54	76	110	160
Indicators				
pH (units)	7.4	7.5	7.3	7.3
Specific conductance (μmhos/cm)	470	550	630	670
Total organic carbon	6.6	2.8	<2.0	2.4
Total organic halogen	0.015	0.180	0.030	<0.010
	0.014	0.160	0.027	<0.010
	0.015	0.190	0.027	<0.010
	0.013	0.180	0.029	<0.010

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.44. 1986 concentrations of parameters from well Y-GMW-6[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/13/86)	2nd Qtr. (4/15/86)	3rd Qtr. (9/10/86)	4th Qtr. (12/11/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.4	0.4	0.462	0.484
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	<0.02
Mercury	<0.0005	<0.0005	0.0002	<0.0003
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.17	<0.1	<0.1	<0.1
Nitrate nitrogen	0.2	0.3	<0.1	<0.2
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<3.3	<5.1	<3.4
Gross alpha (pCi/L)	16	8.0	<1.0	29
Gross beta (pCi/L)	60	26	38	180
Total coliform (Ct/100 mL)	4	<1	<1	<1
Groundwater quality				
Chloride	5	<2	2	2
Iron	0.85	0.80	1.55	0.59
Manganese	0.02	0.01	0.049	0.044
Phenols	<0.001	<0.001	0.001	<0.001
Sodium	5.8	4.7	9.08	7.85
Sulfate	<10	10	10	10
Indicators				
pH (units)	7.6	8.2	7.6	7.9
Specific conductance (μmhos/cm)	340	350	350	340
Total organic carbon	<2.0	2.9	9.4	2.7
Total organic halogen	0.026	0.095	0.044	0.051
	0.025	0.080	0.060	*c*
	0.026	0.110	0.049	*c*
	0.028	0.090	0.075	*c*

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.45. 1986 concentrations of parameters from well Y-GMW-7[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/6/86)	2nd Qtr. (5/1/86)	3rd Qtr. (7/31/86)	4th Qtr. (11/4/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	<0.2	<0.2	0.0611
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	0.02	<0.01	<0.006
Lead	0.02	0.02	0.05	<0.02
Mercury	0.0007	0.0010	0.0009	0.0004
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.3	<0.1	0.2	0.15
Nitrate nitrogen	0.5	0.5	<0.1	0.2
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<3.3	<5.0	<5.7
Gross alpha (pCi/L)	16	<1.0	4.7	7.4
Gross beta (pCi/L)	<4	6.2	<4.0	26
Total coliform (Ct/100 mL)	40	800	120[c]	<1
Groundwater quality				
Chloride	<2	<2	2	<2
Iron	4.4	11	6.6	4.34
Manganese	0.010	0.45	0.43	0.190
Phenols	<0.001	<0.001	0.002	0.002
Sodium	0.6	0.9	0.5	0.57
Sulfate	12	12	<10	30
Indicators				
pH (units)	6.8	6.4	6.7	6.2
Specific conductance (μmhos/cm)	110	99	110	96
Total organic carbon	3.6	3	3.9[d]	8.0
Total organic halogen	0.033	0.110	0.041	0.111
	0.028	0.130	*c*	0.125
	0.031	0.100	*c*	0.111
	0.036	0.110	*c*	0.096

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.
[d]Sample date 8/4/86.

Table 6.2.46. 1986 concentrations of parameters from well Y-GMW-8[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/7/86)	2nd Qtr. (4/22/86)	3rd Qtr. (8/25/86)	4th Qtr. (11/4/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.6	0.6	0.712	0.770
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	<0.02
Mercury	<0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	<0.1	<0.1	<0.1	<0.1
Nitrate nitrogen	0.3	0.2	0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<3.3	<5.1	<3.1
Gross alpha (pCi/L)	<1.0	23	28	9.7
Gross beta (pCi/L)	<4.0	15	94	<4.0
Total coliform (Ct/100 mL)	<1	<1	<1	4
Groundwater quality				
Chloride	130	130	130	130
Iron	0.59	0.39	0.70	0.92
Manganese	0.32	0.36	0.438	0.470
Phenols	0.002	<0.001	0.005	0.001
Sodium	7.3	8.9	8.66	8.05
Sulfate	<10	<10	<10	7
Indicators				
pH (units)	6.6	6.7	6.7	6.6
Specific conductance (μmhos/cm)	1040	1100	1100	1000
Total organic carbon	30	26	25	19
Total organic halogen	1.89	0.89	2.89	8.25
	2.01	0.92	2.74	9.34
	1.81	0.88	2.59	7.87
	1.88	0.90	2.42	7.54

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.47. 1986 concentrations of parameters from well Y-GMW-9 at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/7/86)	2nd Qtr. (4/30/86)	3rd Qtr. (9/15/86)	4th Qtr. (11/4/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.4
Barium	<0.2	<0.2	0.0691	0.0866
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	0.008	<0.006
Lead	0.01	0.05	<0.02	0.2
Mercury	<0.0005	<0.0005	0.0002	0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.73	<0.1	<0.1	<0.1
Nitrate nitrogen	0.5	0.2	0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.2	<5.5	<3.8
Gross alpha (pCi/L)	<1.0	<1.0	9.0	<1.0
Gross beta (pCi/L)	41	23	5.5	40
Total coliform (Ct/100 mL)	<1	<1	<1	<1
Groundwater quality				
Chloride	<2	<2	<2	3
Iron	<0.06	0.75	0.03	0.26
Manganese	<0.01	0.01	<0.001	0.007
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	3.3	6.0	5.87	4.55
Sulfate	<10	<10	<10	9
Indicators				
pH (units)	11	12	11.5	11.6
Specific conductance (μmhos/cm)	390	1500	560	700
Total organic carbon	<2	3.7	<2.0	2.0
Total organic halogen	0.017	0.120	0.029	<0.010
	c	0.140	0.057	<0.010
	c	0.120	0.049	<0.010
	c	0.110	0.060	<0.010

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.48. 1986 concentrations of parameters from well Y-GMW-10 at Bear Creek Valley Waste Dispsoal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/13/86)	2nd Qtr. (4/24/86)	3rd Qtr. (8/25/86)	4th Qtr. (12/2/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	<0.2	<0.2	0.186	0.139
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	0.02	<0.02	<0.02
Mercury	<0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	<0.1	<0.1	<0.1	<0.1
Nitrate nitrogen	0.4	0.6	0.1	0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.1	<5.0	<2.9
Gross alpha (pCi/L)	<1.0	<1.0	<1.0	120
Gross beta (pCi/L)	9.8	<4.0	<4.0	150
Total coliform (Ct/100 mL)	220	<1	<1	8
Groundwater quality				
Chloride	4	5.6	3	5
Iron	1.1	0.49	3.40	0.08
Manganese	0.03	0.02	0.132	0.008
Phenols	<0.001	<0.001	<0.010	0.005
Sodium	2.4	2.8	3.72	3.19
Sulfate	15	12	<10	11
Indicators				
pH (units)	7.2	7.7	7.6	7.1
Specific conductance (μmhos/cm)	380	410	350	420
Total organic carbon	2.2	<2.0	2.7	49
Total organic halogen	0.024	0.105	0.070	0.195
	0.025	0.100	0.086	0.190
	0.024	0.110	0.075	0.207
	0.022	0.110	0.088	0.197

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.49. 1986 concentrations of parameters from well Y-GMW-13 at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)			
	1st Qtr. *b*	2nd Qtr. (5/8/86)	3rd Qtr. *b*	4th Qtr. *b*
Drinking water				
Arsenic		<0.06		
Barium		<0.2		
Cadmium		<0.002		
Chromium		<0.01		
Lead		<0.01		
Mercury		<0.0005		
Selenium		<0.002		
Silver		<0.01		
Fluoride		0.20		
Nitrate nitrogen		0.2		
Endrin		*c*		
Lindane		*c*		
Methoxychlor		*c*		
Toxaphene		*c*		
2,4-D		*c*		
Silvex		*c*		
Radium (pCi/L)		<3.3		
Gross alpha (pCi/L)		<1.0		
Gross beta (pCi/L)		15		
Total coliform (Ct/100 mL)		<1		
Groundwater quality				
Chloride		<2		
Iron		2.4		
Manganese		1.2		
Phenols		<0.001		
Sodium		7.0		
Sulfate		13		
Indicators				
pH (units)		7.0		
Specific conductance (μmhos/cm)		250		
Total organic carbon		2.8		
Total organic halogen		0.078		
		0.073		
		0.088		
		0.069		
		0.081		

[a]See Fig. 6.2.11.
[b]Not sampled.
[c]Not measured.

Table 6.2.50. 1986 concentrations of parameters from well Y-GMW-15 at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)			
	1st Qtr. *b*	2nd Qtr. *b*	3rd Qtr. (7/23/86)	4th Qtr. *b*
Drinking water				
Arsenic			<0.06	
Barium			<0.2	
Cadmium			<0.002	
Chromium			<0.01	
Lead			<0.01	
Mercury			<0.0005	
Selenium			<0.002	
Silver			<0.01	
Fluoride			<0.1	
Nitrate nitrogen			<0.1	
Endrin			*c*	
Lindane			*c*	
Methoxychlor			*c*	
Toxaphene			*c*	
2,4-D			*c*	
Silvex			*c*	
Radium (pCi/L)			<4.5	
Gross alpha (pCi/L)			<1.0	
Gross beta (pCi/L)			<4.0	
Total coliform (Ct/100 mL)			190	
Groundwater quality				
Chloride			<2	
Iron			0.21	
Manganese			0.15	
Phenols			0.004	
Sodium			6.4	
Sulfate			16	
Indicators				
pH (units)			7.7	
Specific conductance (μmhos/cm)			310	
Total organic carbon			4	
Total organic halogen			0.200	
			0.190	
			0.190	
			0.200	

[a]See Fig. 6.2.11.
[b]Not sampled.
[c]Not measured.

Table 6.2.51. 1986 concentrations of parameters from well Y-GMW-17 at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/12/86)	2nd Qtr. (4/21/86)	3rd Qtr. (8/28/86)	4th Qtr. (12/11/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.3	0.3	0.405	0.458
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	0.02
Mercury	<0.0005	<0.0005	0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	0.004	<0.004
Fluoride	0.15	0.1	<0.1	<0.1
Nitrate nitrogen	0.3	0.3	<0.1	<0.2
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.1	<2.9	<3.1
Gross alpha (pCi/L)	<1.0	28	<1.0	51
Gross beta (pCi/L)	<4.0	20	<4.0	<4.0
Total coliform (Ct/100 mL)	<1	<1	<1	<1
Groundwater quality				
Chloride	<2	<2	<2	<2
Iron	0.54	0.48	0.76	2.75
Manganese	0.02	0.04	0.038	0.134
Phenols	<0.001	<0.001	<0.001	0.001
Sodium	3.8	5.0	5.20	5.19
Sulfate	<10	<10	<10	<10
Indicators				
pH (units)	7.7	7.7	7.6	7.8
Specific conductance (μmhos/cm)	330	320	340	330
Total organic carbon	2.2	<2	2.2	3.3
Total organic halogen	0.026	0.100	0.021	0.021
	0.024	0.110	0.039	*c*
	0.026	0.110	0.010	*c*
	0.024	0.100	0.039	*c*

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.52. 1986 concentrations of parameters from well Y-GMW-18[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/10/86)	2nd Qtr. (5/7/86)	3rd Qtr. (8/26/86)	4th Qtr. (12/2/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.06	<0.04
Barium	<0.2	<0.2	<0.2	0.186
Cadmium	<0.002	<0.002	<0.002	<0.003
Chromium	<0.01	<0.01	<0.01	<0.006
Lead	0.02	<0.01	0.02	<0.02
Mercury	<0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.01	<0.004
Fluoride	0.20	<0.1	0.1	<0.1
Nitrate nitrogen	0.6	0.2	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.8	<5.1	<5.2
Gross alpha (pCi/L)	26	9.3	<1.0	43
Gross beta (pCi/L)	42	<4.0	<4.0	40
Total coliform (Ct/100 mL)	<1	30	200	<1
Groundwater quality				
Chloride	9.0	17	5.0	20
Iron	6.3	2.9	2.7	0.78
Manganese	0.29	1.5	0.66	0.246
Phenols	<0.001	<0.001	0.002	0.007
Sodium	2.0	3.5	3.7	4.20
Sulfate	110	36	26	11
Indicators				
pH (units)	6.5	6.1	6.3	6.5
Specific conductance (μmhos/cm)	420	340	360	380
Total organic carbon	27	6.2	12	6.2
Total organic halogen	0.083	0.180	0.114	0.105
	0.077	0.190	0.166	0.103
	0.087	0.170	0.144	0.085
	0.085	0.190	0.130	0.098

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.53. 1986 concentrations of parameters from well Y-GMW-19[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/10/86)	2nd Qtr. (4/28/86)	3rd Qtr. (8/26/86)	4th Qtr. (12/10/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.2	0.2	0.273	0.321
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	<0.02
Mercury	<0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	<0.1	<0.1	<0.1	<0.1
Nitrate nitrogen	0.1	0.2	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.2	<4.9	<5.0
Gross alpha (pCi/L)	<1.0	<1.0	<1.0	<1.0
Gross beta (pCi/L)	130	<4.0	<4.0	23
Total coliform (Ct/100 mL)	<1	<1	<1	70
Groundwater quality				
Chloride	69	75	84	64
Iron	1.8	2.4	1.32	16.4
Manganese	0.08	0.09	0.092	4.85
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	13	16	17.7	14.6
Sulfate	58	56	64	46
Indicators				
pH (units)	7.1	7.1	7.0	6.6
Specific conductance (μmhos/cm)	880	900	890	760
Total organic carbon	40	3.4	5.4	12
Total organic halogen	0.190	0.250	0.178	0.094
	0.170	0.260	0.120	*c*
	0.170	0.240	0.150	*c*
	0.150	0.220	0.183	*c*

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.54. 1986 concentrations of parameters from well Y-GMW-20[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/10/86)	2nd Qtr. (5/7/86)	3rd Qtr. (8/27/86)	4th Qtr. (12/10/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	<0.2	<0.2	0.0993	0.0949
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	0.02	0.02	0.04	<0.02
Mercury	0.0012	0.0016	0.0014	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	<0.1	<0.1	<0.1	<0.1
Nitrate nitrogen	0.4	0.2	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.0	<3.2	<5.0
Gross alpha (pCi/L)	23	<1.0	<1.0	61
Gross beta (pCi/L)	<4.0	24	91	14
Total coliform (Ct/100 mL)	28	<1	<1	<1
Groundwater quality				
Chloride	47	56	52	39
Iron	2.1	6.0	3.19	0.34
Manganese	0.11	0.38	0.387	10.6
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	24	26	25.5	39.5
Sulfate	44	36	37	56
Indicators				
pH (units)	7.2	7.2	6.8	7.0
Specific conductance (μmhos/cm)	720	760	670	700
Total organic carbon	28	3.8	5.0	5.6
Total organic halogen	0.148	0.120	0.368	0.180
	0.150	0.140	0.311	*c*
	0.150	0.130	0.328	*c*
	0.140	0.110	0.329	*c*

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.55. 1986 concentrations of parameters from well GW-89[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/24/86)	2nd Qtr. (6/19/86)	3rd Qtr. (9/18/86)	4th Qtr. (12/16/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.5	1.4	1.53	0.620
Cadmium	0.003	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	0.074	0.011
Lead	0.04	<0.01	0.12	0.04
Mercury	0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.28	0.18	0.2	0.17
Nitrate nitrogen	0.2	0.1	0.2	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	<3.1	5.3	<5.0	<4.9
Gross alpha (pCi/L)	19	33	11	32
Gross beta (pCi/L)	66	6.4	34	<4.0
Total coliform (Ct/100 mL)	<1	<1	<1	<1
Groundwater quality				
Chloride	17	75	66	19
Iron	2.2	2.0	9.05	3.53
Manganese	1.1	2.0	2.31	1.47
Phenols	<0.001	<0.001	<0.001	<0.001
Sodium	6.4	11	10.1	7.12
Sulfate	<10	<10	<10	<10
Indicators				
pH (units)	7.1	7.2	7.3	7.6
Specific conductance (μmhos/cm)	370	700	660	390
Total organic carbon	2.9	6.0	7.0	5.6
Total organic halogen	0.035	0.285	0.050	0.076
	0.036	0.300	0.040	0.102
	0.034	0.290	0.040	0.064
	0.036	0.270	0.0609	0.062

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.56. 1986 concentrations of parameters from well GW-90[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/25/86)	2nd Qtr. (6/19/86)	3rd Qtr. (9/18/86)	4th Qtr. (12/16/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	<0.2	<0.2	0.334	0.245
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.1	0.093	0.023
Lead	0.05	0.04	0.32	0.11
Mercury	0.0005	<0.0005	<0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.18	0.12	0.13	0.1
Nitrate nitrogen	0.2	0.1	0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	<3.1	<3.1	<2.77	<5.5
Gross alpha (pCi/L)	30	64	11	29
Gross beta (pCi/L)	<4	11	35	<4.0
Total coliform (Ct/100 mL)	10	<1	<1	<1
Groundwater quality				
Chloride	2.0	3	3	2
Iron	1.5	0.52	12.8	4.98
Manganese	0.87	0.46	0.575	0.447
Phenols	<0.001	<0.001	0.002	<0.001
Sodium	24	31	31.5	26.6
Sulfate	17	14	13	22
Indicators				
pH (units)	8.0	8.2	7.9	8.0
Specific conductance (μmhos/cm)	400	350	380	410
Total organic carbon	2.5	42	9.6	4.4
Total organic halogen	0.330	0.245	<0.010	0.143
	0.330	0.250	<0.010	0.149
	0.340	0.240	<0.010	0.145
	0.320	0.240	<0.010	0.136

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

Table 6.2.57. 1986 concentrations of parameters from well GW-234[a] at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/25/86)	2nd Qtr. (6/19/86)	3rd Qtr. (9/18/86)	4th Qtr. (12/16/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	1.3	<0.2	1.47	0.758
Cadmium	0.004	<0.002	<0.003	<0.003
Chromium	0.21	<0.01	0.299	0.090
Lead	0.05	<0.01	0.13	0.16
Mercury	0.0005	<0.0005	0.0003	0.0005
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	<0.004	<0.004
Fluoride	0.20	0.14	0.15	0.14
Nitrate nitrogen	0.3	0.1	<0.1	<0.1
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.1	<5.3	<3.5
Gross alpha (pCi/L)	110	<1.0	87	42
Gross beta (pCi/L)	190	77	180	22
Total coliform (Ct/100 mL)	<1	<1	<1	100
Groundwater quality				
Chloride	2.4	3	4	2
Iron	150	3.3	147	71.7
Manganese	2.7	1.1	2.21	2.24
Phenols	0.004	<0.001	0.001	<0.001
Sodium	8.1	8.7	9.18	7.78
Sulfate	36	27	17	24
Indicators				
pH (units)	7.7	7.7	7.3	7.6
Specific conductance (μmhos/cm)	380	400	400	380
Total organic carbon	4.8	9.2	380	8.8
Total organic halogen	0.330	0.240	<0.010	0.059
	0.340	0.230	<0.010	0.057
	0.340	0.240	<0.010	0.060
	0.310	0.240	<0.010	0.060

[a]See Fig. 6.2.11.
[b]During 1986 detection levels for several parameters varied.
[c]Not measured.

waste (e.g., dry solids, contaminated equipment), and its volume. This site is still used for burial of solid low-level radioactive waste and asbestos.

Inactive sites. SWSA 4 was established in Melton Valley because the Conasauga Shale found in this area was thought to be better suited for disposal operations. SWSA 4 is located on the south side and at the foot of Haw Ridge, west of White Oak Creek.

SWSA 4 was established in 1951 and closed in 1958. Records of the types and volumes of waste disposed of in SWSA 4 before 1957 were destroyed in a fire. Records from 1957 and 1958 indicate approximately 7650 m^3 and 10,080 m^3, respectively, were buried. During the life of SWSA 4, ORNL produced only about half of the waste that was buried. The other half was a combination of wastes shipped in from over 50 different facilities. Very limited information is available about the types, concentrations, and quantities of waste disposed of at SWSA 4.

In an effort to decrease the impact of water intrusion, a surface runoff collector and diversion system were constructed in 1975. Several seeps have developed in various parts of SWSA 4. All analyses of the seeps and drainage from SWSA 4 have concentrated on the radionuclides present. No data concerning the presence of hazardous waste are available.

SWSA 5, located in Melton Valley, along Melton Branch, and east of the confluence of Melton Branch and White Oak Creek, consists of two sections on the hillside east of White Oak Creek and south of Haw Ridge. The site was selected based on topography, soil, distance from the ORNL site, lack of surface flooding, and depth to the groundwater table. It was established in 1958 and closed in 1973. Certain sections of SWSA 5 are still open for handling of transuranics.

Records on SWSA 5 operations were limited to volume, types of waste (laboratory wipes, contaminated equipment, glass, etc.), and basic radiological inventory. No data concerning specifics about hazardous waste disposed of at the site are available.

In May 1975, corrective action was taken to reduce the seepage in an area found to be contaminated with various radionuclides. Action in the south area included removal of overburden on certain trench areas, installation of two underground dams, and covering of the area with a PVC membrane. The areas were recovered with overburden, and a grass cover was planted to inhibit erosion. In addition, a near-surface seal of bentonite-shale mixture was placed over 14 trenches in the northern section.

Waste pit 1, located in Melton Valley just west of SWSA 4 along Lagoon Road, was opened as an experiment in 1951 and was closed in 1952. Its original purpose was to store concentrated low-level liquid waste in the tight, impermeable formation of the Conasauga Shale. Information discovered during the operation of the pit showed that the liquid seeped out, but the formation retained a high percentage of the isotopes. Therefore, this and later pits were used as seepage pits for radioactive liquid waste.

Waste pit 2 was built in weathered Conasauga Shale along the crest of a low ridge in Melton Valley and was designed to function as a seepage pit. Waste pit 1 was built in 1952, and pits 3 and 4 were built adjacent to it in 1955 and 1956, respectively. Each pit was approximately 4.6 m deep with sides sloping at an angle of 30°. Each pit had top dimensions of 64 by 30.5 m.

In an effort to get better interaction of the shale and certain radionuclides, NaOH was added to raise the pH to approximately 12 in pits 2, 3, and 4. By the end of 1958 approximately 91.2×402.8 L of radioactive liquid waste had been dumped into the pits.

Information relative to the waste handled was limited to radionuclide concentrations. Because the source of the radioactive liquid waste was laboratory and glovebox process drainage, it appears that a wide range of chemical and hazardous waste was disposed of in each pit. Very limited data are available on the seepage from the area; analysis has concentrated on the radionuclides present (18). Waste pits 2, 3, and 4 were backfilled with earth and paved over with asphalt in 1963, 1962, and 1981, respectively.

Based on studies of waste seepage pits 2, 3, and 4, it was determined that most of the waste solution moved parallel with the shale bedding.

Therefore, beginning with waste trench 5, the seepage basins constructed in Melton Valley were long, narrow trenches. Trench 5, opened and closed in 1960, was approximately 4.6 m deep with sides sloping so that the width at the bottom was 3 m. The top dimension of this trench was approximately 91.44 by 1.22 m. Waste sent to the trench was similar to that sent to pits 2, 3, and 4 consisting of general low-level radioactive liquid waste from ORNL facilities. Specific information on the waste handled is limited and relates mainly to radionuclides present. Waste trench 5 was backfilled with coarse, crushed limestone, capped with compacted dirt, and paved over with asphalt.

Waste trench 6 was constructed in Melton Valley in 1961 to replace trench 5. However, trench 6 operated only from September 7 to October 10 because of rapid migration of radioactivity from the trench to surface seeps attributed to groundwater flow through fractures in the shale. Trench 6 was constructed similar to trench 5 with a top dimension of 500 by 1.22 m. Trench 6 has since been backfilled with limestone and covered with asphalt.

Waste handled by trench 6 was radioactive process waste similar to that handled in the other pits and trenches. No specific information is available regarding hazardous waste handled or contained in the seeps.

Trench 7 was constructed in Melton Valley in the general area of the other pits and trenches. The trench was constructed in two separate sections with an overflow line connecting them. Liquids were added first to one section until it was filled and then to the second section. Trench 7 was the last seepage trench used for disposal of radioactive liquid waste at ORNL. It was approximately 4.6 m deep with sloping sides. Top dimensions of the trench were 61 by 1.22 m.

Waste handled was radioactive liquid from ORNL facilities including laboratory drainage. Limited available information is mainly concerned with radionuclides.

Monitoring system for active sites. The ORNL installation has a groundwater network consisting of 22 wells located adjacent to three impoundment areas: 3524, 7900, and 3539-40 (Figs. 6.2.13 and 6.2.14). The 3524 area consists of wells 31-001, 31-002, 31-003, 31-004, 31-013, and 31-015. The 7900 area consists of wells 32-001, 32-002, 32-003, 32-004, 32-005, 33-001, 33-002, and 33-003. The 3539-40 area consists of wells 31-005, 31-006, 31-007, 31-008, 31-009, 31-010, 31-011, and 31-012. The wells are classified as upgradient (reference) or downgradient depending on their location relative to the general direction of groundwater flow. Upgradient wells (31-001, 31-007, 31-009, 32-001, 33-001) were located so as to provide groundwater samples that would not be affected significantly by possible leakage from the impoundment. Downgradient wells (those not listed as upgradient) were located immediately adjacent to the waste management facility. RCRA well specifications are given in Table 6.2.58.

In accordance with regulations, each time a well was sampled at least four measurements per well were recorded for pH, specific conductance, and temperature. Four measurements were recorded for total organic carbon and total organic halides, and one measurement was recorded for the other parameters. Summaries of the total concentrations for total metals and other parameters are given in Tables 6.2.59 through 6.2.61. Concentrations of total metals include both metals in the liquid form and sediment. Samples collected for dissolved metals were filtered to remove particulate matter, and the concentrations were determined. Summary concentrations of dissolved metals are given in Table 6.2.62.

During 1986, water samples were collected twice from the shallow wells, four times from deep wells 31-013, 31-015, and 32-004, and three times from well 31-011 (which was dry during the third sampling period of the deep wells). The results are given in Tables 6.2.63 through 6.2.84.

Summaries of total concentrations for total metals and other parameters are given in Tables 6.2.85 through 6.2.92. The concentrations of total metals here also include liquid metals and metals in sediment, and samples collected for dissolved

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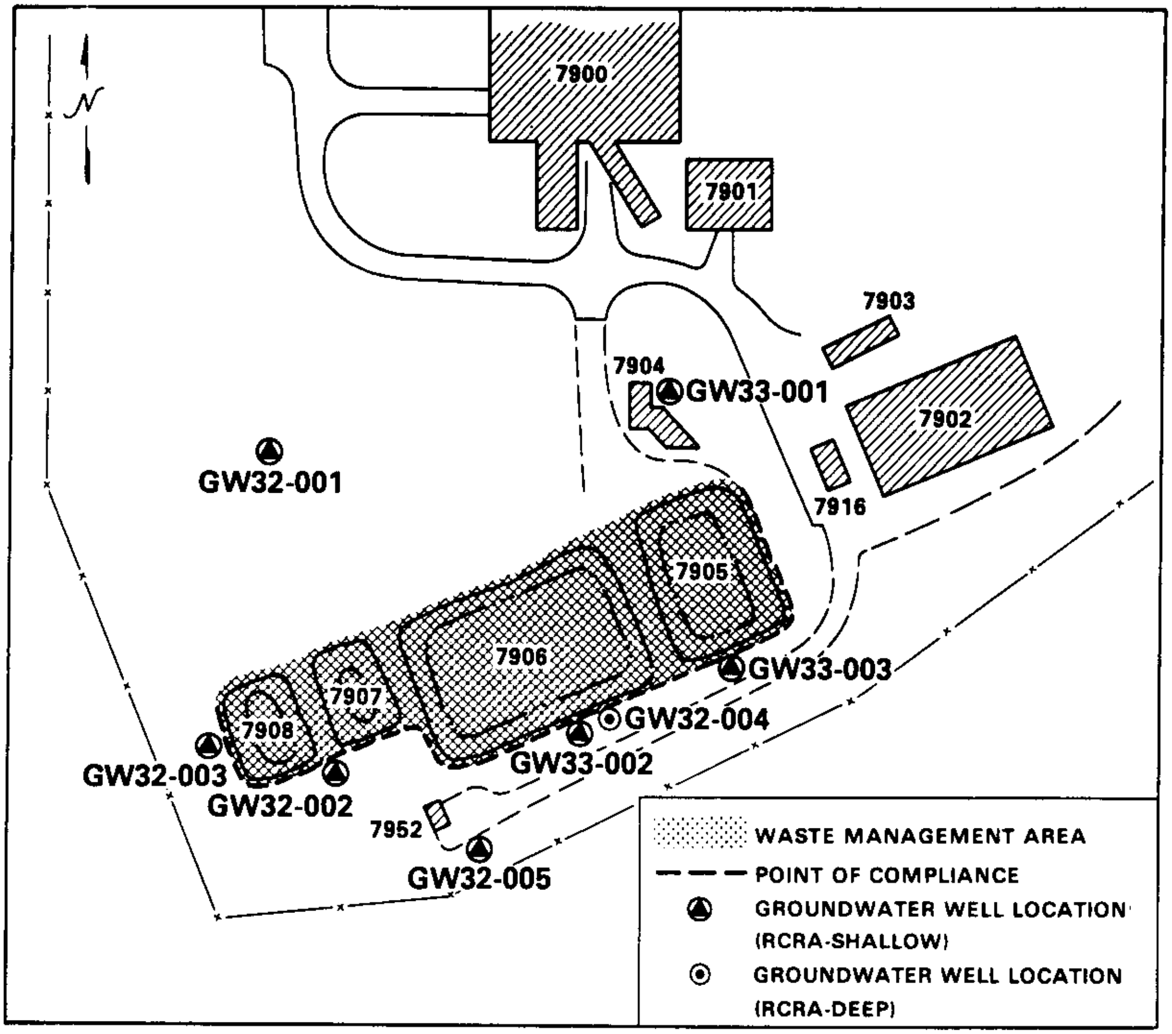

Fig. 6.2.14. Locations of groundwater wells around ponds 7905, 7906, 7907, and 7908.

metals were also filtered. Summary concentrations of dissolved metals are given in Table 6.2.92.

In comparing analytical values to EPA Interim Primary Drinking Water Standards, it was found that the values for several of the wells exceeded the standards for Ba, Cr, endrin, Pb, nitrate, gross alpha, and Ra (Table 6.2.93). Values for gross beta exceeded the calculated standard at least once at all wells.

The EPA Interim Primary Drinking Water Standard for gross beta is an annual dose equivalent of 4 millirem. A concentration was calculated from this dose based on ingestion of 2.2 L of water per day. All gross beta was assumed to be ^{90}Sr, which is a worst-case analysis. Its dose conversion factor of 1.438 rem/μCi was used to calculate the concentration.

Monitoring of inactive sites. Groundwater was sampled from wells in Solid Waste Storage Area (SWSA) 6 at ORNL (Fig. 6.2.15). Groundwater was sampled from wells in SWSAs 4 and 5 and from the pits and trenches (Figs. 6.2.16 to 6.2.18). Wells were selected for annual sampling from a group of about 100 monitoring wells, based on historical data and surface water flow

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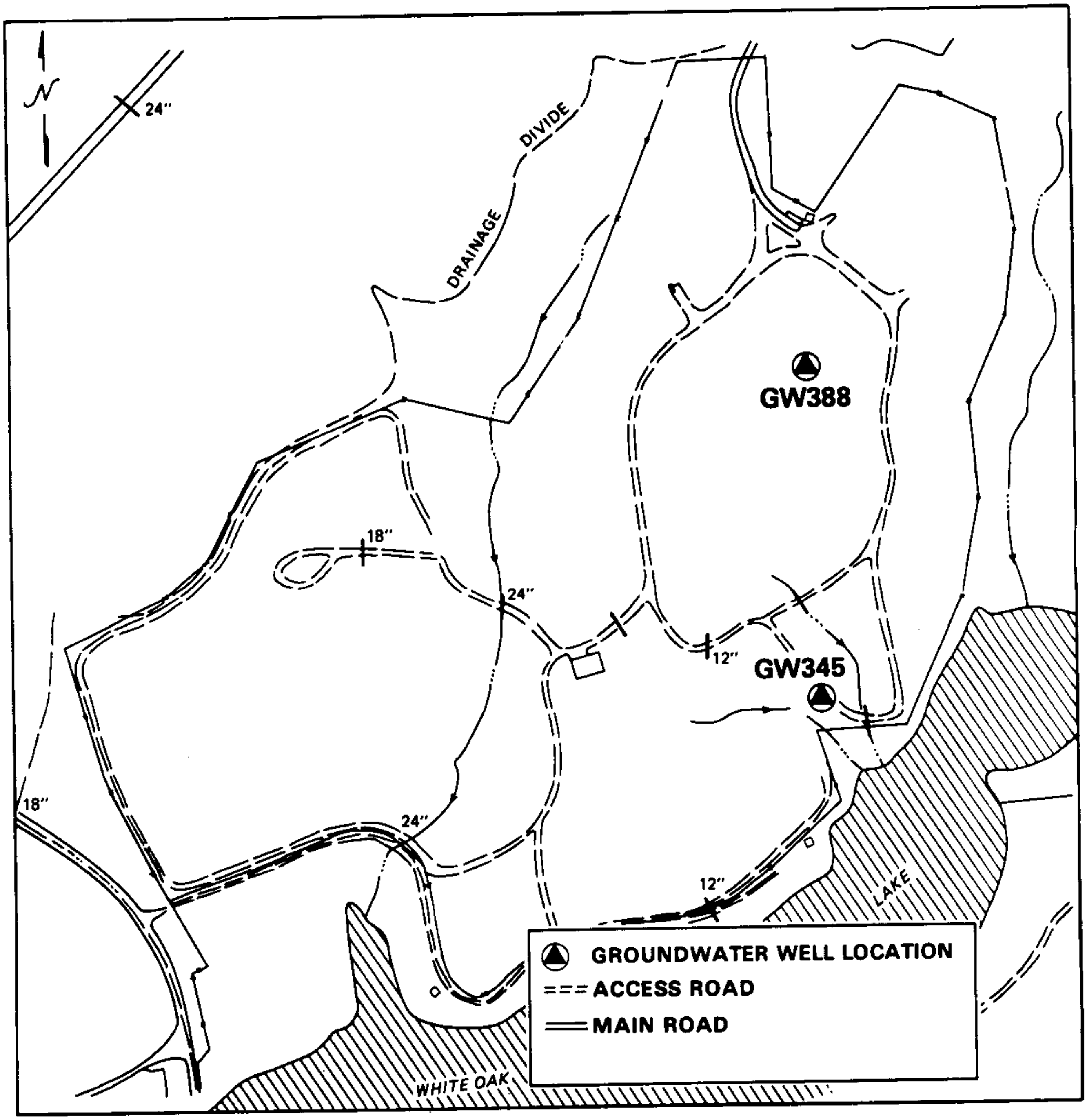

Fig. 6.2.15. Locations of some of the groundwater wells sampled near Solid Waste Storage Area 6.

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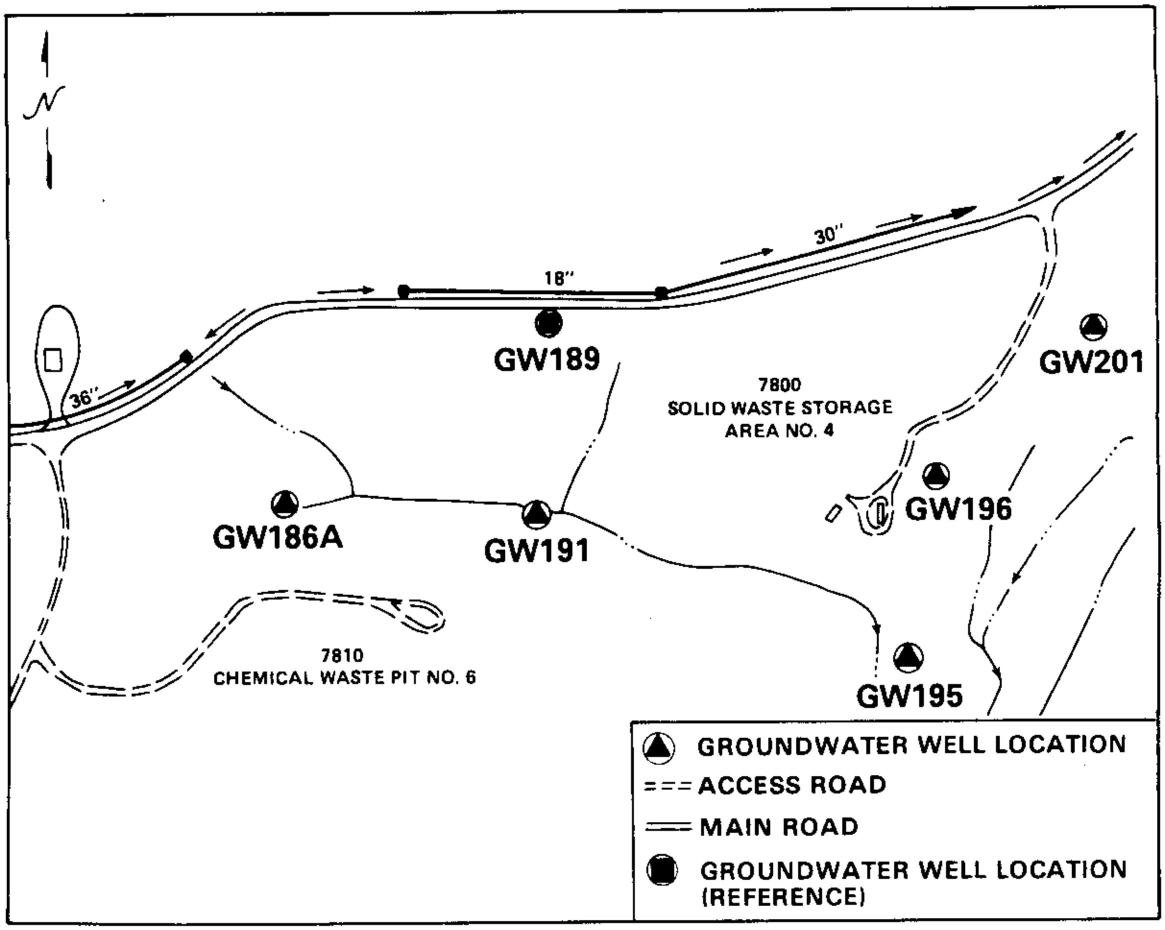

Fig. 6.2.16. Locations of some of the groundwater wells sampled near Solid Waste Storage Area 4.

patterns. Well number 189 (Fig. 6.2.15) in SWSA 4 was selected as a reference location because it is hydraulically upgradient from the waste storage area. It is to be considered only as a reference well and not as a background well because it is located in the SWSA.

During 1986, water samples collected from 18 wells were analyzed for gamma emitters, gross alpha and gross beta activity, tritium, and total strontium. Data on the concentrations of radionuclides measured in the monitoring and reference wells are presented in Table 6.2.94. Confidence intervals were not calculated because of the large variability among the well concentrations in a given SWSA. The average concentrations of specific radionuclides measured during 1986 appear to be similar to those measured during 1985.

The 3513 impoundment was constructed in 1944 to serve as a holding basin for wastewater until discharge into White Oak Creek. This unlined impoundment, which is ~67 by 67 m wide and 1 m deep, received ORNL liquid wastes until 1976 when a new process waste treatment plant began operations. Its location is illustrated in Fig. 6.2.19. On the east and north of the 3513 impoundment are three similar unlined impoundments (a large holding basin, 3524, and two smaller holding ponds, 3539 and 3540), which are currently being used to receive wastewater from ORNL. These holding basins and leaking underground waste lines represent

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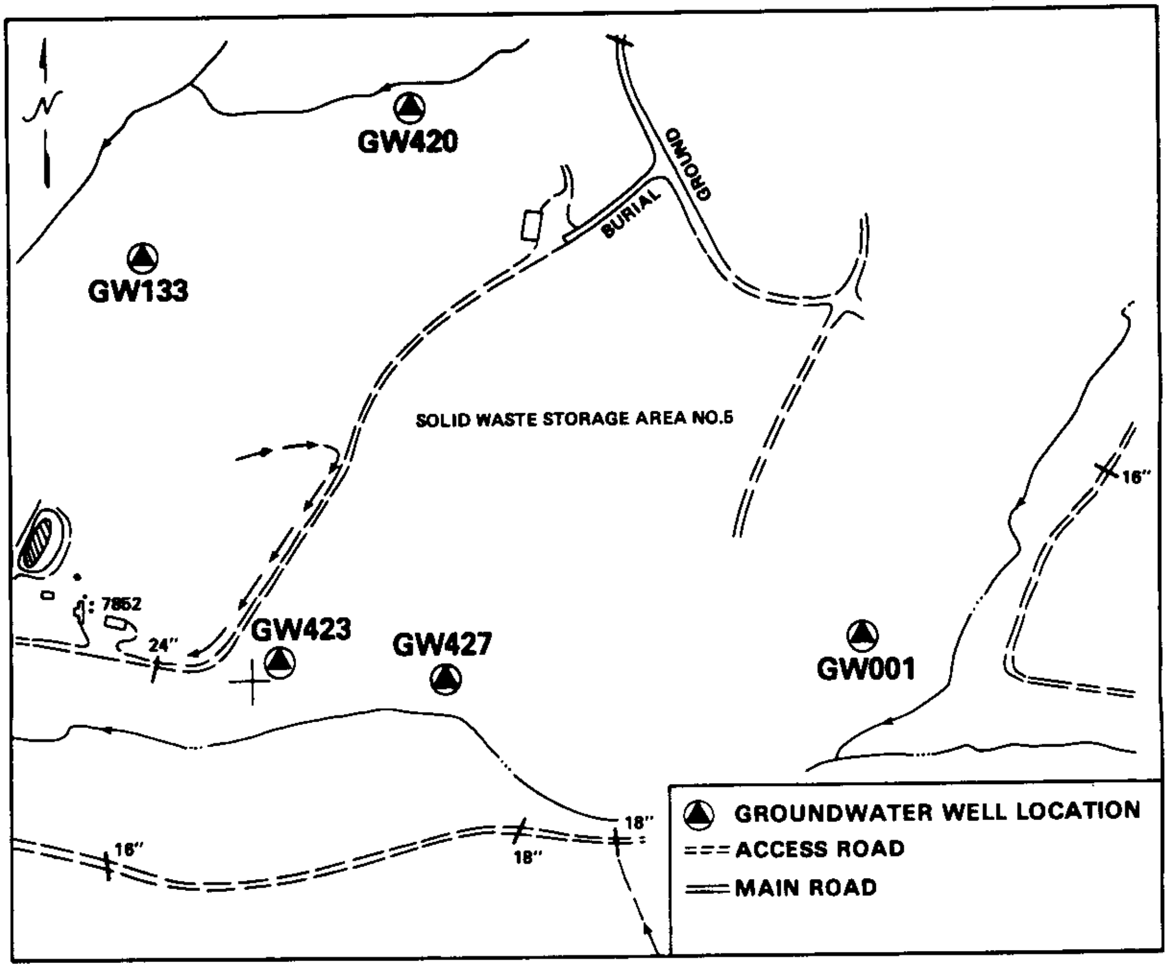

Fig. 6.2.17. Locations of some of the groundwater wells sampled near Solid Waste Storage Area 5.

potential sources of contamination to the groundwater, which is sampled from monitoring wells around 3513 (Francis and Stansfield, 1986).

The estimated capacity of the impoundment is 7.1×10^6 L. The net annual precipitation input to the pond is ~56 cm (which corresponds to $\sim 2.5 \times 10^6$ L). The water level is maintained by pumping the overflow water to the 3524 impoundment, where it is processed.

Five monitoring wells were installed around the perimeter of the 3513 impoundment in January 1985. The locations of these wells are shown in Fig. 6.2.20. Monitoring wells 1 and 1A were located to sample groundwater upgradient from the impoundment. "Upgradient" is defined here as the direction of increasing static head of the groundwater table. Monitoring well 1 (the bottom of which is 2.4 m below the ground surface) is not as deep as well 1A (the bottom of which is 7.6 m below the ground surface). The major difference is that well 1 does not penetrate the limestone bedrock underlying the clay soil. Well 1A, on the other hand, penetrates ~1 m into the limestone bedrock. The other three wells (2, 3, and 4) were located with the intent of sampling groundwater downgradient from the impoundment. These wells penetrate ~0.6 m into the limestone bedrock. Thus, approximately one-third of the well screen (which is 2.1 m in length) is located in the limestone bedrock (Francis and

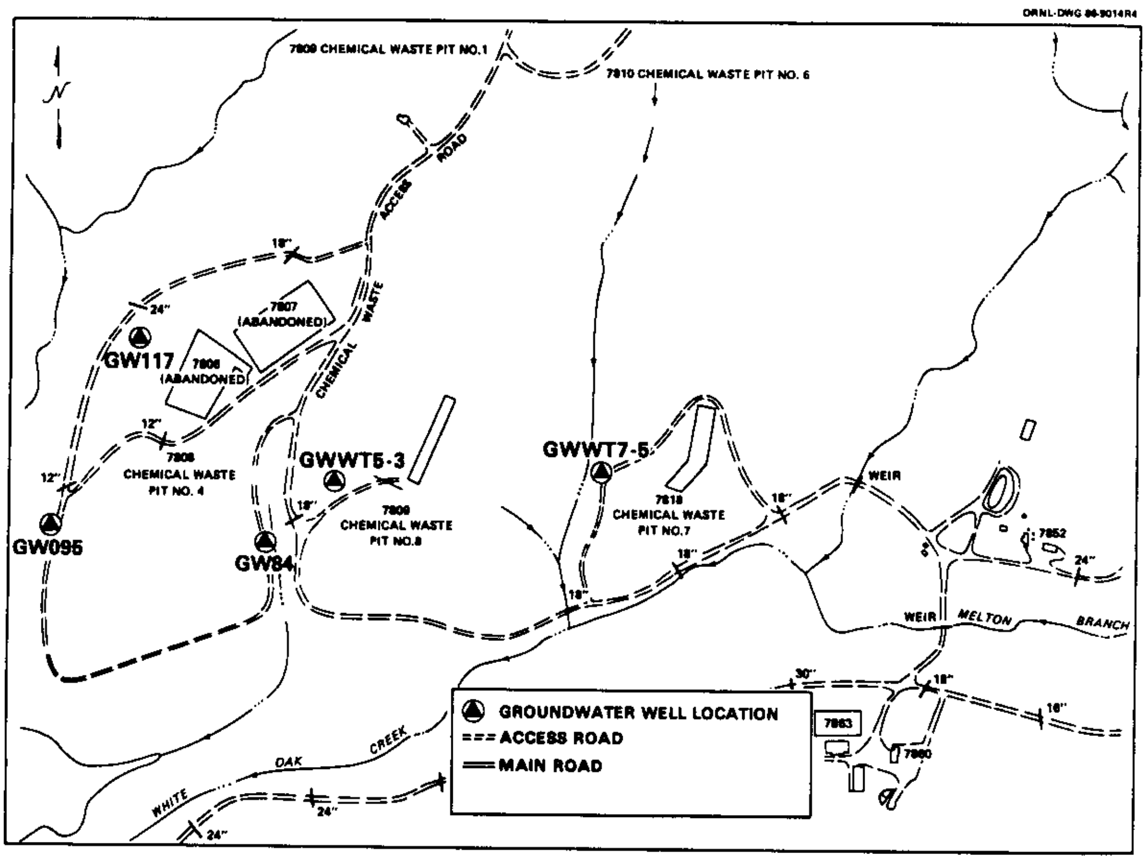

Fig. 6.2.18. Locations of some of the groundwater wells sampled near pits.

Stansfield, 1986). A geologic cross section of the 3513 impoundment area, illustrating the elevation of the groundwater in relation to the monitoring wells, is presented in Fig. 6.2.21.

The monitoring wells are constructed of 5.1-cm-diam stainless steel well screen and casing. The well screens have a continuous slot, 0.25 mm wide. The length of well screens ranges from 0.6 to 2.1 m, and all are surrounded by a sand pack of medium-grained quartz sand that extends a minimum of 30 cm above the elevation of the top of the well screen.

As shown in Table 6.2.95, mean concentrations of chromium, lead, gross alpha, gross beta, and mean counts of coliform bacteria in the downgradient wells exceed the maximum allowable levels estalished by RCRA. The maximum levels are also exceeded for mean counts of coliform bacteria and mean concentrations of gross alpha and gross beta in the upgradient wells, indicating possible migration of contaminant from one of the adjacent unlined impoundments (impoundments 3524, 3539, or 3940; see Fig. 6.2.19) or leakage from a broken transfer line (Stansfield and Francis, 1986a).

The high mean values for chromium in the downgradient wells appear to be because of the high chromium values measured in wells 2 and 4 during the first quarter of sampling (Table 6.2.95). The high concentrations of lead in the downgradient wells appear to have been caused by the high values observed in monitoring well 3 during the last three quarters of sampling. For this well, all three samples were in excess of the RCRA limit (0.05 mg/L) (Francis and Stansfield, 1986).

The groundwater from downgradient wells 2 and 4 contained considerably more gross alpha and gross beta activity than the groundwater

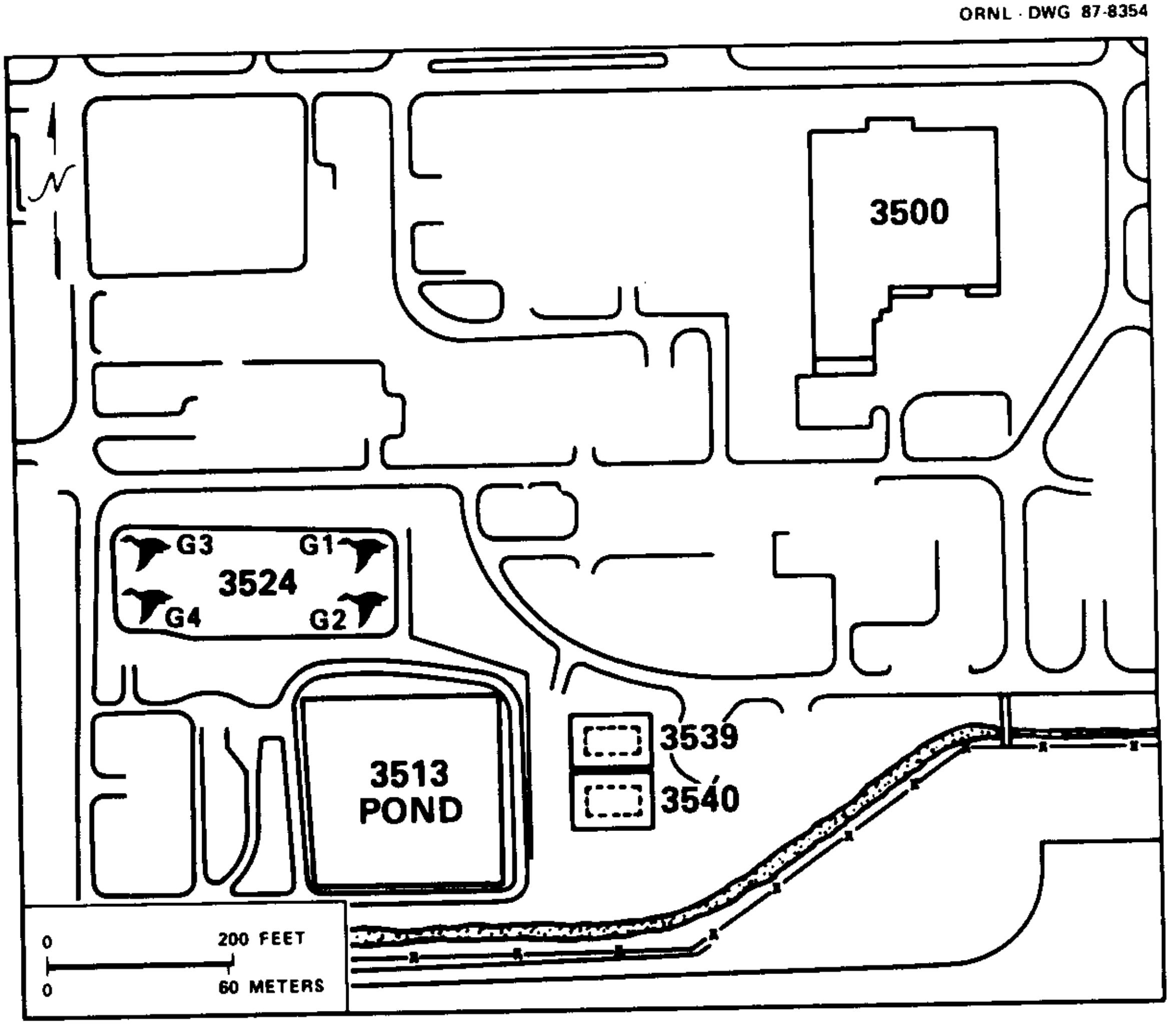

Fig. 6.2.19. Location of 3513 impoundment within ORNL.

from well 3 (the other downgradient well). Well 2 contained especially high concentrations of gross beta activity (mean value >1.85 pCi/L). One of the gross alpha measurements involved an analytical detection level greater than the RCRA limit (the measurement of the sample taken the first quarter from well 4). However, its inclusion or omission in the data set had little effect on the mean values of gross alpha in the downgradient wells. For example, the mean value for gross alpha in downgradient wells was <0.1739 pCi/L when all measurements were used and 0.1776 pCi/L when the measurement involving a detection level greater than the RCRA limit was deleted. In either case, both mean values exceeded the RCRA limit (Francis and Stansfield, 1986).

The mean levels of tritium and ^{90}Sr in groundwater from the downgradient wells were considerably greater than the level of activity necessary to give a total body dose of 4 mR/year to a person drinking 2.2 L of water per day for a year (see Table 6.2.95). However, only one tritium measurement in the upgradient wells (a measurement of 28.12 pCi/L taken the third quarter from well 1A) exceeded the calculated limit of 24.79 pCi/L.

Those concentrations measured in groundwater that exceeded the RCRA maximum limits are listed in Table 6.2.96. Measurements in which the

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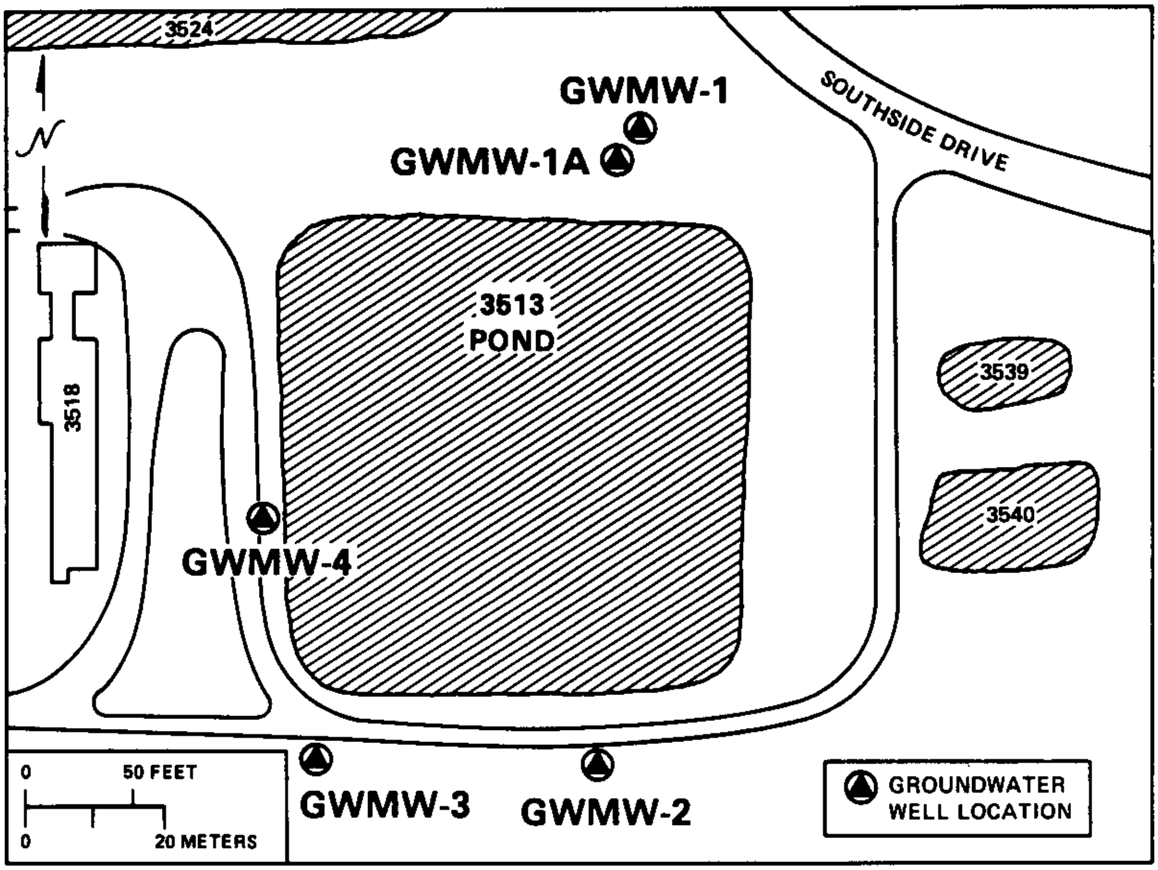

Fig. 6.2.20. Location of groundwater wells around 3513 impoundment.

ORNL - DWG 87-8349

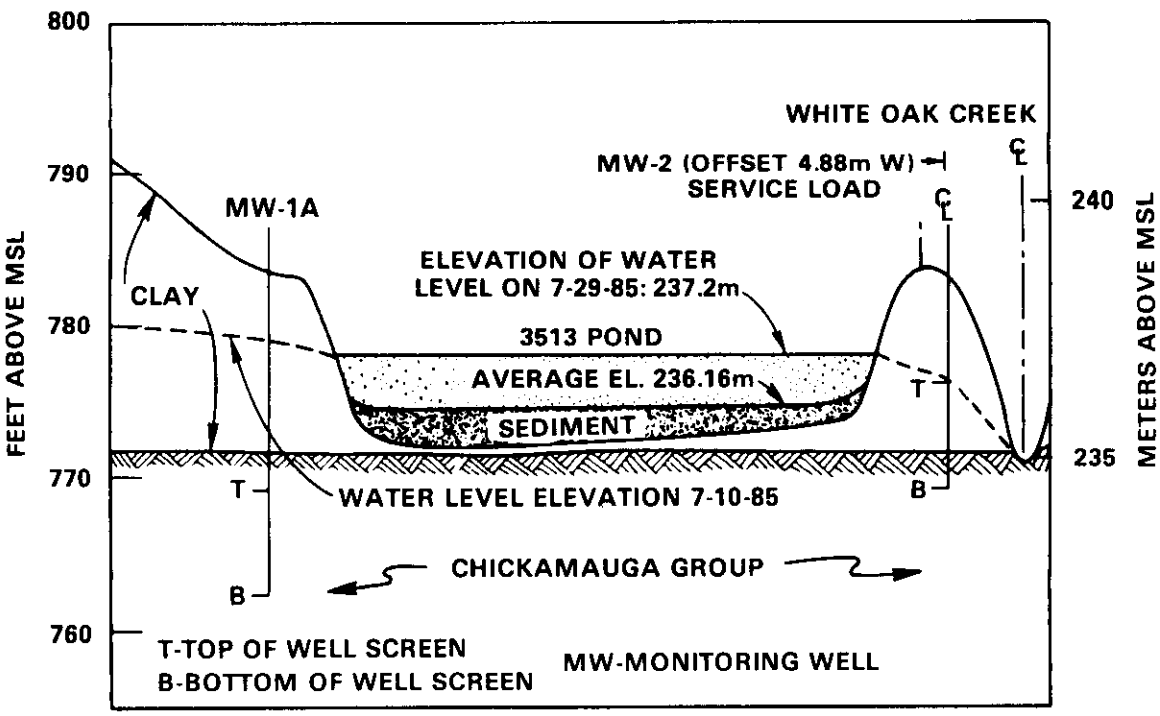

Fig. 6.2.21. Geologic cross section of the 3513 impoundment area.

Table 6.2.58. RCRA well specifications at ORNL

Well ID[a,b]	Installation date	Geological unit formation	Ground surface elevation (m)	Bottom of bore hole elevation (m)	Bottom of wells screen elevation (m)	Top of wells screen elevation (m)
			3524 area			
31-001 (873)	08/14/85	Chickamauga	242.3	235.4	235.4	237.0
31-002 (874)	08/13/85	Chickamauga	238.6	234.8	234.8	236.4
31-003 (875)	08/18/85	Chickamauga	239.4	235.4	235.4	237.0
31-004 (876)	08/11/85	Chickamauga	238.9	235.0	235.2	236.8
31-013 (885)	11/08/85	Chickamauga	238.8	223.2	223.5	226.6
31-015 (886)	10/26/85	Chickamauga	242.3	233.3	233.3	234.8
			3539-40 area			
31-005 (877)	08/09/85	Chickamauga	240.0	235.1	235.2	236.9
31-006 (878)	08/09/85	Chickamauga	240.2	234.8	235.1	236.7
31-007 (879)	08/08/85	Chickamauga	241.7	235.3	235.5	237.2
31-008 (880)	08/08/85	Chickamauga	240.3	235.4	235.5	237.1
31-009 (881)	08/07/85	Chickamauga	241.5	235.0	235.1	236.7
31-010 (882)	08/21/85	Chickamauga	241.2	235.6	235.7	237.3
31-011 (883)	10/24/85	Chickamauga	240.2	224.7	224.7	228.2
31-012 (884)	08/20/85	Chickamauga	240.2	234.9	235.0	236.6
			7900 area			
32-001 (887)	07/19/85	Conasauga	248.2	239.4	240.1	241.8
32-002 (888)	08/05/85	Conasauga	244.2	238.1	238.1	239.7
32-003 (889)	08/23/85	Conasauga	246.0	239.5	239.6	241.3
32-004 (890)	11/06/85	Conasauga	245.1	229.6	229.9	232.9
32-005 (891)	08/22/85	Conasauga	244.5	237.2	237.2	238.9
33-001 (892)	07/29/85	Conasauga	247.3	239.8	240.4	242.0
33-002 (893)	08/05/85	Conasauga	245.2	238.8	238.8	240.4
33-003 (894)	08/01/85	Conasauga	246.0	239.6	239.6	241.3

[a]New well numbers are given in parentheses.
[b]On all figures, groundwater wells are given the designation "GW" before the well ID number.

Table 6.2.59. 1986 concentrations of parameters in wells around 3524 area[a]

Parameter	Number of samples	Concentration (mg/L)[b]			
		Max	Min	Av	95% CC[c]
2,4,5-TP Silvex	16	<0.01	<0.01	<0.01	0
2,4-D	16	<0.01	<0.01	<0.01	0
Ag	16	<0.005	<0.005	<0.005	0
As	16	<0.01	<0.01	<0.01	0
Ba	16	<1.0	<1.0	<1.0	0
Cd	16	<0.002	<0.002	<0.002	0
Cl	16	11	4.8	7.4	1.0
Cr	16	<0.02	<0.02	<0.020	0
Endrin	16	<0.0002	<0.0002	<0.0002	0
F	16	<1.0	<1.0	<1.0	0
Fe	16	1.7	0.080	0.51	0.27
Fecal coliform[d]	16	1.0	0	0.25	0.22
Gross alpha[e]	16	0.016	0.00027	0.0048	0.0021
Gross beta[e]	16	5.9	0.0092	0.63	0.76
Hg	16	<0.0001	<0.0001	<0.0001	0
Lindane	16	<0.002	<0.002	<0.002	0
Methoxychlor	16	<0.008	<0.008	<0.008	0
Mn	16	4.0	0.01	0.75	0.62
Na	16	30	14	21	2.3
NO_3	16	<5.0	<5.0	<5.0	0
Pb	16	0.040	<0.02	<0.022	0.0028
pH[f]	126	8.2	6.5	7.5	0.047
Phenols	16	0.0020	<0.001	<0.0012	0.00020
Ra (total)[d]	16	0.0057	0.00011	0.00081	0.00067
Se	16	<0.005	<0.005	<0.005	0
SO_4	16	250	11	62	31
Specific conductance[g]	126	0.60	0.017	0.29	0.022
Temperature[h]	126	24	12	18	0.59
Total organic carbon	64	3.6	0.76	1.9	0.20
Total organic halides	64	0.20	<0.01	<0.036	0.011
Toxaphene	16	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.13.
[b]During 1986 detection levels for several parameters varied.
[c]95% confidence coefficient about the average.
[d]Units are colonies per 100 mL.
[e]Units are pCi/mL.
[f]Values in pH units.
[g]Units are in μmhos/cm.
[h]Units are in °C.

Table 6.2.60. 1986 concentrations of parameters in wells around 3539–40 area[a]

Parameter	Number of samples	Concentration (mg/L)[b]			
		Max	Min	Av	95% CC[c]
2,4,5-TP Silvex	15	<0.01	<0.01	<0.01	0
2,4-D	15	0.060	<0.01	<0.013	0.0067
Ag	15	<0.005	<0.005	<0.005	0
As	15	<0.01	<0.01	<0.01	0
Ba	15	1.3	<1.0	<1.0	0.040
Cd	15	<0.002	<0.002	<0.002	0
Cl	15	17	2.7	8.7	1.9
Cr	15	0.050	<0.020	<0.023	0.0042
Endrin	15	<0.0002	<0.0002	<0.0002	0
F	15	<1.0	<1.0	<1.0	0
Fe	15	10	0.050	2.3	1.5
Fecal coliform[d]	15	1.0	0	0.47	0.27
Gross alpha[e]	15	0.025	0.00081	0.0060	0.0032
Gross beta[e]	15	0.35	0.0035	0.054	0.046
Hg	15	<0.0001	<0.0001	<0.0001	0
Lindane	15	<0.002	<0.002	<0.002	0
Methoxychlor	15	<0.008	<0.008	<0.008	0
Mn	15	10	0.010	4.2	2.0
Na	15	220	4.6	37	37
NO_3	15	<5.0	<5.0	<5.0	0
Pb	15	1.2	<0.020	<0.11	0.16
pH[f]	175	13	6.8	8.2	0.32
Phenols	15	0.0030	<0.001	<0.0012	0.00029
Ra (total)[e]	15	0.038	0.00027	0.0042	0.0049
Se	15	<0.005	<0.005	<0.005	0
SO_4	15	250	5.0	61	37
Specific conductance[g]	175	9.8	0.010	1.0	0.36
Temperature[h]	175	22	14	18	0.35
Total organic carbon	60	23	1.6	4.8	1.5
Total organic halides	60	0.093	<0.005	<0.022	0.0066
Toxaphene	15	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.13.
[b]During 1986 detection levels for several parameters varied.
[c]95% confidence coefficient about the average.
[d]Units are colonies per 100 mL.
[e]Units are pCi/mL.
[f]Values in pH units.
[g]Units are in μmhos/cm.
[h]Units are in °C.

Table 6.2.61. 1986 concentrations of parameters in wells around 7900 area[a]

Parameter	Number of samples	Concentration (mg/L)[b]			
		Max	Min	Av	95% CC[c]
2,4,5-TP Silvex	18	<0.01	<0.01	<0.01	0
2,4-D	18	<0.01	<0.01	<0.01	0
Ag	18	<0.005	<0.005	<0.005	0
As	18	<0.01	<0.01	<0.01	0
Ba	18	<1.0	<1.0	<1.0	0
Cd	18	<0.002	<0.002	<0.002	0
Cl	18	62	2.4	16	7.6
Cr	18	0.15	<0.02	<0.027	0.014
Endrin	18	0.00050	<0.0002	<0.00022	0.00003
F	18	1.1	<1.0	<1.0	0.011
Fe	18	0.51	0.050	0.25	0.067
Fecal coliform[d]	18	1.0	0	0.39	0.24
Gross alpha[e]	18	0.14	0.00030	0.015	0.016
Gross beta[e]	18	2.7	0.0051	0.30	0.32
Hg	18	<0.0001	<0.0001	<0.0001	0
Lindane	18	<0.002	<0.002	<0.002	0
Methoxychlor	18	<0.008	<0.008	<0.008	0
Mn	18	0.45	0.040	0.15	0.060
Na	18	43	3.3	11	5.6
NO_3	18	57	<5.0	<14	8.2
Pb	18	<0.02	<0.020	<0.02	0
pH[f]	231	9.0	7.0	7.7	0.062
Phenols	18	<0.001	<0.0010	<0.001	0
Ra (total)[e]	18	0.041	0.000060	0.0033	0.0045
Se	18	<0.005	<0.0050	<0.005	0
SO_4	18	140	<5.0	<46	19
Specific conductance[g]	231	0.50	0.010	0.12	0.013
Temperature[h]	231	23	14	18	0.21
Total organic carbon	72	2.2	0.52	0.82	0.083
Total organic halides	72	0.045	<0.0050	<0.011	0.0017
Toxaphene	18	<0.005	<0.0050	<0.005	0

[a]See Fig. 6.2.14.
[b]During 1986 detection levels for several parameters varied.
[c]95% confidence coefficient about the average.
[d]Units are colonies per 100 mL.
[e]Units are pCi/mL.
[f]Values in pH units.
[g]Units are in μmhos/cm.
[h]Units are in °C.

Table 6.2.62. 1986 concentrations of dissolved metals in wells around impoundments 3524, 3539–40, and 7900[a]

Parameter	Number of samples	Concentration (mg/L)[b]			
		Max	Min	Av	95% CC[c]
		Impoundment 3524			
Ag	14	<0.005	<0.005	<0.005	0
As	14	<0.01	<0.01	<0.01	0
Ba	14	<1	<1	<1	0
Cd	14	<0.002	<0.002	<0.002	0
Cr	14	<0.02	<0.02	<0.02	0
Fe	14	1.5	<0.05	<0.25	0.22
Hg	14	<0.0001	<0.0001	<0.0001	0
Mn	14	4.1	<0.01	<0.80	0.72
Na	14	29	14	21	2.4
Pb	14	<0.02	<0.02	<0.02	0
Se	14	<0.005	<0.005	<0.005	0
		Impoundment 3539-40			
Ag	14	<0.0050	<0.005	<0.005	0
As	14	<0.010	<0.01	<0.01	0
Ba	14	<1	<1	<1	0
Cd	14	<0.002	<0.002	<0.002	0
Cr	14	0.033	<0.02	0.021	0.0019
Fe	14	6.3	0.050	1.3	0.81
Hg	14	<0.0001	<0.0001	<0.0001	0
Mn	14	10	0.010	4.5	1.9
Na	14	210	4.5	25	29
Pb	14	0.78	0.020	0.074	0.11
Se	14	<0.005	<0.005	<0.005	0
		Impoundment 7900			
Ag	17	<0.005	<0.005	<0.005	0
As	17	<0.01	<0.01	<0.01	0
Ba	17	<1	<1	<1	0
Cd	17	<0.002	<0.002	<0.002	0
Cr	17	<0.02	<0.02	<0.02	0
Fe	17	0.15	<0.05	<0.057	0.012
Hg	17	<0.0001	<0.0001	<0.00010	0
Mn	17	0.40	0.010	0.10	0.053
Na	17	43	3.4	10	5.8
Pb	17	<0.02	<0.02	<0.020	0
Se	17	<0.005	<0.005	<0.0050	0

[a]See Figs. 6.2.13 and 6.2.14.
[b]During 1986 detection levels for several parameters varied.
[c]95% confidence coefficient about the average.

Table 6.2.63. 1986 concentrations of parameters in well 31-001, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	5.9	5.6	5.8	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	1.5	1.5	1.5	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.0073	0.0050	0.0060	
Gross beta[d]	2	5.1	0.043	0.12	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	0.30	0.22	0.26	
Na	2	22	22	22	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	7	7.9	7.8	7.9	0.030
Phenols	2	0.002	<0.001	<0.002	
Ra (total)[d]	2	<0.0057	0.0027	0.0030	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	94	90	92	
Specific conductance[e]	7	0.30	0.28	0.29	0.010
Temperature[f]	7	21	20	21	0.19
Total organic carbons	8	2.2	0.84	1.6	0.37
Total organic halides	8	0.053	0.020	0.030	0.0081
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.64. 1986 concentrations of parameters in well 31-002, 3524 area[a]

Analysis	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	1.0	1.0	1.0	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	7.4	6.6	7.0	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	1.0	1.0	1.0	
Fe	2	0.19	0.16	0.18	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.032	0.0027	0.0018	
Gross beta[d]	2	0.78	0.57	0.68	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	3.3	2.3	2.8	
Na	2	15	14	14.3	
NO_3	2	<5	<5	<5	
Pb	2	0.020	0.020	0.020	
pH	7	7.5	7.3	7.5	0.060
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00035	0.00027	0.0003	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	33	31	32	
Specific conductance[e]	7	0.49	0.18	0.23	0.090
Temperature[f]	7	13	12	13	0.29
Total organic carbons	8	2.2	1.6	1.9	0.15
Total organic halides	8	0.20	<0.01	<0.10	0.070
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.65. 1986 concentrations of parameters in well 31-003, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	9.7	5.6	7.7	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	1.0	1.0	1.00	
Fe	2	1.7	0.12	0.90	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.016	0.0050	0.010	
Gross beta[d]	2	6.0	2.2	4.1	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	4	0.32	2.1	
Na	2	26	18	22	
NO_3	2	<5	<5	<5	
Pb	2	0.02	0.02	0.02	
pH	7	7.7	7.4	7.5	0.08
Phenols	2	0.002	<0.001	<0.002	
Ra (total)[d]	2	0.00054	0.00011	0.00032	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	19	11	15	
Specific conductance[e]	7	0.23	0.20	0.21	0.01
Temperature[f]	7	16	16	16	0.18
Total organic carbons	8	2.7	2.2	2.4	0.12
Total organic halides	8	0.043	<0.01	<0.02	0.01
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.66. 1986 concentrations of parameters in well 31-004, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	1	1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	9.8	8.8	9.3	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1.0	<1.0	<1.0	
Fe	2	0.08	0.08	0.08	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.012	0.0038	0.0081	
Gross beta[d]	2	0.032	0.0092	<0.021	
Hg	2	<0.0001	<0.0001	<0.0001	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	0.32	0.18	0.25	
Na	2	17	17	17	
NO_3	2	<5	<5	<5	
Pb	2	0.040	0.030	0.040	
pH	7	8.2	7.4	7.7	0.20
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.0010	0.00092	0.0010	
Se	2	<0.005	<0.005	<0.0050	
SO_4	2	54	52	53	
Specific conductance[e]	7	0.38	0.20	0.31	0.060
Temperature[f]	7	15	12	13	0.97
Total organic carbons	8	2.2	1.7	1.9	0.14
Total organic halides	8	0.070	0.020	0.050	0.010
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]µmhos/cm.
[f]°C.

Table 6.2.67. 1986 concentrations of parameters in well 31-013, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	4	<0.01	<0.01	<0.01	0
2,4-D	4	<0.01	<0.01	<0.01	0
Ag	4	<0.005	<0.005	<0.005	0
As	4	<0.01	<0.01	<0.01	0
Ba	4	<1	<1	<1	0
Cd	4	<0.002	<0.002	<0.002	0
Cl	4	11	8.7	10	1.1
Cr	4	0.02	0.02	0.02	0
Endrin	4	<0.0002	<0.0002	<0.0002	0
F	4	1	1	1	0
Fe	4	0.38	0.21	0.33	0.08
Fecal coliform[c]	4	0	0	0	0
Gross alpha[d]	4	<0.0054	0.0011	0.030	0.0018
Gross beta[d]	4	0.14	0.038	0.064	0.051
Hg	4	<0.0001	<0.0001	<0.0001	0
Lindane	4	<0.002	<0.002	<0.002	0
Methoxychlor	4	<0.008	<0.008	<0.008	0
Mn	4	0.070	<0.01	0.030	0.03
Na	4	30	17	22	5.5
NO_3	4	<5	<5	<5	0
Pb	4	<0.02	<0.02	<0.02	0
pH	28	8.2	7	7.6	0.09
Phenols	4	0.002	<0.001	<0.002	0
Ra (total)[d]	4	0.0010	0.00032	0.00069	0.00031
Se	4	<0.005	<0.005	<0.005	0
SO_4	4	22	11	15	4.8
Specific conductance[e]	28	0.60	0.020	0.30	0.07
Temperature[f]	28	21	16	18	0.38
Total organic carbons	16	3.6	1.6	2.6	0.48
Total organic halides	16	0.070	<0.01	<0.02	0.01
Toxaphene	4	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.68. 1986 concentrations of parameters in well 31-015, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	4	<0.01	<0.01	<0.01	0
2,4-D	4	<0.01	<0.01	<0.01	0
Ag	4	<0.005	<0.005	<0.005	0
As	4	<0.01	<0.01	<0.01	0
Ba	4	1	1	1	0
Cd	4	<0.002	<0.002	<0.002	0
Cl	4	5.5	4.8	5.3	0.33
Cr	4	0.02	0.02	0.02	0
Endrin	4	<0.0002	<0.0002	<0.0002	0
F	4	1	1	1	0
Fe	4	0.50	0.26	0.37	0.10
Fecal coliform[c]	4	0	0	0	0
Gross alpha[d]	4	0.0057	0.0010	0.0033	0.0022
Gross beta[d]	4	0.030	<0.012	0.018	0.0081
Hg	4	<0.0001	<0.0001	<0.0001	0
Lindane	4	<0.002	<0.002	<0.002	0
Methoxychlor	4	<0.008	<0.008	<0.01	0
Mn	4	0.28	0.21	0.25	0.03
Na	4	27	23	24	1.6
NO_3	4	<5	<5	<5.0	0
Pb	4	0.02	0.02	0.02	0
pH	28	8.2	6.5	7.3	0.10
Phenols	4	<0.001	<0.001	<0.001	0
Ra (total)[d]	4	0.00032	0.00011	0.00026	0.00010
Se	4	<0.005	<0.005	<0.005	0
SO_4	4	250	100	138	75
Specific conductance[e]	28	0.60	0.20	0.35	0.04
Temperature[f]	28	24	19	21	0.57
Total organic carbons	16	2.3	0.76	1.2	0.28
Total organic halides	16	0.054	<0.02	<0.03	0.01
Toxaphene	4	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.69. 1986 concentrations of parameters in well 31-005, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	7.4	7.2	7.3	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	2.6	1.3	2.0	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.0070	0.0060	0.0011	
Gross beta[d]	2	0.11	0.054	0.082	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	10	6.8	8.5	
Na	2	6.9	5.4	6.2	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.5	7.1	7.3	0.090
Phenols	2	0.003	<0.001	<0.002	
Ra (total)[d]	2	0.0007	0.00065	0.00068	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	68	59	64	
Specific conductance[e]	14	0.43	0.24	0.34	0.040
Temperature[f]	14	21	15	18	1.2
Total organic carbons	8	2.7	1.8	2.2	0.28
Total organic halides	8	<0.01	<0.01	<0.01	0
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.70. 1986 concentrations of parameters in well 31-006, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	8.0	7.7	7.8	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	2.5	1.1	1.8	
Fecal coliform[c]	2	1.0	0	<0.50	
Gross alpha[d]	2	0.0054	0.00081	0.0031	
Gross beta[d]	2	0.0062	0.0035	0.0049	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0008	<0.008	
Mn	2	6.7	6.0	6.4	
Na	2	4.8	4.6	4.7	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.6	7.0	7.3	0.13
Phenols	2	0.0020	<0.0010	<0.001	
Ra (total)[d]	2	0.003	0.00035	0.0017	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	15	11	13	
Specific conductance[e]	14	0.27	0.14	0.21	0.020
Temperature[f]	14	22	16	18	1.1
Total organic carbons	8	2.7	2.3	2.5	0.080
Total organic halides	8	0.050	<0.005	<0.02	0.010
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.71. 1986 concentrations of parameters in well 31-007, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	10	8.1	9.1	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.95	0.94	0.95	
Fecal coliform[c]	2	1.0	0	0.5	
Gross alpha[d]	2	0.0035	0.00030	0.0032	
Gross beta[d]	2	0.030	0.0097	0.020	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0008	<0.008	
Mn	2	1.3	0.94	1.1	
Na	2	30	26	28	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.7	7.2	7.5	0.10
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00041	0.0030	0.000035	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	250	210	230	
Specific conductance[e]	14	0.74	0.62	0.66	0.02
Temperature[f]	14	17	16	17	0.29
Total organic carbons	8	2.9	2.4	2.6	0.11
Total organic halides	8	0.020	<0.005	<0.01	0.0027
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.

[b]95% confidence coefficient about the average of more than two samples.

[c]Colonies/100 mL.

[d]pCi/mL.

[e]μmhos/cm.

[f]°C.

Table 6.2.72. 1986 concentrations of parameters in well 31-008, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	6.9	6.9	6.9	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	6.6	5.9	6.3	
Fecal coliform[c]	2	1.0	0	<0.5	
Gross alpha[d]	2	0.0062	0.0041	0.0051	
Gross beta[d]	2	0.059	0.0049	0.032	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	8.7	8.0	8.4	
Na	2	7.8	7.0	7.4	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.7	6.8	7.2	0.13
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.038	0.0025	0.020	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	27	25	26	
Specific conductance[e]	14	0.070	<0.01	<0.04	0.010
Temperature[f]	14	21	14	16	2.0
Total organic carbons	8	2.7	2.2	2.4	0.11
Total organic halides	8	0.020	<0.005	<0.01	0.41
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.73. 1986 concentrations of parameters in well 31-009, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	17	17	17	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.98	0.18	0.58	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.014	0.0022	0.0083	
Gross beta[d]	2	0.0097	0.0086	0.0092	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	3.0	2.5	2.8	
Na	2	12	12	12	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	7	7.2	7.0	7.2	0.060
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	<0.0051	0.00027	<0.0027	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	42	36	39	
Specific conductance[e]	7	0.45	0.39	0.41	0.015
Temperature[f]	7	18	17	17.5	0.13
Total organic carbons	8	3.8	2.9	3.4	0.21
Total organic halides	8	0.093	0.060	0.074	0.010
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.74. 1986 concentrations of parameters in well 31-010, 3539–39 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	9.2	7.7	8.5	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	1.3	0.99	1.1	
Fecal coliform[c]	2	1.0	0	<0.50	
Gross alpha[d]	2	0.007	0.0011	0.0041	
Gross beta[d]	2	0.076	0.046	0.061	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	0.50	0.45	0.48	
Na	2	11	7.9	9.3	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	7	8.0	7.8	7.9	0.044
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00051	0.00030	0.00041	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	69	69	69	
Specific conductance[e]	7	0.26	0.21	0.23	0.012
Temperature[f]	7	17	15	16	0.35
Total organic carbons	8	2.2	1.6	1.8	0.15
Total organic halides	8	<0.01	<0.01	<0.01	0
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.75. 1986 concentrations of parameters in well 31-011, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	0.060	<0.01	<0.04	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	1.3	1.0	1.2	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	6.9	2.7	4.8	
Cr	2	0.050	0.030	0.040	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.070	0.050	0.060	
Fecal coliform[c]	2	0	0	0	
Gross alpha[d]	2	0.025	0.0016	0.013	
Gross beta[d]	2	0.35	0.032	0.20	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	<0.01	<0.01	<0.01	
Na	2	220	200	210	
NO_3	2	<5	<5	<5	
Pb	2	1.2	0.26	0.73	
pH	28	13	13	13	0.070
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.0057	0.0046	0.0051	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	19	14	16	
Specific conductance[e]	28	9.8	0.52	5.9	1.8
Temperature[f]	28	22	16	19	0.81
Total organic carbons	8	23	15	19	2.8
Total organic halides	8	0.060	0.030	0.050	0.010
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.76. 1986 concentrations of parameters in well 31-012, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	1			<0.01	
2,4-D	1			<0.01	
Ag	1			<0.005	
As	1			<0.01	
Ba	1			<1	
Cd	1			<0.002	
Cl	1			7.4	
Cr	1			<0.02	
Endrin	1			<0.0002	
F	1			<1	
Fe	1			10	
Fecal coliform[c]	1			1.0	
Gross alpha[d]	1			0.0022	
Gross beta[d]	1			0.0057	
Hg	1			<0.0001	
Lindane	1			<0.002	
Methoxychlor	1			<0.008	
Mn	1			8.5	
Na	1			5.4	
NO_3	1			<5	
Pb	1			<0.02	
Phenols	1			<0.001	
Ra (total)[d]	1			0.0076	
Se	1			<0.005	
SO_4	1			<5	
Total organic carbons	4	3.3	2.9	3.1	0.21
Total organic halides	4	<0.01	<0.01	<0.01	0
Toxaphene	1	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.77. 1986 concentrations of parameters in well 32-001, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	6.2	6.1	6.2	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.14	0.050	0.10	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.0043	0.0041	0.0042	
Gross beta[d]	2	0.054	<0.01	<0.032	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.12	0.10	0.11	
Na	2	6.6	3.3	5.0	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	8.5	7.1	7.9	0.31
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00043	0.000057	0.00024	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	24	19	21	
Specific conductance[e]	14	0.090	<0.01	<0.040	0.020
Temperature[f]	14	18	15	16	0.52
Total organic carbons	8	0.76	0.54	0.68	0.051
Total organic halides	8	0.030	<0.005	<0.01	0.050
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.78. 1986 concentrations of parameters in well 32-002, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	26	19	22	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.13	0.080	0.11	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.0027	0.0021	0.0024	
Gross beta[d]	2	<0.2	<0.0059	<0.0062	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.070	0.040	0.060	
Na	2	5.6	5.4	5.5	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.7	7.4	7.6	0.048
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.0018	0.00057	0.0012	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	16	16	16	
Specific conductance[e]	14	0.18	0.090	0.13	0.020
Temperature[f]	14	19	17	18	0.37
Total organic carbons	8	0.81	0.57	0.70	0.070
Total organic halides	8	0.050	<0.01	<0.022	0.010
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.79. 1986 concentrations of parameters in well 32-003, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	2.5	2.4	2.5	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.30	0.15	0.23	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	<0.0054	0.0035	0.0045	
Gross beta[d]	2	<0.0092	<0.0057	<0.0074	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.10	0.050	0.080	
Na	2	3.5	3.3	3.4	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.8	7.5	7.6	0.051
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.0006	0.00011	0.00035	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	<5	<5	<5	
Specific conductance[e]	14	0.060	<0.010	<0.040	0.010
Temperature[f]	14	21	17	17	0.59
Total organic carbons	8	0.88	0.62	0.77	0.080
Total organic halides	8	<0.01	<0.005	<0.01	0.0019
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.80. 1986 concentrations of parameters in well 32-004, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	4	<0.01	<0.01	<0.01	0
2,4-D	4	<0.01	<0.01	<0.01	0
Ag	4	<0.005	<0.005	<0.005	0
As	4	<0.01	<0.01	<0.01	0
Ba	4	<1	<1	<1	0
Cd	4	<0.002	<0.002	<0.002	0
Cl	4	8.0	5.3	6.7	1.1
Cr	4	<0.02	<0.02	<0.02	0
Endrin	4	<0.0002	<0.0002	<0.0002	0
F	4	<1	<1	<1	0
Fe	4	0.43	0.17	0.30	0.11
Fecal coliform[c]	4	0	0	0	0
Gross alpha[d]	4	0.14	0.0003	0.039	0.068
Gross beta[d]	4	1.0	<0.013	<0.26	0.49
Hg	3	<0.0001	<0.0001	<0.0001	0
Lindane	4	<0.002	<0.002	<0.002	0
Methoxychlor	4	<0.008	<0.0008	<0.008	0
Mn	4	0.16	0.11	0.14	0.021
Na	4	8.7	7.7	8.4	0.47
NO_3	4	<5	<5	<5	0
Pb	4	<0.02	<0.02	<0.02	0
pH	28	9.0	7.6	8.2	0.17
Phenols	4	<0.001	<0.001	<0.001	0
Ra (total)[d]	4	<0.012	0.00024	<0.0033	0.0058
Se	4	<0.005	<0.005	<0.005	0
SO_4	4	32	20	26	5.3
Specific conductance[e]	28	0.50	<0.01	<0.14	0.080
Temperature[f]	28	20	15	17	0.48
Total organic carbons	16	2.2	0.53	1.0	0.33
Total organic halides	16	0.010	<0.005	<0.01	0.00085
Toxaphene	4	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.81. 1986 concentrations of parameters in well 32-005, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	14	13	14	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.41	0.36	0.39	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.0018	0.00032	0.0011	
Gross beta[d]	2	<0.012	<0.0051	<0.0086	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.008	<0.008	
Mn	2	0.45	0.34	0.40	
Na	2	6.5	6.5	6.5	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	8.6	7.4	7.5	
Phenols	2	<0.001	<0.000	<0.001	
Ra (total)[d]	2	0.0014	0.00027	0.00085	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	44	43	44	
Specific conductance[e]	14	0.12	0.070	0.10	0.010
Temperature[f]	14	19	16	17	0.45
Total organic carbons	8	1.0	0.68	0.83	0.080
Total organic halides	8	0.013	<0.005	<0.01	0.0021
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.82. 1986 concentrations of parameters in well 33-001, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	62	52	57	
Cr	2	0.15	<0.02	<0.1	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	<1	<1	<1	
Fe	2	0.51	0.15	0.33	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.002	0.0018	0.0018	
Gross beta[d]	2	<0.010	<0.0065	<0.0082	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.080	0.040	0.060	
Na	2	6.5	6.0	6.2	
NO_3	2	<5	<5	<5	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.8	7.0	7.5	0.16
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00038	0.00014	0.00026	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	70	64	67	
Specific conductance[e]	14	0.23	0.12	0.17	0.030
Temperature[f]	14	21	19	20	0.28
Total organic carbons	8	0.81	0.59	0.67	0.052
Total organic halides	8	0.010	<0.005	<0.01	0.0018
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.83. 1986 concentrations of parameters in well 33-002, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	16	15	15.5	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	0.0005	<0.0002	<0.0004	
F	2	<1	<1	<1	
Fe	2	0.48	0.18	0.33	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.018	0.0035	0.011	
Gross beta[d]	2	0.30	0.27	0.28	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.33	0.26	0.30	
NO_3	2	49	31	40	
Pb	2	<0.02	<0.02	<0.02	
pH	14	7.7	7.0	7.4	0.13
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.00038	0.00022	0.00030	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	75	72	74	
Specific conductance[e]	14	0.25	0.050	0.19	0.032
Temperature[f]	14	20	17	18	0.63
Total organic carbons	8	1.1	0.62	0.83	0.13
Total organic halides	8	0.010	<0.005	<0.01	0.0018
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.84. 1986 concentrations of parameters in well 33-003, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
2,4,5-TP Silvex	2	<0.01	<0.01	<0.01	
2,4-D	2	<0.01	<0.01	<0.01	
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cl	2	16	15	16	
Cr	2	<0.02	<0.02	<0.02	
Endrin	2	<0.0002	<0.0002	<0.0002	
F	2	1.1	1.0	1.1	
Fe	2	0.24	0.11	0.18	
Fecal coliform[c]	2	1.0	0	0.50	
Gross alpha[d]	2	0.054	0.0035	0.029	
Gross beta[d]	2	2.7	1.0	1.8	
Hg	2	<0.0001	<0.0001	<0.0001	
Lindane	2	<0.002	<0.002	<0.002	
Methoxychlor	2	<0.008	<0.0080	<0.008	
Mn	2	0.070	0.040	0.060	
Na	2	43	41	42	
NO_3	2	57	39	48	
Pb	2	<0.02	<0.02	<0.02	
pH	14	8.6	7.0	7.5	0.25
Phenols	2	<0.001	<0.001	<0.001	
Ra (total)[d]	2	0.041	0.00054	0.021	
Se	2	<0.005	<0.005	<0.005	
SO_4	2	140	140	140	
Specific conductance[e]	14	0.23	0.16	0.19	0.010
Temperature[f]	14	23	16	18	1.3
Total organic carbons	8	1.1	0.52	0.85	0.20
Total organic halides	8	<0.01	<0.005	<0.01	0
Toxaphene	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.13.
[b]95% confidence coefficient about the average of more than two samples.
[c]Colonies/100 mL.
[d]pCi/mL.
[e]μmhos/cm.
[f]°C.

Table 6.2.85. 1986 concentrations of dissolved metals in wells 31-001, 31-002, and 31-003, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 31-001		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.29	0.21	0.25
Na	2	22	21	22
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-002		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.08	<0.05	<0.07
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	2.3	0.10	1.2
Na	2	15	14	14
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-003		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	1.6	1.2	1.4
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	4.1	3.2	3.6
Na	2	25	17	21
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005

[a]See Fig. 6.2.13.

Table 6.2.86. 1986 concentrations of dissolved metals in wells 31-004, 31-013, and 31-015, 3524 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
		Well 31-004			
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cr	2	<0.02	<0.02	<0.02	
Fe	2	<0.05	<0.05	<0.05	
Hg	2	<0.0001	<0.0001	<0.0001	
Mn	2	0.15	0.090	0.12	
Na	2	18	17	18	
Pb	2	<0.02	<0.02	<0.02	
Se	2	<0.005	<0.005	<0.005	
		Well 31-013			
Ag	3	<0.005	<0.005	<0.005	0
As	3	<0.01	<0.01	<0.01	0
Ba	3	<1	<1	<1	0
Cd	3	<0.002	<0.002	<0.002	0
Cr	3	<0.02	<0.02	<0.02	0
Fe	3	0.15	<0.05	<0.11	0.061
Hg	3	<0.0001	<0.0001	<0.0001	0
Mn	3	<0.01	<0.01	<0.01	0
Na	3	29	17	22	7.4
Pb	3	<0.02	<0.02	<0.02	0
Se	3	<0.005	<0.005	<0.005	0
		Well 31-015			
Ag	3	<0.005	<0.005	<0.005	0
As	3	<0.01	<0.01	<0.01	0
Ba	3	<1	<1	<1	0
Cd	3	<0.002	<0.002	<0.002	0
Cr	3	<0.02	<0.02	<0.02	0
Fe	3	0.17	0.090	0.13	0.041
Hg	3	<0.0001	<0.0001	<0.0001	0
Mn	3	0.26	0.21	0.25	0.033
Na	3	27	23	25	2.1
Pb	3	<0.02	<0.02	<0.02	0
Se	3	<0.005	<0.005	<0.005	0

[a]See Fig. 6.2.13.

[b]95% confidence coefficient about the average of more than two samples.

Table 6.2.87. 1986 concentrations of dissolved metals in wells 31-005, 31-006, and 31-007, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 31-005		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	2.4	1.1	1.7
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	10	6.7	8.5
Na	2	7.0	5.4	6.2
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-006		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	1.6	0.22	0.89
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	7.0	5.8	6.4
Na	2	4.8	4.5	4.7
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-007		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	0.070	<0.05	<0.060
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	1.3	0.92	1.1
Na	2	31	26	29
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005

[a]See Fig. 6.2.13.

Table 6.2.88. 1986 concentrations of dissolved metals in wells 31-008, 31-009, and 31-010, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 31-008		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	6.3	3.3	4.8
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	8.5	8.0	8.2
Na	2	7.8	6.8	7.3
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-009		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	1.0	0.65	0.83
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	3.0	2.4	2.7
Na	2	11.9	11.7	11.8
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 31-010		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	0.98	0.65	0.82
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.45	0.45	0.45
Na	2	10	7.9	8.9
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005

[a]See Fig. 6.2.13.

Table 6.2.89. 1986 concentrations of dissolved metals in wells 31-011 and 31-012, 3539–40 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 31-011		
Ag	1			<0.005
As	1			<0.01
Ba	1			<1
Cd	1			<0.002
Cr	1			<0.033
Fe	1			<0.05
Hg	1			<0.0001
Mn	1			<0.01
Na	1			210
Pb	1			0.78
Se	1			<0.005
		Well 31-012		
Ag	1			<0.005
As	1			<0.01
Ba	1			<1
Cd	1			<0.002
Cr	1			<0.02
Fe	1			<0.07
Hg	1			<0.0001
Mn	1			7.7
Na	1			5.0
Pb	1			<0.02
Se	1			<0.005

[a]See Fig. 6.2.13.

Table 6.2.90. 1986 concentrations of dissolved metals in wells 32-001, 32-002, and 32-003, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 32-001		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.15	0.10	0.11
Na	2	5.6	3.4	4.9
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 32-002		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.040	<0.01	<0.025
Na	2	5.8	5.2	5.6
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 32-003		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.10	0.030	0.065
Na	2	3.5	3.4	3.5
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005

[a]See Fig. 6.2.14.

Table 6.2.91. 1986 concentrations of dissolved metals in wells 32-004, 32-005, and 33-001, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% CC[b]
		Well 32-004			
Ag	3	<0.005	<0.005	<0.005	0
As	3	<0.01	<0.01	<0.01	0
Ba	3	<1	<1	<1	0
Cd	3	<0.002	<0.002	<0.002	0
Cr	3	<0.02	<0.02	<0.02	0
Fe	3	0.15	<0.05	0.09	0.050
Hg	3	<0.0001	<0.0001	<0.0001	0
Mn	3	0.14	0.090	0.12	0.031
Na	3	8.9	7.7	8.4	0.74
Pb	3	<0.02	<0.02	<0.02	0
Se	3	<0.005	<0.005	<0.005	0
		Well 32-005			
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cr	2	<0.02	<0.02	<0.02	
Fe	2	<0.05	<0.05	<0.05	
Hg	2	<0.0001	<0.0001	<0.0001	
Mn	2	0.49	0.31	0.36	
Na	2	6.5	6.5	6.5	
Pb	2	<0.02	<0.02	<0.02	
Se	2	<0.005	<0.005	<0.005	
		Well 33-001			
Ag	2	<0.005	<0.005	<0.005	
As	2	<0.01	<0.01	<0.01	
Ba	2	<1	<1	<1	
Cd	2	<0.002	<0.002	<0.002	
Cr	2	<0.02	<0.02	<0.02	
Fe	2	<0.05	<0.05	<0.05	
Hg	2	<0.0001	<0.0001	<0.0001	
Mn	2	0.070	0.040	0.060	
Na	2	6.3	6.2	6.3	
Pb	2	<0.02	<0.02	<0.02	
Se	2	<0.005	<0.005	<0.005	

[a]See Fig. 6.2.14.

[b]95% confidence coefficient about the average of more than two samples.

Table 6.2.92. 1986 concentrations of dissolved metals in wells 33-002 and 33-003, 7900 area[a]

Parameter	No. of samples	Concentration (mg/L)		
		Max	Min	Av
		Well 33-002		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.24	0.14	0.19
Na	2	19	13	16
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005
		Well 33-003		
Ag	2	<0.005	<0.005	<0.005
As	2	<0.01	<0.01	<0.01
Ba	2	<1	<1	<1
Cd	2	<0.002	<0.002	<0.002
Cr	2	<0.02	<0.02	<0.02
Fe	2	<0.05	<0.05	<0.05
Hg	2	<0.0001	<0.0001	<0.0001
Mn	2	0.030	<0.01	<0.02
Na	2	43	40	42
Pb	2	<0.02	<0.02	<0.02
Se	2	<0.005	<0.005	<0.005

[a]See Fig. 6.2.14.

Table 6.2.93. Concentrations of parameters whose values exceed standards in groundwater wells on the ORNL site

Area	Well ID[a]	Date	Parameters							
			Gross beta (pCi/mL)	Gross alpha (pCi/mL)	Ra (pCi/mL)	Ba (mg/L)	Cr (mg/L)	Endrin (mg/L)	Pb (mg/L)	NO_3 (mg/L)
	Standard[b]		0.0035	0.015	0.0050					
3524	31-001	03/19/86	0.043							
		06/25/86	0.19		0.0057					
	31-002	03/20/86	0.57							
		06/26/86	0.78							
	31-003	03/19/86	6.0	0.016						
		06/26/86	2.2							
	31-004	03/20/86	0.0092							
		06/27/86	0.032							
	31-013	03/27/86	0.14							
		08/21/86	0.038							
		09/26/86	0.038							
		12/09/86	0.041							
	31-015	03/27/86	0.012							
		08/21/86	0.015							
		09/25/86	0.014							
		12/09/86	0.030							
3539-40	31-005	03/17/86	0.054							
		06/17/86	0.11							
	31-006	03/18/86	0.0062							
	31-007	03/17/86	0.030							
		06/17/86	0.0097							
	31-008	03/18/86	0.0049							
		06/17/86	0.059		0.038					
	31-009	03/17/86	0.0086							
		06/25/86	0.0097		0.0051					
	31-010	03/18/86	0.046							
		06/25/86	0.076							

Table 6.2.93. (continued)

Area	Well ID[a]	Date	Parameters: Gross beta (pCi/mL)	Gross alpha (pCi/mL)	Ra (pCi/mL)	Ba (mg/L)	Cr (mg/L)	Endrin (mg/L)	Pb (mg/L)	NO_3 (mg/L)
3539-40	Standard		0.0035	0.015	0.0050	1.0	0.050	0.00020	0.050	10
	31-011	03/18/86	0.032						0.78 (dissolved) 1.2 (total)	
		08/20/86	0.35	0.025	0.0057	1.1 (dissolved) 1.3 (total)			0.26 (total)	
	31-012	06/25/86	0.0057							
7900	32-001	03/24/86	0.010							
		06/24/86	0.054							
	32-002	03/24/86	0.0059							
		06/28/86	0.0065							
	32-003	03/24/86	0.0057							
		06/18/86	0.0092							
	32-004	03/26/86	0.013							
		08/20/86	0.017							
		09/24/86	0.026							
		12/10/86	0.027							
	32-005	03/25/86	0.0051							
		06/24/86	0.012							
	33-001	03/25/86	0.010							
		06/18/86	0.0065				0.15			
	33-002	03/26/86	0.27							31
		06/18/86	0.30	0.018				0.00050		49
	33-003	03/26/86	2.7							39
		06/24/86	1.0	0.054	0.041					57

[a]See Figs. 6.2.11.
[b]EPA Interim Primary Drinking Water Standard.

Table 6.2.94. 1986 groundwater monitoring of radionuclides around ORNL solid waste storage areas

Parameter	Number of wells sampled	Concentration (pCi/L)		
		Max	Min	Av
		Solid Waste Storage Area 4[a]		
^{60}Co	5	<9	<6	<7
^{137}Cs	5	<9	<6	<7
Gross alpha	5	2,000	35	750
Gross beta	5	62,000	1,300	20,500
^{3}H	5	2,000,000	59,000	520,000
Total radioactive Sr	5	38,000	810	13,000
		Solid Waste Storage Area 5[b]		
^{60}Co	5	<6	<3	<5
^{137}Cs	5	1.9	0.30	1.2
Gross alpha	5	41	11	23
Gross beta	5	32,000	54	6,600
^{3}H	5	49,000,000	21,000	11,000,000
Total radioactive Sr	5	17,000	3.0	3,500
		Solid Waste Storage Area 6[c]		
^{60}Co	2	<9	<9	<9
^{137}Cs	2	<6	<6	<6
Gross alpha	2	24	16	20
Gross beta	2	100	62	81
^{3}H	2	23,000	16,000	19,000
Total radioactive Sr	2	23	8.9	16
		Pits and Trenches[d]		
^{60}Co	5	3,000	5.4	710
^{137}Cs	5	8.1	0.81	2.6
Gross alpha	5	1,100	11	235
Gross beta	5	16,000	49	4,500
^{3}H	5	92,000	32,000	51,000
Total radioactive Sr	5	73	4.9	22
		Reference Wells[a]		
^{60}Co	1	<9	<9	<9
^{137}Cs	1	<6	<6	<6
Gross alpha	1	41	41	41
Gross beta	1	54	54	54
^{3}H	1	<500	<500	<500
Total radioactive Sr	1	9.2	9.2	9.2

[a] See Fig. 6.2.15.
[b] See Fig. 6.2.16.
[c] See Fig. 6.2.17.
[d] See Fig. 6.2.18.

Table 6.2.95. Mean groundwater concentrations measured in monitoring wells at the 3513 impoundment

Parameter	Maximum level allowed[a,b]	Measured[a])	
		Upgradient	Downgradient
National Interim Primary Drinking Water Standards (NIPDWS)			
Arsenic	0.05	<0.0033	<0.0040
Barium	1	<0.24	0.35
Cadmium	0.01	<0.0014	<10.0
Chromium	0.05	<0.029	0.18
Coliform bacteria, count/100 mL	1	1.3	10.0
Endrin	0.0002	<0.0002	<0.0001
Fluoride	1.4–2.4	<1.0	<1.0
Gross alpha, Bq/L	0.556	1.9	<5.1
Gross beta, Bq/L	0.13[c]	5.4	23
Lead	0.05	<0.010	0.15
Lindane	0.004	<0.0011	<0.0011
Mercury	0.002	0.0002	<0.0002
Methyoxychlor	0.1	<0.0041	<0.0041
Nitrate-N	10	<5.0	<3.5
226Ra, Bq/L	0.19	<0.03	<0.0609
Selenium	0.01	<0.0050	<0.0050
Silver	0.05	<0.03	<0.03
Toxaphene	0.005	<0.0035	<0.0035
2,4,5-TP Silvex	0.01	<0.0075	<0.0079
2,4-D	0.1	<0.0075	<0.0078
Parameters establishing groundwater quality			
Chloride	ND	6.4	18
Iron	ND	2.7	24
Maganese	ND	1.5	3.9
Phenols	ND	<0.005	<0.005
Sodium	ND	23	31
Sulfate	ND	80	<13
Parameters used as indicators of groundwater contamination			
pH	ND	6.5	6.4
Specific conductance, μS/cm	ND	820	660
Total organic carbon	ND	4.8	5.9
Total organic halides	ND	0.067	0.14
Nonregulated parameters			
Copper[d]	ND	<0.025	<0.028
^{137}Cs, Bq/L	ND	1.3	0.39
Dissolved oxygen	ND	5.0	4.5
Nicel[d]	ND	0.06	0.36
Polychlorinated biphenyls (PCBs)	ND	0.0001	0.0001
^{90}Sr, Bq/L	0.13[c]	2.4	13
Temperature, ↓C	ND	15	18
Tritium, Bq/L	670[c]	350	4800
Zinc[d]	ND	<0.061	0.15

[a]Concentrations are in mg/L unless otherwise stated.

[b]ND = maximum level for that parameter not defined.

[c]Level of activity necessary to give a total body dose of 4 mR/year to a person drinking 2.2 L of water per day for a year. [d]Hazardous substance guidelines issued by the State of Tennessee (L. W. Gregory, Division of Solid Waste Management, Department of Health and Environment, State of Tennessee, personal communication, 1985).

Source: C. W. Francis and R. G. Stansfield, 1986 *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year*, ORNL/TM-10193, Oak Ridge, Tennessee.

Table 6.2.96. Measured concentrations in groundwater at 3513 impoundment that were in excess of RCRA maximum limits for groundwater

Parameter	Unit	RCRA limit	Sampling quarter[a]			
			1	2	3	4
Well 1						
Coliform bacteria	count/10 mL	1	8	BL	BL	BL
Gross alpha	pCi/L	0.02	0.074	0.037	0.074	0.074
Gross beta	pCi/L	0.005	0.19	0.074	0.19	0.11
^{90}Sr	pCi/L	0.005	ND	0.037	0.074	0.074
Well 1A						
Chromium	mg/L	0.05	0.14	BL	BL	BL
Coliform bacteria	count/100 mL	1	2	BL	BL	BL
Gross alpha	pCi/L	0.02	0.037	0.037	0.222	0.15
Gross beta	pCi/L	0.005	0.26	0.19	0.48	0.3
^{90}Sr	pCi/L	0.005	ND	0.11	0.11	0.11
Tritium	pCi/L	24.8	ND	BL	28	BL
Well 2						
Chromium	mg/L	0.05	1.2	BL	BL	BL
Gross alpha	pCi/L	0.02	0.15	0.037	0.67	0.63
Gross beta	pCi/L	0.005	2.0	1.67	2.4	2.3
^{90}Sr	pCi/L	0.005	ND	0.962	1.2	1.18
Tritium	pCi/L	24.8	ND	130	130	107
Well 3						
Chromium	mg/L	0.05	0.07	BL	BL	BL
Coliform bacteria	count/100mL	1	2	BL	8	120
Gross alpha	pCi/L	0.02	BL	BL	0.074	0.074
Gross beta	pCi/L	0.005	0.15	0.037	0.15	0.074
Lead	mg/L	0.05	BL	1.4	0.06	0.08
^{90}Sr	pCi/L	0.005	ND	0.015	0.024	0.052
Tritium	pCi/L	24.8	ND	85	104	89
Well 4						
Chromium	mg/L	0.05	0.69	BL	BL	BL
Gross alpha	pCi/L	0.02	BL	BL	0.15	0.19
Iron	pCi/L	0.005	0.33	0.26	0.56	0.70
^{90}Sr	pCi/L	0.005	ND	0.18	0.26	0.26
Tritium	pCi/L	24.8	ND	81	74	133

[a] BL = below RCRA groundwater limit; ND = not determined.

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

analytical detection level exceeded the RCRA limit were not included (e.g., gross alpha, ^{226}Ra, and silver). Excessive levels of chromium were observed in all three downgradient wells for the first quarter of sampling, but measurements from the same wells at later sampling dates were below the RCRA limit. The dominant contaminants appear to be radionuclides; i.e., excessive levels of gross alpha and gross beta were observed in groundwater samples taken from all monitoring wells. There appears to be a trend in elevated levels of lead in groundwater sampled from well 3 as compared with the other downgradient wells. Those parameters that showed significant differences at the 0.05 level are listed in Table 6.2.97. Comparisons of indicator parameters in each of the upgradient and downgradient wells with background levels over the four quarters sampled at the 3513 monitoring wells are presented in Table 6.2.98.

The Old Hydrofracture Facility (OHF) was used for the permanent disposal of liquid radioactive waste in impermeable shale formations from 1964 to 1979. The facility is located at the confluence of Melton Branch and White Oak Creek, ~1.5 km southwest of the ORNL main complex (see Fig. 6.2.22). The impoundment is downslope, ~50 m to the northwest, of building 7852, which contains the control room used in injecting liquid radioactive waste, in the form of a grout, into impermeable shale formations at depths ranging from ~230 to 300 m. The impoundment, which is ~30 m long and 6 m wide and 1 to 2 m deep, was constructed in 1963 as an emergency containment basin for possible spillage of grout. The design

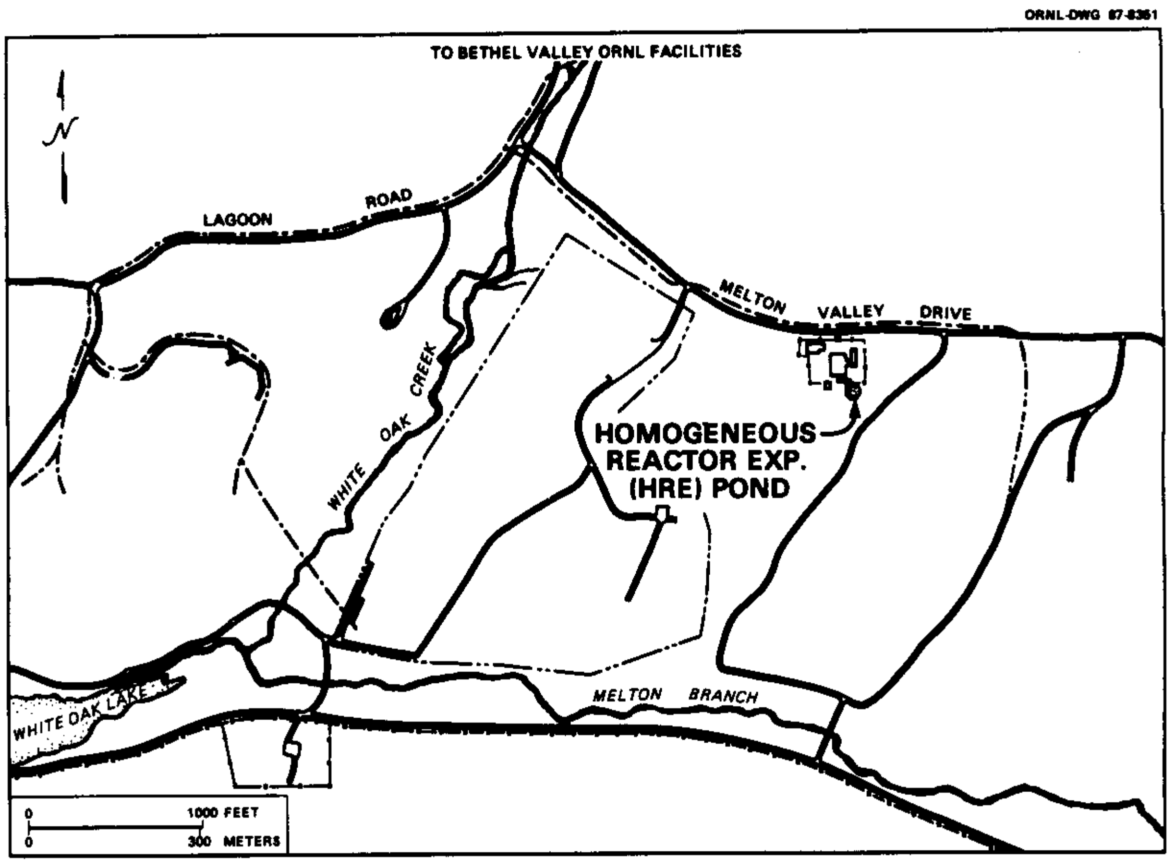

Fig. 6.2.22. Location of Old Hydrofracture Facility at ORNL.

Table 6.2.97. Significant differences in water quality parameters between monitoring wells at the 3513 impoundment

Parameter	Concentrations in monitoring wells 1–4[a,b]			
	1	2	3	4
Chloride, mg/L	6.4§	36*	12†	6.6§
Dissolved oxygen, mg/L	4.6*	3.5†	4.6*	5.4*
Iron, mg/L	2.7†	8.8†	51*	12†
Gross beta, mR/year	5.4§	54*	2.6§	11†
Tritium, pCi/L	1.295†	122.1*†	92.5*†	318.2*
Manganese, mg/L	1.5†	4.8*	3.8*	3.2*
pH (units)	6.5†	6.7*	6.3†§	6.3§
Sulfate, mg/L	80*	20†	6†	13†
Specific conductance, μmhos/cm	820*	602*†	620†	730*†
^{90}Sr, pCi/L	0.0851§	1.11*	0.0296§	0.2368†
Total organic carbon, mg/L	4.8†	3.6†	7.1†	7.2*
Total organic halides, mg/L	0.07†	0.07†	0.17*	0.19*
Zinc, mg/L	0.06†	0.07*†	0.29*	0.09*†

[a]Concentrations are statistically different (0.05 level) between wells if they do not have similar superscripts (*, †, §). The statistical comparisons were determined using the Duncan's multiple-range test of the GLM procedure, as outlined in SAS 1985.

[b]Concentrations found in monitoring well 1A were averaged with those in monitoring well 1 for statistical comparison.

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

Specific conductance (μmhos/cm)	250
Total organic carbon	2.8
Total organic halogen	0.078
	0.073
	0.088
	0.069
	0.081

[a]See Fig. 6.2.11.
[b]Not sampled.
[c]Not measured.

Table 6.2.51. 1986 concentrations of parameters from well Y-GMW-17 at Bear Creek Valley Waste Disposal Area

Parameter	Concentration (mg/L)[b]			
	1st Qtr. (3/12/86)	2nd Qtr. (4/21/86)	3rd Qtr. (8/28/86)	4th Qtr. (12/11/86)
Drinking water				
Arsenic	<0.06	<0.06	<0.04	<0.04
Barium	0.3	0.3	0.405	0.458
Cadmium	<0.002	<0.002	<0.003	<0.003
Chromium	<0.01	<0.01	<0.006	<0.006
Lead	<0.01	<0.01	<0.02	0.02
Mercury	<0.0005	<0.0005	0.0002	<0.0002
Selenium	<0.002	<0.002	<0.002	<0.002
Silver	<0.01	<0.01	0.004	<0.004
Fluoride	0.15	0.1	<0.1	<0.1
Nitrate nitrogen	0.3	0.3	<0.1	<0.2
Endrin	*c*	*c*	*c*	*c*
Lindane	*c*	*c*	*c*	*c*
Methoxychlor	*c*	*c*	*c*	*c*
Toxaphene	*c*	*c*	*c*	*c*
2,4-D	*c*	*c*	*c*	*c*
Silvex	*c*	*c*	*c*	*c*
Radium (pCi/L)	*c*	<5.1	<2.9	<3.1
Gross alpha (pCi/L)	<1.0	28	<1.0	51
Gross beta (pCi/L)	<4.0	20	<4.0	<4.0
Total coliform (Ct/100 mL)	<1	<1	<1	<1
Groundwater quality				
Chloride	<2	<2	<2	<2
Iron	0.54	0.48	0.76	2.75
Manganese	0.02	0.04	0.038	0.134
Phenols	<0.001	<0.001	<0.001	0.001
Sodium	3.8	5.0	5.20	5.19
Sulfate	<10	<10	<10	<10
Indicators				

capacity is 3.8 × 10^5 L. Stansfield and Francis (1986b) estimated the pond to contain ~3.0 × 10^5 L in August of 1985. Differences between mean annual precipitation (~140 cm) and mean annual evaporation indicate that ~140,000 L is leaking annually from the pond and entering the groundwater (Francis and Stansfield, 1986).

Four monitoring wells in this study were installed in March 1985 around the perimeter of the OHF impoundment (see Fig. 6.2.23). Monitoring well 1 was located to sample groundwater upgradient from the impoundment. This well is located at the northeast corner of the impoundment ~15 m from the edge of the

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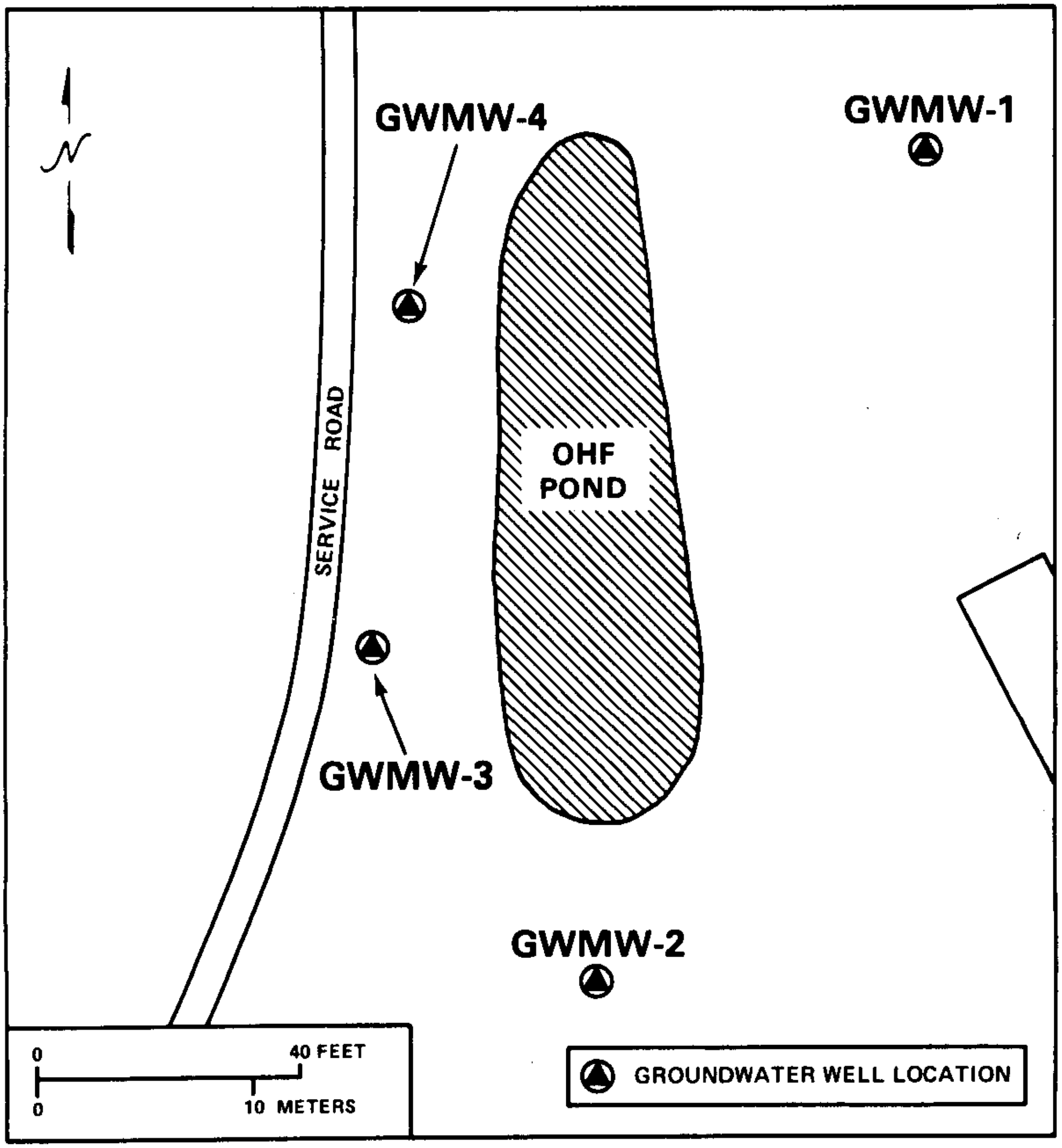

Fig. 6.2.23. Locations of some of the groundwater wells sampled around Old Hydrofracture Pond.

standing water contained in the impoundment. However, it is also located ~30 m downgradient from a disposal trench in a low-level solid waste storage area (SWSA 5), which is a potential source of contamination. Monitoring wells 2, 3, and 4 were located to collect groundwater downgradient from the impoundment. The depth from ground surface of monitoring well 1 is ~10 m as compared with ~7 m for monitoring wells 2, 3 and 4. A geologic cross section of the impoundment, illustrating the relative position of the water table and the monitoring wells. The sediments in the bottom of the impoundment were in direct contact with the water table on July 29, 1985 (Francis and Stansfield, 1986).

The monitoring wells in this study were constructed of 7.60-cm-diam fiberglass well screen and casing. The 3.0-m-long well screens contain two rows of slots, each 0.25 mm wide, to allow the movement of groundwater into the wells. A medium-grained quartz sand was packed around the screen extending to ~30 cm above the top of the well screen. A bentonite clay seal ~30 cm in length was placed on top of the sand pack. The remainder of the boring was backfilled with portland cement concrete (Francis and Stansfield, 1986).

Except for radioactivity (gross alpha and gross beta measurements) and counts of coliform bacteria counts, the mean concentrations of NIPDWS contaminants determined in downgradient wells were below RCRA maximum limits (see Table 6.2.99). The major contaminants in downgradient wells appear to be ^{90}Sr and tritium (mean concentrations of 17.02 and 2960 pCi/L, respectively, over four quarters of sampling). The tritium concentrations appear to be derived from a source other than the impoundment, as the mean concentration of tritium in the upgradient wells over the same four quarters of sampling was slightly higher (3367 pCi/L) than the mean for the downgradient wells. The most likely source of tritium in these groundwater samples is the low-level radiological waste disposed of in the burial ground (SWSA 5) northeast of the OHF (Francis and Stansfield, 1986). Tritium has been observed in groundwater sampled immediately below this waste burial ground. For example, in 1974 water samples from seeps at the bottom of the hill on the south side of the burial grounds contained 3.7×10^{11} pCi/L of tritium (Duguid, 1976).

In addition to radiological measurements and coliform counts, there were instances where the concentrations of barium, chromium, and lead in the downgradient wells exceeded the RCRA maximum limits (see Table 6.2.100). The degree to which these concentrations exceeded the limit was generally very small: for example, the concentration of barium was 1.09 mg/L and the limit was 1; the concentration of chromium was 0.08 mg/L (limit, 0.05); and the concentration of lead was 0.09 mg/L (limit, 0.05). Lead concentrations in monitoring well 3 were 0.08, 0.08, and 0.09 mg/L, respectively, in the last three quarters sampled (Francis and Stansfield, 1986). Those parameters that showed significant differences at the 0.05 level are listed in Table 6.2.101. Comparisons of indicator parameters in each of the wells are presented in Table 6.2.102.

The Homogeneous Reactor Experiment No. 2 (HRE) impoundment was built in 1955 to serve as a settling basin for low-level radioactive waste generated by the HRE. The HRE facility is located in Melton Valley, ~900 m southeast of the main ORNL complex (see Fig. 6.2.24). When constructed, the capacity of the impoundment was $\sim 1.2 \times 10^6$ L (20 by 20 m and ~3 m deep). The impoundment received liquid wastes intermittently from 1957 through 1962. In 1970 the impoundment was drained and backfilled with soil and partially weathered shale from the surrounding area. The filled impoundment was then capped with crushed limestone and asphaltic concrete (Francis and Stansfield, 1986).

Four monitoring wells were installed during February and March of 1985 around the perimeter of the HRE impoundment (Fig. 6.2.25). Monitoring well 1 was installed at the far northwest corner of the asphaltic cap. The location of monitoring well 1 farther upslope and off the asphaltic cap area was restricted by aboveground and belowground structures. Based on water level measurements, this well is considered to be upgradient from the impoundment. None of the other wells (2, 3, and

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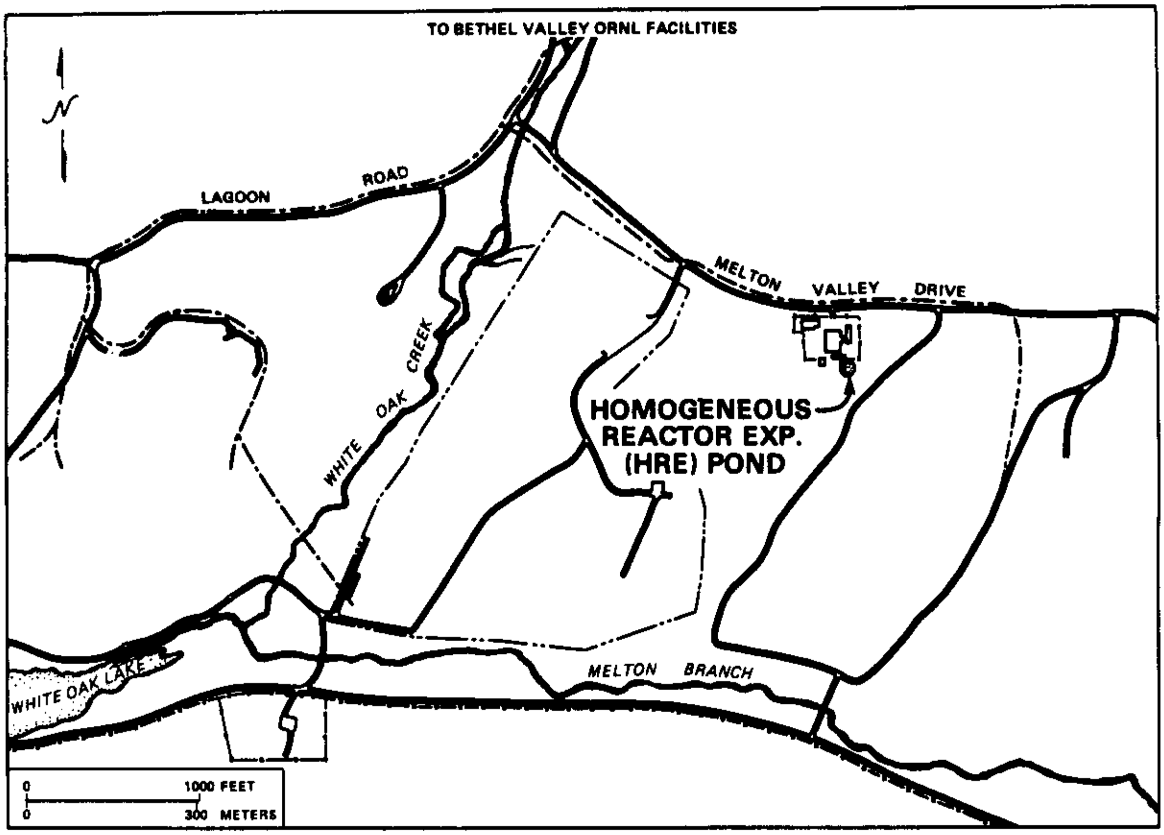

Fig. 6.2.24. Location of Homogeneous Reactor Experiment Pond.

4) installed to sample groundwater downgradient of the covered impoundment, were located within the area of the enclosed asphaltic cap. Depths from ground level to the bottom of the monitoring wells range from 9 m for monitoring well 1 to ~7.5 m for downgradient wells.

The construction of the monitoring wells at the HRE impoundment is similar to that of the wells at the OHF impoundment; i.e., the well screens and casings are made of 7.6-cm-diam fiberglass rather than stainless steel, which was used for the 3513 impoundment wells (Francis and Stansfield, 1986).

Mean values for the RCRA groundwater protection parameters in upgradient and downgradient monitoring wells over the four quarters of sample collection are presented in Table 6.2.103. As in the case of the 3513 and OHF impoundments, the major contaminants in groundwater downgradient of the HRE impoundment appear to be alpha and beta radionuclides. Mean counts of coliform bacteria in both downgradient and upgradient wells are also in excess of drinking water standards. It is not clear why excessive counts of coliform bacteria are present in upgradient wells. Similar high counts were observed in the 3513 and OHF impoundments (see Tables 6.2.95 and 6.2.99). Waterfowl, muskrat, and woodchucks, are known to inhabit the ponds and adjoining areas and most likely contribute to the bacteria counts in downgradient wells, but their presence should not have a major impact on upgradient wells (Francis and Stansfield, 1986).

The mean concentration of chromium in the upgradient wells was found to exceed the drinking water standard (<0.065 as compared with the limit of 0.05 mg/L); however, this is an artifact

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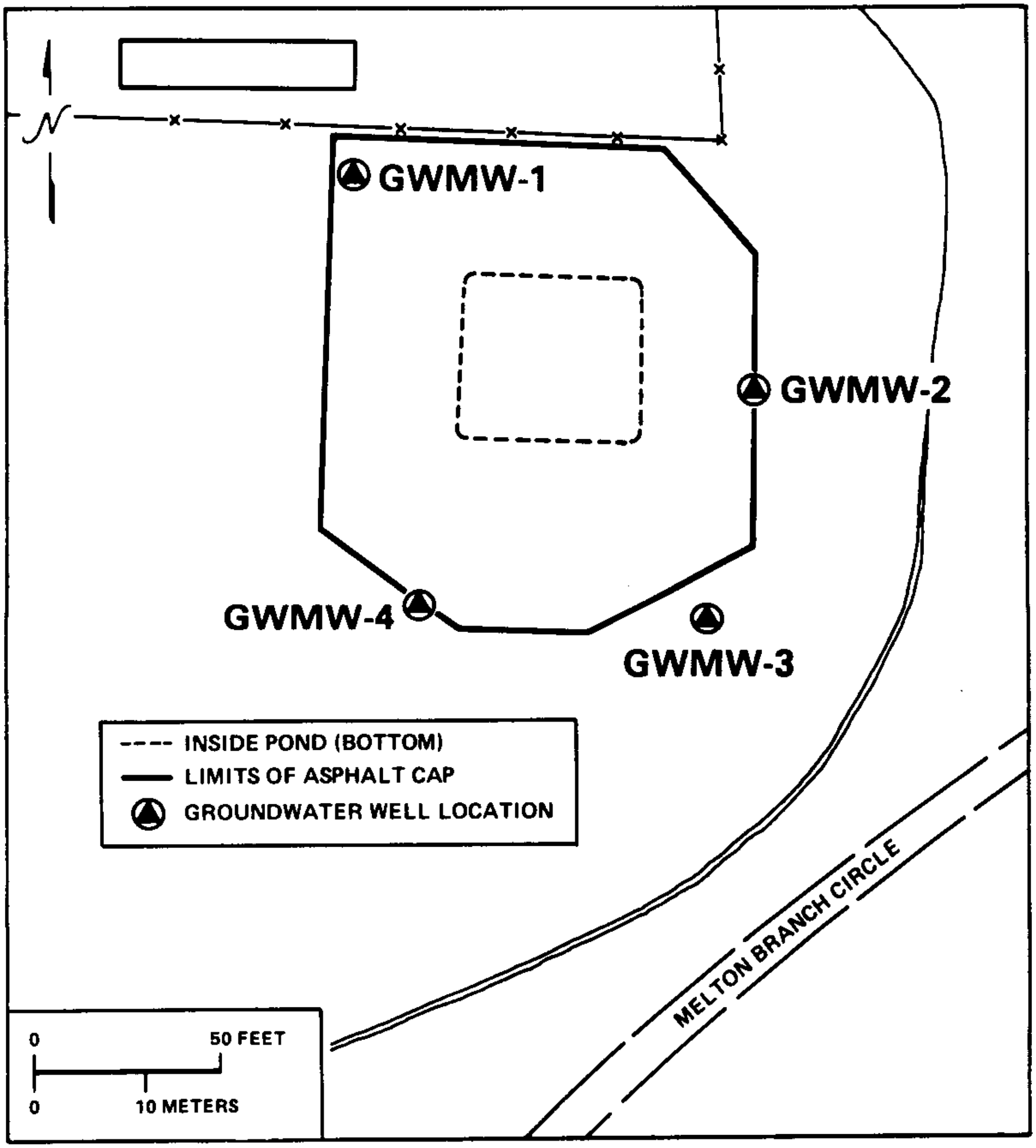

Fig. 6.2.25. Location of groundwater wells around Homogeneous Reactor Experiment Pond.

resulting from the analytical detection levels being in excess of the drinking water limit. The detection limit for the second quarter sample from monitoring well 1 was 0.2 mg/L. If this value is deleted from the data set, the mean chromium concentration in the upgradient wells is 0.0203 mg/L. A similar relationship exists for silver. For example, the mean concentration for silver in the downgradient wells was <0.0645 mg/L if all measured values were used and the analytical detection level was used as an estimate for that value. The analytical detection level for

Table 6.2.99. Mean groundwater concentrations measured in monitoring wells at the Old Hydrofracture Facility impoundment

Parameter[a]	Maximum level allowed[a,b]	Measured[a]	
		Upgradient	Downgradient
National Interim Primary Drinking Water Standards (NIPDWS)			
Arsenic	0.05	<0.0028	<0.003
Barium	1	0.45	0.57
Cadmium	0.01	<0.0011	<0.002
Chromium	0.05	<0.027	<0.031
Coliform bacteria, count/100 mL	1	5.2	<6.4
Endrin	0.0002	<0.0001	<0.0002
Fluoride	1.4-2.4	<1.0	<1.0
Gross alpha, pCi/L	0.021	<0.044	<2.2
Gross beta, pCi/L	0.005[c]	0.178	26.3
Lead	0.05	<0.01	<0.042
Lindane	0.004	<0.0009	<0.001
Mercury	0.002	<0.0001	<0.0045
Methoxychlor	0.1	<0.0033	<0.004
Nitrate-N	10	2.7	<3.8
^{226}Ra, pCi/L	0.007	<0.004	<0.007
Selenium	0.01	0.0033	<0.004
Silver	0.05	<0.042	<0.036
Toxaphene	0.005	<0.0032	<0.0035
2,4,5-TP Silvex	0.01	<0.0070	<0.0075
2,4-D	0.1	<0.0070	<0.0075
Parameters establishing groundwater quality			
Chloride	ND	12	19
Iron	ND	2.7	17
Manganese	ND	0.20	2.9
Phenols	ND	<0.0012	<0.0012
Sodium	ND	13	24
Sulfate	ND	20	16
Parameters used as indicators of groundwater contamination			
pH (units)	ND	6.5	6.3
Specific conductance, μmhos/cm	ND	710	450
Total organic carbon	ND	4.5	5.7
Total organic halides	ND	0.11	0.13
Nonregulated parameters			
Copper[d]	1	<0.02	<0.026
^{137}Cs, pCi/L	ND	0.044	0.063
Dissolved oxygen	ND	6.9	7.4
Nickel[d]	5	<0.06	<0.06
Polychlorinated biphenyls (PCBs)	ND	0.0001	0.0001
^{90}Sr, pCi/L	0.005[c]	0.07	17
Temperature, °C	ND	16	16
Tritium, pCi/L	24.79[c]	3370	3000
Zinc[d]	5	<0.06	<0.1476

[a]Concentrations are in mg/L unless otherwise stated; mean values do not relate to detection levels.

[b]ND = maximum level for that parameter not defined.

[c]Level of activity necessary to give a total body dose of 4 mR/year to a person drinking 2.2 L of water per day for a year.

[d]Hazardous substance guidelines issued by the State of Tennessee (L. W. Gregory, Division of Solid Waste Management, Department of Health and Environment, State of Tennessee, personal communication, 1985).

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundment: Results After One Year*, ORNL/TM-10193, Oak Ridge, Tenn.

Table 6.2.100. Measured concentrations in groundwater at the Old Hydrofracture Facility impoundment that were in excess of RCRA maximum limits for groundwater

Parameter	Unit	RCRA limit	Sampling quarter[a]			
			1	2	3	4
Well 1						
Coliform bacteria	count/100 mL	1	5	16	BL	BL
Gross alpha	pCi/L	0.02	BL	0.074	0.034	0.11
Gross beta	pCi/L	0.005	4	0.19	0.26	ND
^{90}Sr	pCi/L	0.005	ND	0.074	0.074	0.074
Tritium	pCi/L	25	ND	2900	2780	4440
Well 2						
Coliform bacteria	count/100 mL	1	BL	10	BL	BL
Gross alpha	pCi/L	0.02	BL	BL	0.037	0.11
Gross beta	pCi/L	0.005	0.074	0.074	0.11	0.11
Lead	mg/L	0.05	BL	BL	0.10	BL
^{90}Sr	pCi/L	0.005	ND	BL	0.015	BL
Tritium	pCi/L	25	ND	7030	2150	5180
Well 3						
Barium	mg/L	1	BL	1.10	BL	BL
Chromium	mg/L	0.05	BL	0.08	BL	BL
Coliform bacteria	count/100 mL	1	48	BL	BL	BL
Gross alpha	pCi/L	0.02	0.037	0.037	0.037	1.9
Gross beta	pCi/L	0.005	0.296	14.10	21.1	8.2
Lead	mg/L	0.05	BL	0.08	0.08	0.09
^{90}Sr	pCi/L	0.005	ND	9.25	8.9	4.5
Tritium	pCi/L	25	ND	2220	185	7770
Well 4						
Coliform bacteria	count/100 mL	1	18	BL	BL	BL
Gross alpha	pCi/L	0.02	0.407	0.11	0.037	23
Gross beta	pCi/L	0.005	22.2	48.1	100	100
^{90}Sr	pCi/L	0.005	ND	15.5	52	63
Tritium	pCi/L	25	ND	1220	410	520

[a]BL = below RCRA groundwater limit; ND = not determined.

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

Table 6.2.101. Student's t-test for indicators of groundwater contamination at the Old Hydrofracture Facility impoundment

Well	Quarter	pH		Specific conductance (μmhos/cm)		Total organic carbon (mg/L)		Total organic halides (mg/L)	
		Mean	Significance[a]	Mean	Significance[a]	Mean	Significance[a]	Mean	Significance[a]
Background[b]		6.4		820		4.8		0.067	
1	1	6.2	SV	820	SV	3.4	NS	0.020	NS
	2	6.8	**	610	NS	7.0	**	0.010	SV
	3	6.4	NS	670	NS	5.2	NS	0.223	**
	4	6.4	*	820	*	1.9	**	0.073	NS
2	1	6.3	SV	760	SV	6.3	SV	0.013	SV
	2	6.9	**	580	*	8.3	**	0.009	SV
	3	6.4	NS	640	NS	3.2	*	0.23	**
	4	6.1	**	650	NS	3.3	NS	0.044	*
3	1	6.5	SV	710	SV	3.2	SV	0.033	SV
	2	6.5	NS	240	**	7.0	**	0.029	SV
	3	6.5	NS	310	**	8.9	**	0.27	**
	4	6.3	*	680	NS	3.9	NS	0.061	NS
4	1	6.2	SV	260	SV	2.2	SV	0.049	SV
	2	6.2	**	160	**	5.7	*	0.037	SV
	3	5.5	SV	200	SV	9.0	**	0.26	**
	4	6.1	**	280	**	2.4	**	0.069	NS

[a]SV = single value; ND = not determined; NS = not significant; * = significant at the 0.05 level; ** = significant at the 0.01 level.

[b]Mean background concentrations determined from upgradient monitoring wells over four quarters of sampling (see Table A-5 in the Appendix).

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

Table 6.2.102. Significant differences in water quality parameters between monitoring wells at the Old Hydrofracture Facility impoundment

Parameter	Concentrations in monitoring wells 1–4[a]			
	1	2	3	4
Chloride, mg/L	12†	18*†	25*	14†
Iron, mg/L	2.7†	11*†	37*	2.3†
Gross beta, mR/year	5†	2†	300†	1800*
Manganese, mg/L	0.2†	1.5†	6.1*	1.0†
Sodium, mg/L	13†	16†	39*	17†
pH (units)	6.5*	6.4*	6.4*	6.1†
Sulfate, mg/L	20*	12†	18*	18*
Specific conductance, μmhos/cm	710*	630*	440†	220§
^{90}Sr, pCi/L	0.07†	0.011†	7.4†	44.4

[a]Concentrations are statistically different (0.05 level) between wells if they do not have similar superscripts (*, †, §). The statistical comparisons were determined using the Duncan's multiple-range test of the GLM procedure, as outlined in SAS 1985.

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

Table 6.2.103. Mean groundwater concentrations measured in monitoring wells at the Homogeneous Reactor Experiment No. 2 impoundment

Parameter[a]	Maximum level allowed[a,b]	Measured[a]	
		Upgradient	Downgradient
National Interim Primary Drinking Water Standards (NIPDWS)			
Arsenic	0.05	<0.0028	<0.0044
Barium	1	<0.30	<0.74
Cadmium	0.01	<0.0006	<0.0010
Chromium	0.05	<0.065	<0.031
Coliform bacteria, count/100 mL	1	3.0	3.3
Endrin	0.0002	<0.0002	<0.0002
Fluoride	1.4-2.4	<1.0	<1.0
Gross alpha, pCi/L	0.021	0.15	<0.81
Gross beta, pCi/L	0.005[c]	0.14	14.1
Lead	0.05	<0.022	<0.020
Lindane	0.004	<0.0014	<0.0014
Mercury	0.002	<0.0001	<0.0001
Methoxychlor	0.1	<0.0043	<2.5
^{226}Ra, pCi/L	0.007	<0.0002	<0.002
Selenium	0.01	<0.0033	<0.0033
Silver	0.05	<0.035	<0.06
Toxaphene	0.005	<0.0035	<0.0039
2,4,5-TP Silvex	0.01	<0.0075	<0.0075
2,4-D	0.1	<0.0075	<0.0075
Parameters establishing groundwater quality			
Chloride	ND	8.5	5.5
Iron	ND	1.9	24
Manganese	ND	0.13	4.5
Phenols	ND	<0.0018	0.0012
Sodium	ND	6.3	14
Sulfate	ND	46	44
Parameters used as indicators of groundwater contamination			
pH (units)	ND	6.8	6.7
Specific conductance, μmhos/cm	ND	500	590
Total organic carbon	ND	5.0	3.7
Total organic halides	ND	0.10	0.06
Nonregulated parameters			
Copper[d]	1	<0.02	<0.04
^{137}Cs, pCi/L	ND	0.005	0.018
Dissolved oxygen	ND	4.2	4.5
Nickel[d]	5	<0.06	<0.11
Polychlorinated biphenyls (PCBs)	ND	0.0001	0.0001
^{90}Sr, pCi/L	0.005[c]	0.006	4.81
Temperature, °C	ND	18	17
Tritium, pCi/L	25[c]	0.44	7.0
Zinc[d]	5	<0.02	0.08

[a]Concentrations are in mg/L unless otherwise stated; mean values do not relate to detection levels.

[b]ND = maximum level for that parameter not defined.

[c]Level of activity necessary to give a total body dose of 4 mR/year to a person drinking 2.2 L of water per day for a year.

[d]Hazardous substance guidelines issued by the State of Tennessee (L. W. Gregory, Division of Solid Waste Management, Department of Health and Environment, State of Tennessee, personal communication, 1985).

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

silver for many samples was 0.07 mg/L, and in one case the detection level was as high as 0.42. When those detection levels in excess of the RCRA drinking water limit are deleted from the data set, the mean value for silver in the downgradient wells over the four quarters of sampling is <0.007 mg/L (Francis and Stansfield, 1986).

Measurements in groundwater sampled from the HRE monitoring wells in excess of the RCRA maximum limits for groundwater are listed in Table 6.2.104. As mentioned, the principal parameters in excess of the limits are radionuclides and counts for coliform bacteria. In a few instances concentrations of barium, lead, chromium, and nitrate exceeded the limits; however, those instances were few and the degree of excess was generally quite small (Francis and Stansfield, 1986). Parameters that showed significant differences at the 0.05 level are listed in Table 6.2.105. Also given are comparisons of indicator parameters in each of the wells.

6.2.3 ORGDP Monitoring

Routine groundwater monitoring at ORGDP is limited to the K-1407-B and K-1407-C units. The locations of groundwater wells is shown in Fig. 6.2.26. However, programs are being pursued to develop a monitoring plan and network so that other sites will be routinely monitored. Assessments and characterizations of the ORGDP groundwater quality and flow have been performed by Geraghty and Miller, Inc., which has developed a plan to monitor the groundwater characteristics at several RCRA and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites. The program addressed several areas. The major questions addressed were:

(1) What are the effects of the ORGDP waste disposal activities on the groundwater in and around each of the identified RCRA and CERCLA facilities?

(2) Is groundwater monitoring necessary? If so, where should the wells be located and what should the analytical parameters be?

(3) What remedial actions may improve the quality of groundwater, if required?

During October 1985, 11 groundwater monitoring wells were installed at the K-1407-B and K-1407-C surface impoundments. Figure 6.2.27 is a cross section of these wells. This action brought these units in compliance with interim status RCRA facilities. The first year of background data (FY 1986) was completed the third quarter of CY 1986 and is shown in Tables 6.2.106 through 6.2.116.

A two-part groundwater protection program has been implemented. Part I identified 29 waste treatment, storage, or disposal facilities that might require monitoring. Of these 29, an inspection by G&M determined that only 14 of these sites would require monitoring. Along with the 11 monitoring wells at K-1407-B and K-1407-C, 26 characterization wells for determining the 14 sites' hydrogeology was installed in 1986, and G&M designed a monitoring well network. The network plans call for installation of 42 additional groundwater monitoring wells at the 14 sites. These wells were installed in the first quarter of CY 1987. A total of 79 wells were installed during Part I of the ORGDP Groundwater Protection Program.

Part II of the program involves the groundwater assessment of 39 more ORGDP sites. The same program of site review, characterization, and monitor plan design and installation will be initiated in 1987.

Table 6.2.104. Measured concentrations in groundwater at the Homogeneous Reactor Experiment No. 2 impoundment that were in excess of RCRA maximum limits for groundwater

Parameter	Unit	RCRA limit	Sampling quarter[a]			
			1	2	3	4
Well 1						
Coliform bacteria	count/100 mL	1	8	4	BL	BL
Gross alpha	pCi/L	0.02	0.037	0.037	BL	0.33
Gross beta	pCi/L	0.005	0.37	0.15	0.037	0.037
Lead	mg/L	0.05	0.07	BL	BL	BL
Nitrate-N	mg/L	10	24	BL	BL	BL
Well 2						
Coliform bacteria	count/100 mL	1	30	BL	BL	2
Endrin	mg/L	0.0002	0.0008	BL	BL	BL
Gross alpha	pCi/L	0.02	0.222	0.22	BL	7.4
Gross beta	pCi/L	0.005	26.7	35.2	30	31.1
^{226}Ra	pCi/L	0.007	0.012	BL	BL	BL
^{90}Sr	pCi/L	0.005	ND	20	5.2	15.9
Well 3						
Barium	mg/L	1	2	BL	BL	BL
Coliform bacteria	count/100 mL	1	BL	2	BL	BL
Gross alpha	pCi/L	0.02	0.037	BL	BL	0.074
Gross beta	pCi/L	0.005	0.89	0.15	0.074	0.037
Lead	mg/L	0.05	0.09	BL	BL	BL
^{90}Sr	pCi/L	0.005	ND	0.048	BL	BL
Toxaphene	mg/L	0.005	0.005	BL	BL	BL
Well 4						
Barium	mg/L	1	2.7	BL	BL	BL
Chromium	mg/L	0.05	BL	0.06	BL	BL
Coliform bacteria	count/100 mL	1	BL	6	BL	BL
Gross alpha	pCi/L	0.02	0.89	BL	BL	BL
Gross beta	pCi/L	0.005	33.3	7.8	2.4	2.3
^{90}Sr	pCi/L	0.13	ND	0.037	1.9	1.2

[a]BL = below RCRA groundwater limit.
[b]ND = not determined.
Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, Tenn.

Table 6.2.105. Significant difference in water quality parameters between monitoring wells at the Homogeneous Reactor Experiment No. 2 impoundment

Parameter	Concentrations in monitoring wells 1–4[a]			
	1	2	3	4
Chloride (mg/L)	8.5*	7.2*†	4.6†	4.6†
Tritium (Bq/L)	12§	170†	390*	24§
Sodium (mg/L)	6.3†	12†	25*	5.8†
pH	6.8*†	6.6†	6.7*†	6.9*
Sulfate (mg/L)	46*†	57*	41†	35†
^{90}Sr (Bq/L)	0.2†	370*	0.5†	28†
Temperature (°C)	18*	17*†	16†	17*†

[a]Concentrations are statistically different (0.05) between wells if they do not have similar superscripts (*, †, §). The statistical comparisons were determined using the Duncan's multiple-range test of the GLM procedure as outlined in SAS 1985.

Source: C. W. Francis and R. G. Stansfield, 1986. *Groundwater Monitoring at Three Oak Ridge National Laboratory Inactive Waste Impoundments: Results After One Year,* ORNL/TM-10193, Oak Ridge, TN.

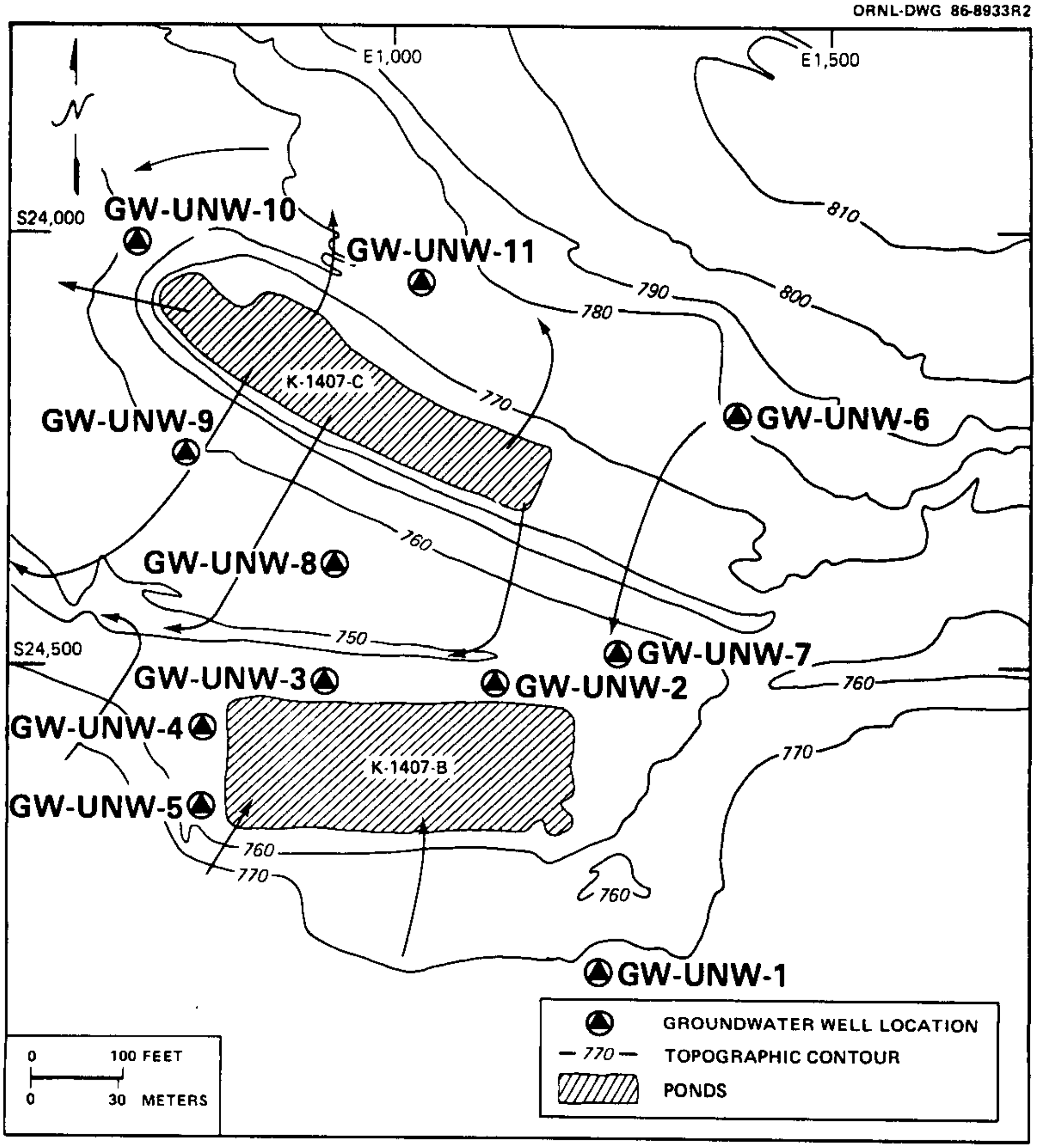

Fig. 6.2.26. Location of groundwater wells around surface impoundments.

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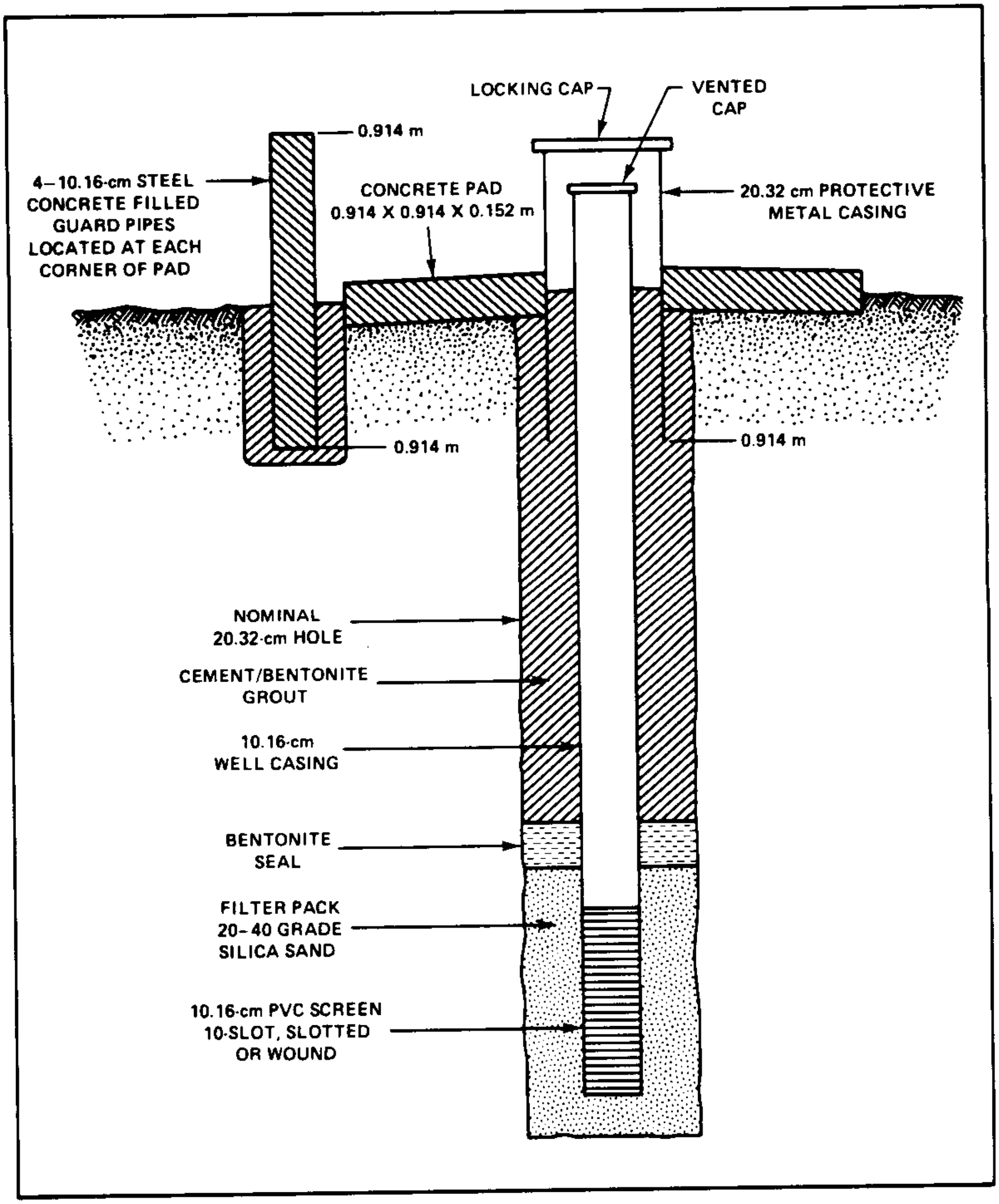

Fig. 6.2.27. Cross section of the ORGDP groundwater wells.

Table 6.2.106. FY-1986 concentrations of parameters in well UNW-1[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	4.1	0.91	6.5	<0.020	8.8	0.043	8.7	<0.020
Sb	<0.05	<0.05			<0.05	<0.05	<0.05	<0.05
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005
Ba	0.17	0.13	0.18	0.14	0.18	0.11	0.24	0.16
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.020	0.014	0.027	0.73	0.0057	<0.004	0.0099	0.041
Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.005	<0.003
Ca	47	46	67	65	59	57	62	66
Cr	<0.01	<0.01	<0.01	<0.010	<0.010	<0.010	0.013	<0.010
Co	0.020	0.017	0.0051	<0.005	0.013	<0.005	0.018	0.011
Cu	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	1.2	6.2	9.7	0.029	12	0.030	18	0.90
Pb	0.006	0.005	<0.004	<0.004	0.008	0.005	0.010	<0.004
Li	0.0048	<0.004	<0.004	<0.004	<0.004	<0.004	0.0073	<0.004
Mg	19	18	23	22	19	16	20	19
Mn	6.5	7.5	4.8	5.0	7.1	6.4	4.4	4.0
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	0.015	0.012	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Nb	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
P	0.25	<0.20	<0.20	<0.20	<0.20	<0.20	0.65	0.31
K	2.8	2.3	3.8	1.2	3.4	0.89	5.1	2.6
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	7.5	4.0	11	2.3	14	2.2	14	2.4
Ag	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	6.9	7.3	7.2	8.2	6.9	6.7	6.2	6.4
Sr	0.13	0.13	0.14	0.14	0.13	0.12	0.12	0.12
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.16	0.027	0.15	<0.003	0.29	0.0069	0.37	0.022
U	0.007	0.009	0.004	0.003	<0.001	0.004	<0.001	<0.001
V	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0094	<0.005
Zn	0.062	0.043	0.015	<0.0010	0.048	0.044	0.030	0.0038
Zr	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Table 6.2.106. UNW-1 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	72.41[d]	6	<3	<1
Beta activity (pCi/L)	98.83[d]	6.5	<7	3
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	5.92	6.6	6.6	6.5
Conductivity (μmhos/cm)	320	530	421	464
Total coliform bacteria (cc/100 ml)	NF[f]	NF	NF	2[d]
Fecal coliform bacteria	NF			
Phenols	0.002	0.002	0.011	<0.001
Total organic carbon	90	6.5	93	101
Total organic chloride (μg/L)	23	94	1400	53
Chloride	16	17.9	21	20
Fluoride (μg/L)	0.12	IS[g]	0.2	0.3
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Sulfate	30	30	30	25
Temperature (°C)[h]	19	16	25.3	25.0
Groundwater elevation (ft)[h]	762.5	761.7	759.0	761.5

[a]See Fig. 6.2.26; during 1986, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Insufficient sample for analysis.
[h]Field measured.

Table 6.2.107. FY-1986 concentrations of parameters in well UNW-2[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.52	0.13	9.1	<0.020	1.8	<0.020	5.0	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ba	0.055	0.056	0.086	0.039	0.046	0.036	0.075	0.045
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.024	0.025	0.15	0.041	0.014	0.0082	0.037	0.039
Cd	<0.003	<0.003	<0.003	<0.0030	<0.003	<0.003	<0.003	<0.003
Ca	200	190	230	130	250	240	270	280
Cr	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Co	<0.005	<0.005	<0.005	<0.0050	<0.005	<0.005	0.0067	<0.005
Cu	<0.004	<0.004	<0.004	<0.0040	<0.004	<0.004	<0.004	<0.004
Fe	0.2	0.60	11	0.15	1.8	0.039	5.1	<0.0040
Pb	0.004	<0.004	0.010	0.004	0.007	<0.004	0.006	0.004
Li	<0.004	<0.004	<0.004	<0.0040	<0.004	<0.004	0.0045	<0.0040
Mg	23	25	25	24	24	23	26	26
Mn	0.20	0.21	0.59	0.0026	0.27	0.17	0.50	0.21
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	<0.010	<0.010	0.018	<0.010	<0.010	<0.010	<0.010
Nb	<0.007	<0.007	<0.007	<0.0070	<0.007	<0.007	<0.007	<0.007
P	0.24	<0.20	0.20	<0.20	<0.20	<0.20	<0.20	<0.20
K	2.9	3.3	5.4	1.6	1.5	1.3	4.2	3.0
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	6.0	5.8	15	5.3	7.7	4.4	13	5.2
Ag	<0.006	<0.006	<0.006	<0.0060	<0.006	<0.006	<0.006	<0.006
Na	42	43	44	46	47	49	57	60
Sr	0.24	0.25	0.23	0.24	0.21	0.21	0.25	0.25
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.017	0.0074	0.12	<0.0030	0.062	0.013	0.20	0.015
U	0.006	0.016	0.004	0.001	0.001	0.004	0.001	<0.001
V	<0.005	<0.005	<0.005	<0.0050	<0.005	<0.005	0.0055	<0.005
Zn	0.062	0.062	<0.001	<0.0010	0.059	0.060	0.024	0.0061
Zr	<0.005	<0.005	<0.005	<0.005	<0.0050	<0.005	<0.005	<0.005

Table 6.2.107. UNW-2 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	79[d]	14.6	<3	5
Beta activity (pCi/L)	2027[d]	1105[d]	923[d]	753[d]
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.39	7.1	7.2	7.1
Conductivity (μmhos/cm)	800	1299	1348	1636
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.002	<0.003	<0.001	<0.001
Total organic carbon	110	5.6	145	96
Total organic chloride (μg/L)	195	520	140	560
Chloride	137	189	162	235
Fluoride (μg/L)	0.06	IS[g]	0.1	0.2
Nitrate nitrogen (mg/L)	2.6	0.66	0.32	0.27
Sulfate (mg/L)	190	211	229	246
Temperature (°C)[h]	17	10.9	24.4	26.0
Groundwater elevation (ft)[h]	751.8	751.6	753.9	749.6

[a]See Fig. 6.2.26; during 1986, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Insufficient sample for analysis.
[h]Field measured.

Table 6.2.108. FY-1986 concentrations of parameters in well UNW-3[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	1.0	<0.020	4.9	<0.02	1.2	<0.02	4.2	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ba	0.091	0.077	0.11	0.061	0.062	0.048	0.089	0.049
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.056	0.057	0.81	0.86	0.048	0.038	0.066	0.067
Cd	<0.003	<0.0030	<0.003	<0.003	<0.003	<0.003	0.006	<0.0030
Ca	240	230	270	280	290	290	300	300
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.0053	<0.0050	<0.005	<0.005	<0.005	<0.005	0.0061	0.0086
Cu	<0.004	<0.0040	<0.004	<0.004	<0.004	<0.004	<0.004	<0.0040
Fe	0.23	1.7	8.9	0.097	1.5	<0.004	5.6	<0.0040
Pb	<0.004	0.0048	<0.004	<0.004	<0.004	<0.004	0.008	0.0058
Li	0.0048	<0.00480	<0.004	<0.004	<0.004	<0.004	0.0058	0.0043
Mg	37	39	37	38	36	36	37	36
Mn	6.7	7.0	6.0	6.2	7.4	7.1	7.4	7.6
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	0.024	0.026	0.015	<0.010	<0.010	<0.010	0.018	0.016
Nb	<0.0070	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
P	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.87	<0.20
K	3.9	4.2	4.8	2.9	2.3	2.2	4.4	3.6
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	6.6	5.7	12	5.0	6.4	4.6	12	4.8
Ag	<0.0060	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	140	150	130	130	130	130	140	140
Sr	0.47	0.50	0.48	0.49	0.44	0.43	0.46	0.44
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.031	0.0064	0.092	<0.003	0.056	0.0053	0.20	0.021
U	0.007	0.018	0.005	0.003	<0.001	<0.001	<0.001	<0.001
V	<0.0050	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zn	0.051	0.037	<0.001	<0.001	0.053	0.051	0.014	0.0053
Zr	<0.0050	<0.005	<0.005	<0.005	<0.005	<0.005	0.010	<0.005

Table 6.2.108. UNW-3 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	61.43[d]	1.93	<3	9
Beta activity (pCi/L)	96.40[d]	30	29	26
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	1.35	IU[e]	IU	IU
pH (units)	6.16	6.8	7.3	7.1
Conductivity (μmhos/cm)	1600	2040	1940	2240
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.003	0.004	<0.001	<0.001
Total organic carbon	80	4	67	66
Total organic chloride (μg/L)	290	33	140	312
Chloride (mg/L)	274	348	321	356
Fluoride (μg/L)	0.06	IS[g]	0.1	0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Sulfate	455	472	455	480
Temperature (°C)[h]	16.5	15	24.1	23.0
Groundwater elevation (ft)[h]	751.7	752.0	754.0	752.0

[a]See Fig. 6.2.26; during 1986, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Insufficient sample for analysis.
[h]Field measured.

Table 6.2.109. FY-1986 concentrations of parameters in well UNW-4[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.90	<0.020	3.8	<0.020	3.2	<0.02	8.4	<0.020
Sb	<0.05	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ba	0.020	0.016	0.018	0.0079	0.078	0.022	0.027	<0.001
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.029	0.028	0.051	0.67	0.013	0.016	0.042	0.054
Cd	<0.0030	<0.003	<0.003	<0.003	<0.003	<0.003	0.0086	0.0030
Ca	140	140	160	170	190	190	220	200
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.023	<0.010
Co	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0092	<0.005
Cu	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	0.11	0.4	4.6	0.053	3.2	<0.004	9.7	<0.004
Pb	0.005	0.005	<0.00450	<0.00450	0.006	0.004	0.004	0.006
Li	0.0058	0.005	<0.0040	<0.004	<0.004	<0.004	0.012	0.0042
Mg	16	15	16	16	17	16	20	16
Mn	0.40	0.38	0.36	0.30	0.36	0.31	0.50	0.25
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.020	<0.010
Nb	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
P	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.27	<0.20
K	2.9	3.0	4.2	1.6	2.9	1.4	8.3	2.8
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	8.7	7.4	12	6.5	11	6.5	19	6.5
Ag	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Na	23	23	25	26	26	26	31	29
Sr	0.23	0.24	0.22	0.23	0.25	0.24	0.27	0.24
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.049	0.0044	0.12	<0.003	0.12	0.0065	0.38	0.023
U	0.009	0.018	0.006	0.005	0.002	<0.001	0.001	<0.001
V	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	<0.005
Zn	0.16	0.061	0.019	<0.001	0.038	0.013	0.044	0.0077
Zr	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0071

Table 6.2.109. UNW-4 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	47.39[d]	2.25	<3	2
Beta activity (pCi/L)	63.60[d]	12.8	3.5	8
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.66	6.9	7.2	7.2
Conductivity (μmhos/cm)	800	1030	960	1130
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.003	0.002	0.002	<0.001
Total organic carbon	85	3.2	100	105
Total organic chloride (μg/L)	127	49	85	185
Chloride	66	8.7	91	210
Fluoride (μg/L)	0.07	IS[g]	0.1	0.1
Nitrate nitrogen	<0.11	<0.5	<0.11	<0.11
Sulfate	58	72	78	180
Temperature (°C)[h]	18	15	26.7	22.4
Groundwater elevation (ft)[h]	751.8	753.6	754.4	750.8

[a]See Fig. 6.2.26; DLs for several parameters varied during 1986.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Insufficient sample for analysis.
[h]Field measured.

Table 6.2.110. FY-1986 concentrations of parameters in well UNW-5[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.15	<0.020	1.1	<0.020	<0.020	<0.020	0.35	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	0.007	<0.005	0.006	<0.005	0.011	0.009
Ba	0.30	0.29	0.30	0.26	0.35	0.32	0.40	0.38
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.019	0.030	0.083	0.046	0.045	0.039	0.0067	0.0094
Cd	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0034	0.0044
Ca	160	160	180	180	200	200	220	220
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.011	0.091	<0.0050	<0.0050	<0.0050	<0.0050	0.0090	0.0094
Cu	<0.0040	<0.0040	0.0048	<0.0040	0.0040	<0.0040	<0.0040	<0.0040
Fe	17	18	28	15	19	16	22	18
Pb	<0.004	0.008	<0.004	<0.004	0.004	0.004	0.005	<0.004
Li	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Mg	19	18	18	18	21	21	21	21
Mn	19	19	17	17	19	19	19	19
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	0.45	0.52	<0.20	<0.20	<0.20	<0.20	0.26	0.29
K	1.9	1.9	0.68	0.60	1.1	1.3	1.0	1.6
Se	<0.005	<0.005	<0.005	<0.005	0.006	0.007	<0.005	<0.005
Si	6.5	6.1	6.4	5.1	5.7	5.5	6.7	5.8
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	14	13	15	16	22	23	21	21
Sr	0.41	0.40	0.37	0.37	0.43	0.42	0.41	0.41
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.0083	0.038	0.021	<0.0030	0.0041	<0.0030	0.039	0.023
U	0.009	0.015	0.004	0.005	0.002	<0.001	0.001	<0.001
V	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zn	0.066	0.043	0.0078	0.0021	0.016	0.033	0.029	0.026
Zr	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.110. UNW-5 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	28.65[d]	8.14	7.7	<1.2
Beta activity (pCi/L)	44.95	3.60	1.8	<1.7
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.20	6.7	6.8	6.8
Conductivity (μmhos/cm)	1000	1270	1230	1330
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.002	<0.001	<0.001	0.007
Total organic carbon	255	8.9	113	110
Total organic chloride (μg/L)	350	17	380	1005
Chloride	199	174	277	265
Fluoride (μg/L)	0.11	IS[e]	0.1	0.2
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Sulfate	5	12	19	13
Temperature (°C)[g]	16	12.9	20	22.3
Groundwater elevation (ft)[g]	760.0	759.6	762.2	759.2

[a]See Fig. 6.2.26; during 1986, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient sample for analysis.
[f]NF = not found.
[g]Field measured.

Table 6.2.111. FY-1986 concentrations of parameters in well UNW-6[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	1.1	0.97	15	<0.020	46	<0.020	2.4	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005
Ba	0.016	0.013	0.040	0.0057	0.14	0.0056	0.0035	<0.0010
Be	<0.0003	<0.0003	<0.0003	<0.0003	0.0093	<0.0003	0.0004	<0.0003
B	<0.0040	<0.0040	0.034	0.023	0.020	<0.0040	0.0041	0.017
Cd	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Ca	61	61	66	66	72	67	72	74
Cr	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Co	<0.0050	<0.0050	<0.0050	<0.0050	0.036	<0.0050	0.0055	<0.0050
Cu	<0.0040	<0.0040	0.010	0.0066	0.061	<0.0040	<0.0040	<0.0040
Fe	2.1	0.79	24	0.027	82	0.0068	2.4	<0.0040
Pb	0.046	0.015	<0.004	<0.004	0.250[d]	<0.004	0.007	<0.0040
Li	<0.0040	<0.0040	0.0064	<0.0040	0.030	<0.0040	<0.0040	<0.0040
Mg	11	10	9.9	9.4	11	8.3	8.9	8.8
Mn	0.20	0.095	0.75	0.0025	3.35	0.027	0.094	<0.0010
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	0.011	0.013	<0.010	0.048	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	<0.20	<0.20	0.45	<0.20	1.9	<0.20	0.30	<0.20
K	2.7	2.6	5.1	1.5	6.6	0.83	2.2	1.9
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	5.0	4.8	19	3.4	46	3.3	6.5	3.7
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	1.8	1.8	1.8	1.9	1.5	1.7	1.5	1.5
Sr	0.053	0.053	0.040	0.038	0.041	0.033	0.037	0.037
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.0088	0.0078	0.18	<0.0030	0.52	0.0038	0.089	0.022
U	0.010	0.020	0.003	0.003	0.005	0.004	<0.001	0.001
V	<0.0050	<0.0050	0.26	<0.0050	0.11	<0.0050	<0.0050	<0.0050
Zn	0.089	0.14	0.084	0.0018	0.30	0.0049	0.71	0.0067
Zr	<0.0050	<0.0050	0.0059	<0.0050	0.017	<0.0050	<0.0050	<0.0050

Table 6.2.111. UNW-6 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	60.18[d]	54[d]	4.8	6
Beta activity (pCi/L)	85.32[d]	34	9.9	8
Total Ra (pCi/L)	<2.70	2.97	5.41[d]	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	7.1	7.4	7.6	7.9
Conductivity (μmhos/cm)	387	418	367	304
Total coliform bacteria	NF[f]	NF	NF	1[d]
Fecal coliform bacteria	NF			
Phenols	<0.001	<0.001	<0.001	<0.001
Total organic carbon	120	1.7	46	48
Total organic chloride (μg/L)	1.6	<8	110	198
Chloride	4	1.7	2.7	3.2
Fluoride (μg/L)	0.09	0.153	0.2	0.2
Nitrate nitrogen	0.16	0.28	0.32	0.39
Sulfate (mg/L)	6	7.1	5.7	7
Temperature (°C)[g]	24	15.3	17	22.9
Groundwater elevation (ft)[g]	759.9	765.1	755.0	753.0

[a]See Fig. 6.2.26; during 1986 the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Field measured.

Table 6.2.112. FY-1986 concentrations of parameters in well UNW-7[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	1.0	0.26	2.8	<0.020	0.28	<0.020	1.4	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	0.012	<0.005	<0.005	<0.005	0.006	<0.005
Ba	0.12	0.12	0.12	0.10	0.13	0.13	0.14	0.14
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.032	0.032	0.083	0.039	0.015	0.023	0.034	0.036
Cd	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Ca	77	79	92	88	120	120	120	120
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.015	0.014	0.0057	<0.0050	0.0083	0.0059	0.020	0.015
Cu	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Fe	4.1	1.3	4.9	0.48	1.8	0.94	3.2	0.16
Pb	<0.004	<0.004	<0.004	<0.004	0.004	0.004	<0.004	<0.004
Li	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Mg	17	17	17	16	19	19	18	18
Mn	9.0	9.1	8.4	8.0	9.9	9.4	10	10
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	0.012	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	0.22	0.25	<0.20	<0.20	<0.20	<0.20	0.32	0.32
K	3.2	2.9	2.8	1.5	2.3	1.3	3.1	3.4
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	4.5	3.6	6.9	2.7	3.7	3.2	5.5	3.3
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	190	190	190	180	230	220	240	240
Sr	0.15	0.15	0.14	0.14	0.16	0.016	0.16	0.16
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.019	0.0039	0.047	<0.0030	0.014	0.0061	0.070	0.016
U	0.011	0.026	0.003	<0.001	0.003	0.001	0.003	0.004
V	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zn	0.034	0.048	0.022	0.0024	0.030	0.035	0.013	0.013
Zr	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.112. UNW-7 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<2.0	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	59.32[d]	41[d]	0.33	8
Beta activity (pCi/L)	109[d]	68[d]	48.3	73[d]
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.4	6.5	6.7	6.5
Conductivity (μmhos/cm)	1088	1380	1525	1770
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.008	0.003	0.005	<0.001
Total organic carbon	360	5.2	188	193
Total organic chloride (μg/L)	1750	53	1390	2675
Chloride	158	193	236	228
Fluoride (μg/L)	0.05	0.081	0.1	0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Sulfate	67	70	84	86
Temperature (°C)[g]	15	12.3	23	21.6
Groundwater elevation (ft)[g]	753.8	755.5	752.4	754.0

[a]See Fig. 6.2.26; during 1986 the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Field measured.

Table 6.2.113. FY-1986 concentrations of parameters in well UNW-8[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.68	0.077	24	<0.020	6.4	<0.020	3.5	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	0.008	0.006	0.005	0.005
Ba	0.055	0.052	0.15	0.046	0.071	0.042	0.053	0.037
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0004	<0.0003
B	0.017	0.0042	0.080	0.041	0.014	<0.0040	0.018	0.0084
Cd	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.046	<0.0030
Ca	70	72	88	76	82	78	78	79
Cr	<0.010	<0.010	0.027	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.0050	<0.0050	0.016	<0.0050	<0.0050	<0.0050	0.0060	<0.0050
Cu	<0.040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Fe	0.74	0.14	31	0.034	6.7	<0.0040	3.2	<0.0040
Pb	0.004	0.011	0.004	<0.004	0.055[d]	<0.004	0.010	<0.004
Li	<0.0040	<0.0040	<0.0097	<0.0040	<0.0040	<0.0040	<0.0040	<0.004
Mg	6.3	6.3	11	5.4	7.0	5.5	5.8	5.2
Mn	0.089	0.060	0.95	0.049	0.28	0.045	0.13	0.038
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	0.020	0.055	<0.010	<0.010	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	<0.20	<0.20	0.55	<0.20	<0.20	<0.20	0.24	<0.20
K	5.5	4.9	18	4.5	6.1	2.3	6.5	4.5
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	7.6	6.9	38	5.7	16	6.1	12	6.3
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	5.2	5.4	8.2	7.8	5.3	4.7	5.5	5.4
Sr	0.094	0.096	0.090	0.075	0.078	0.070	0.071	0.068
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.023	<0.0030	0.39	<0.0030	0.21	<0.0039	0.13	0.014
U	0.006	0.029	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
V	<0.0050	<0.0050	0.018	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zn	0.037	0.029	0.052	0.0094	0.036	0.023	0.018	0.013
Zr	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.113. UNW-8 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	30.86[d]	74[d]	<1	8
Beta activity (pCi/L)[c]	65.14[d]	145[d]	9.28	19
Total Ra (pCi/L)	<2.70	3.24	10.27[d]	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.5	6.5	6.8	6.6
Conductivity (μmhos/cm)	461	517	463	447
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.002	<0.001	<0.001	<0.001
Total organic carbon	300	1.5	84	78
Total organic chloride (μg/L)	410	30	300	242
Chloride	35	1.5	35	37
Fluoride (μg/L)	0.04	0.063	0.1	0.1
Nitrate nitrogen	<0.11	<0.11	<0.11	<0.11
Sulfate	10	12	7.5	7
Temperature (°C)[g]	15	15.0	17.2	18.1
Groundwater elevation (ft)[g]	752.6	753.5	748.1	751.5

[a]See Fig. 6.2.26; during 1986 DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Field measured.

Table 6.2.114. FY-1986 concentrations of parameters in well UNW-9[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.55	0.16	5.3	<0.020	6.5	<0.020	1.3	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.007	0.006
Ba	0.16	0.16	0.16	0.15	0.17	0.14	0.13	0.14
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.031	0.027	0.080	0.041	0.015	0.014	0.010	0.021
Cd	0.0050	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0062
Ca	140	150	160	160	170	170	160	170
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.058	0.055	0.057	0.049	0.056	0.050	0.052	0.056
Cu	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Fe	11	10	21	12	22	11	11	4.5
Pb	0.004	<0.004	0.28[d]	<0.004	0.057[d]	<0.004	0.006	0.005
Li	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Mg	23	24	22	21	22	21	19	20
Mn	22	22	22	21	21	21	18	19
Hg	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	0.013	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	0.24	0.23	<0.20	<0.20	<0.20	<0.20	0.43	0.27
K	6.8	6.7	6.8	5.3	5.7	4.3	6.6	6.3
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	4.5	4.2	9.7	3.5	13	3.6	5.8	3.7
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	100	100	96	97	96	95	89	96
Sr	0.26	0.27	0.22	0.22	0.22	0.21	0.19	0.21
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.0098	<0.0030	0.075	<0.0030	0.19	0.0039	0.071	0.017
U	0.007	0.013	<0.001	<0.001	<0.001	0.004	<0.001	0.001
V	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zn	0.051	0.094	0.013	0.0011	0.030	0.017	0.012	0.011
Zr	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.114. UNW-9 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	24.77[d]	28[d]	<3	1
Beta activity (pCi/L)	43.51	21	11.6	11
Total Ra (pCi/L)	<2.70	<2.70	<2.70	<2.70
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.2	6.9	6.6	6.4
Conductivity (μmhos/cm)	1404	1510	1375	1478
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	0.004	0.001	0.012	0.002
Total organic carbon	155	5.6	182	199
Total organic chloride (μg/L)	132	71	1420	1042
Chloride	208	204	202	178
Fluoride (μg/L)	0.04	0.066	0.1	0.1
Nitrate nitrogen (mg/L)	<0.11	<0.11	<0.11	<0.11
Sulfate (mg/L)	116	112	122	118
Temperature (°C)[g]	20	13.5	17.8	19.3
Groundwater elevation (ft)[g]	754.8	751.8	749.3	751.7

[a]See Fig. 6.2.26; during 1986, DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Field measured.

Table 6.2.115. FY-1986 concentrations of parameters in well UNW-10[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	0.75	0.087	18	0.072	0.65	<0.020	6.2	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.010	<0.005
Ba	0.16	0.15	0.17	0.12	0.14	0.12	0.19	0.15
Be	<0.0003	<0.0003	0.0004	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
B	0.027	0.023	0.23	0.066	0.0040	0.015	0.0093	0.059
Cd	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Ca	110	110	150	150	140	130	130	130
Cr	<0.010	<0.010	0.018	<0.010	<0.010	<0.010	<0.010	<0.010
Co	0.0051	0.0052	0.012	<0.0050	<0.0050	<0.0050	0.012	<0.0050
Cu	<0.0040	<0.0040	0.019	0.78	0.022	<0.0040	<0.0040	<0.0040
Fe	15	11	28	1.6	13	1.5	21	0.023
Pb	0.007	<0.004	<0.004	<0.004	0.005	<0.004	0.025	<0.004
Li	<0.0040	<0.0040	0.011	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Mg	19	19	20	19	19	18	18	18
Mn	7.3	7.2	9.3	9.2	5.9	5.4	6.2	5.6
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	0.013	<0.010	0.031	0.014	<0.010	<0.010	<0.010	<0.010
Nb	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070
P	0.38	0.34	0.50	<0.20	<0.20	<0.20	0.42	0.34
K	3.4	3.6	5.9	2.5	2.3	1.8	5.0	3.7
Se	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005
Si	3.6	2.9	14	2.7	3.8	2.6	9.2	2.5
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	31	30	23	23	32	29	30	30
Sr	0.17	0.17	0.16	0.15	0.15	0.14	0.15	0.14
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.023	<0.0030	0.24	<0.0030	0.019	<0.0030	0.19	0.021
U	0.007	0.019	0.006	0.003	0.001	0.002	<0.001	0.009
V	<0.0050	<0.0050	0.025	<0.0050	<0.0050	<0.0050	0.0078	<0.0050
Zn	0.12	0.055	0.058	0.016	0.068	0.036	0.027	0.0062
Zr	<0.0050	<0.0050	0.014	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.115. UNW-10 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<0.10	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	25.51[d]	15.9[d]	<3	2
Beta activity (pCi/L)	36.76	15.9	3.5	9
Total Ra (pCi/L)	<2.70	<2.70	5.95	<2.707
^{235}U (wt. %)	IU[e]	IU	IU	IU
pH (units)	6.8	6.9	7.0	6.9
Conductivity (μmhos/cm)	768	793	806	885
Total coliform bacteria	NF[f]	NF	NF	NF
Fecal coliform bacteria	NF			
Phenols	<0.001	0.002	<0.001	0.008
Total organic carbon	195	9.1	148	140
Total organic chloride (μg/L)	19	48	280	102
Chloride	36	23	46	35
Fluoride (μg/L)	0.12	IS[g]	0.2	0.2
Nitrate nitrogen (mg/L)	<0.11	<0.11	<0.11	<0.11
Sulfate (mg/L)	20	53	9.7	12
Temperature (°C)[h]	22	12.8	23.0	17.0
Groundwater elevation (ft)[h]	753.6	750.6	749.6	749.6

[a]See Fig. 6.2.26; during 1986, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Insufficient sample for analysis.
[h]Field measured.

Table 6.2.116. FY-1986 concentrations of parameters in well UNW-11[a]

Parameter	Concentration (mg/L)							
	1st Qtr.		2nd Qtr.		3rd Qtr.		4th Qtr.	
	U[b]	F[c]	U	F	U	F	U	F
Al	1.4	0.72	2.0	0.18	0.15	0.025	7.2	<0.020
Sb	<0.050	<0.050			<0.050	<0.050	<0.050	<0.050
As	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ba	0.061	0.053	0.029	0.025	0.031	0.037	0.15	0.058
Be	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0006	<0.0003
B	0.042	0.036	0.030	0.75	0.010	0.016	0.077	<0.0040
Cd	0.011[d]	<0.0030	<0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Ca	48	50	8.1	8.0	22	38	70	61
Cr	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.018	<0.010
Co	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0074	<0.0050
Cu	<0.0075	<0.0040	0.016	0.011	<0.0040	<0.0040	<0.0040	<0.0040
Fe	1.7	0.62	2.3	0.070	0.13	<0.0040	8.8	0.013
Pb	0.334[d]	0.124	<0.016	<0.004	<0.007	<0.004	0.015	0.015
Li	<0.0040	<0.004	<0.004	<0.004	<0.0040	<0.0040	0.0062	<0.0040
Mg	6.6	6.8	1.7	1.5	3.3	4.9	8.8	6.5
Mn	0.18	0.12	0.069	0.040	0.022	0.034	0.41	0.030
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mo	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Ni	<0.010	<0.010	0.027	0.023	<0.010	<0.010	0.016	<0.010
Nb	<0.0070	<0.0070	<0.0070	0.0077	<0.0070	<0.0077	<0.0070	<0.0070
P	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
K	3.5	3.0	2.1	1.6	1.8	1.8	4.3	2.3
Se	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Si	6.1	5.9	5.9	3.4	3.7	4.0	13	5.1
Ag	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Na	3.2	3.3	2.7	3.6	3.1	2.8	2.1	1.9
Sr	0.069	0.070	0.014	0.013	0.026	0.039	0.091	0.078
Tl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Th	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ti	0.026	0.0078	0.050	<0.0030	<0.0030	<0.0030	0.20	<0.0030
U	0.006	0.012	<0.001	0.030	<0.001	0.002	0.004	0.001
V	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0095	<0.0050
Zn	0.17	0.14	0.11	0.085	<0.0010	<0.0010	0.050	0.022
Zr	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 6.2.116. UNW-11 (continued)

Parameter	Concentration (mg/L)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
2,4-D (μg/L)	<1.0	<1.0	<2.0	<2.0
Endrin (μg/L)	<0.05	<0.05	<1.0	<0.10
Lindane (μg/L)	<0.01	<0.01	<0.02	<0.02
Methoxychlor (μg/L)	<0.04	<0.04	<0.08	<0.08
2,4,5-TP Silvex (μg/L)	<0.1	<0.1	<0.2	<0.2
Toxaphene (μg/L)	<1.0	<1.0	<2.0	<2.0
Alpha activity (pCi/L)	26.34[d]	23[d]	1.9	10
Beta activity (pCi/L)	36.40	35	4.0	13
Total Ra (pCi/L)	<2.70	<2.70	4.59	<2.70
^{235}U (wt. %)	1.02	IU[e]	IU	IU
pH (units)	6.9	6.8	6.2	6.7
Conductivity (μmhos/cm)	297	220	146	304
Total coliform bacteria	NF[f]	NF	3[d]	NF
Fecal coliform bacteria	NF			
Phenols (mg/L)	0.008	0.003	0.005	0.002
Total organic carbon	45	32	42	36
Total organic chloride (μg/L)	39	18	310	64
Chloride	3.9	3.3	3.4	2.5
Fluoride (μg/L)	0.09	0.07	<0.1	0.1
Nitrate nitrogen (mg/L)	5.3	2.03	1.52	1.53
Sulfate (mg/L)	12	3.1	4.0	2.6
Temperature (°C)[g]	16	9.1	22.6	20.4
Groundwater elevation (ft)[g]	754.9	753.3	751.8	751.3

[a]See Fig. 6.2.26; during 1086, the DLs for several parameters varied.
[b]U = unfiltered (total metals).
[c]F = filtered (dissolved metals).
[d]Exceeds interim primary drinking water standards.
[e]Insufficient uranium sample obtained for assay analysis.
[f]NF = not found.
[g]Field measured.

7. EXTERNAL GAMMA RADIATION

External gamma radiation is measured to confirm that routine radioactive effluents from the Oak Ridge facilities are not significantly increasing external radiation levels above normal background. Measurements are taken in the relatively small areas accessible to the public where current or past operations could cause radiation levels to be elevated. The monitoring network may also be useful in assessing the impact of unusual occurrences.

Four groups of stations are used for measuring external gamma radiation: along the Clinch River near the ^{137}Cs experimental site (Fig. 7.1), around the perimeter of ORNL (Fig. 7.2), on the Oak Ridge Reservation (Fig. 7.3), and remote from the Reservation (Fig. 7.4). External gamma radiation is measured monthly at the ORNL perimeter and ORR stations T6 and T7, quarterly at sites along the bank of the Clinch River, and semiannually at remote locations. Measurements are taken using calcium fluoride or lithium fluoride thermoluminescent dosimeters (TLDs). Two or three dosimeters are placed in each container, and the containers are suspended 1 m above the ground. Since April 1986, real-time readings of external gamma radiation levels have been collected at 10-min intervals for all ORR stations except T6 and T7.

External gamma radiation levels for the ORNL perimeter, ORR, and remote stations are given in

ORNL-DWG 87-8348

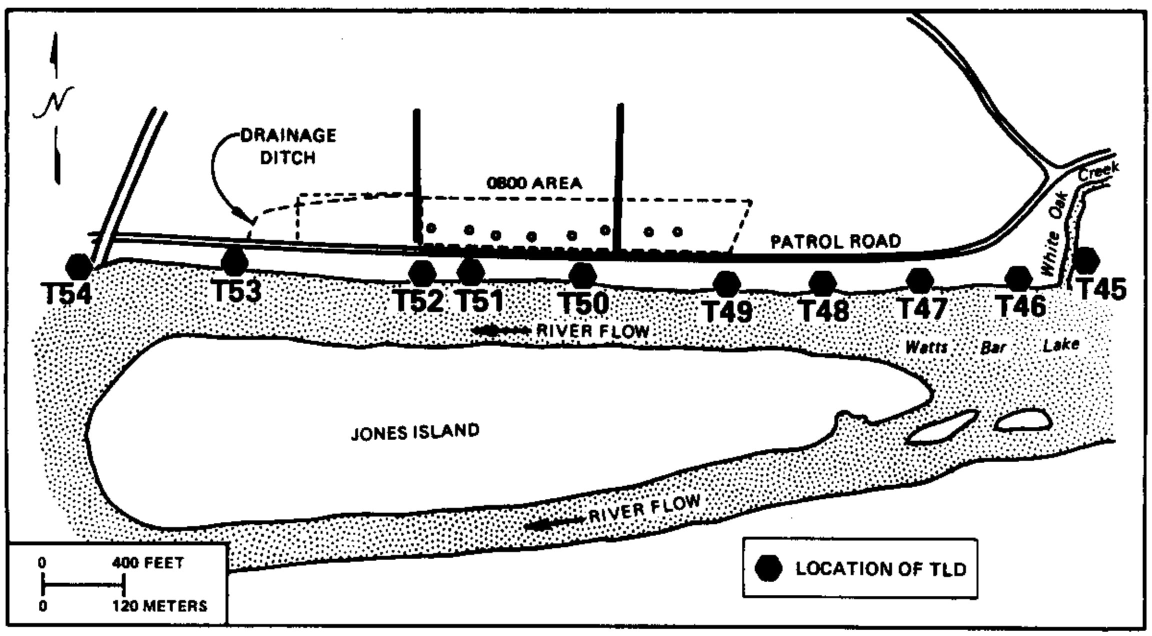

Fig. 7.1. Locations of TLDs along the Clinch River.

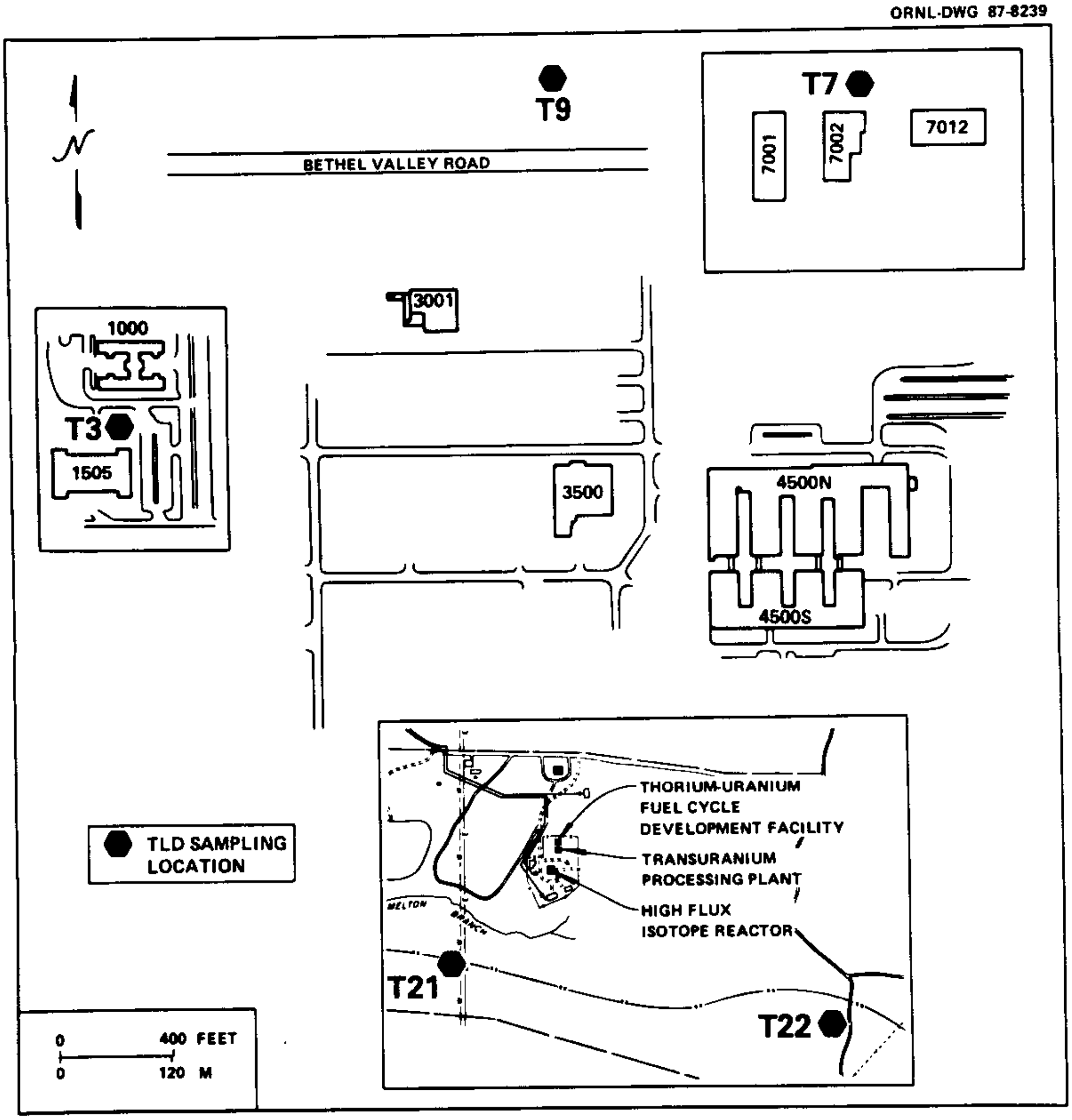

Fig. 7.2. Locations of TLDs around the ORNL perimeter.

Table 7.1. No statistically significant differences in the average measurements between the ORR and remote stations exist. Average radiation measurements at ORNL perimeter stations was statistically higher than either the ORR or the remote stations. Based on the sampling results, the external gamma radiation was statistically lower at the ORNL perimeter, the ORR, and the remote stations in 1986 than in 1985. However, comparisons between 1985 and 1986 data are complicated by the fact that ORNL began using a new TLD system in mid-1986. The new system employs a Panasonic UD702E reader and Panasonic UD804/814 environmental thermoluminescent dosimeter badges. During the changeover to the new system, a Victoreen reader

ORNL-DWG 87-7048

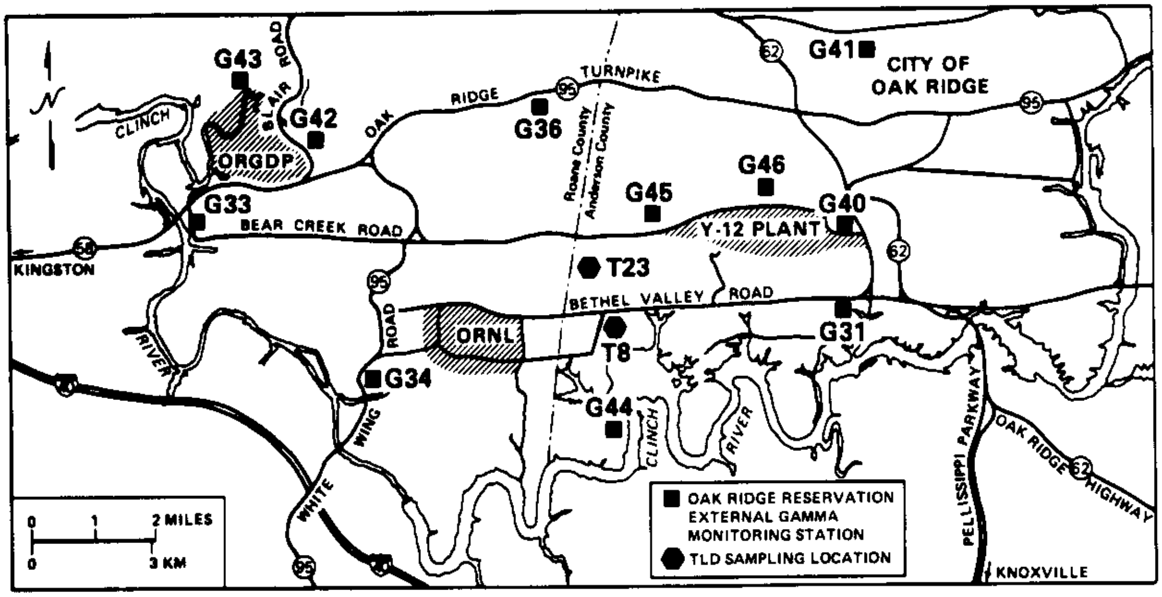

Fig. 7.3. Locations of external gamma radiation monitoring stations on the ORR.

ORNL-DWG 87-7047

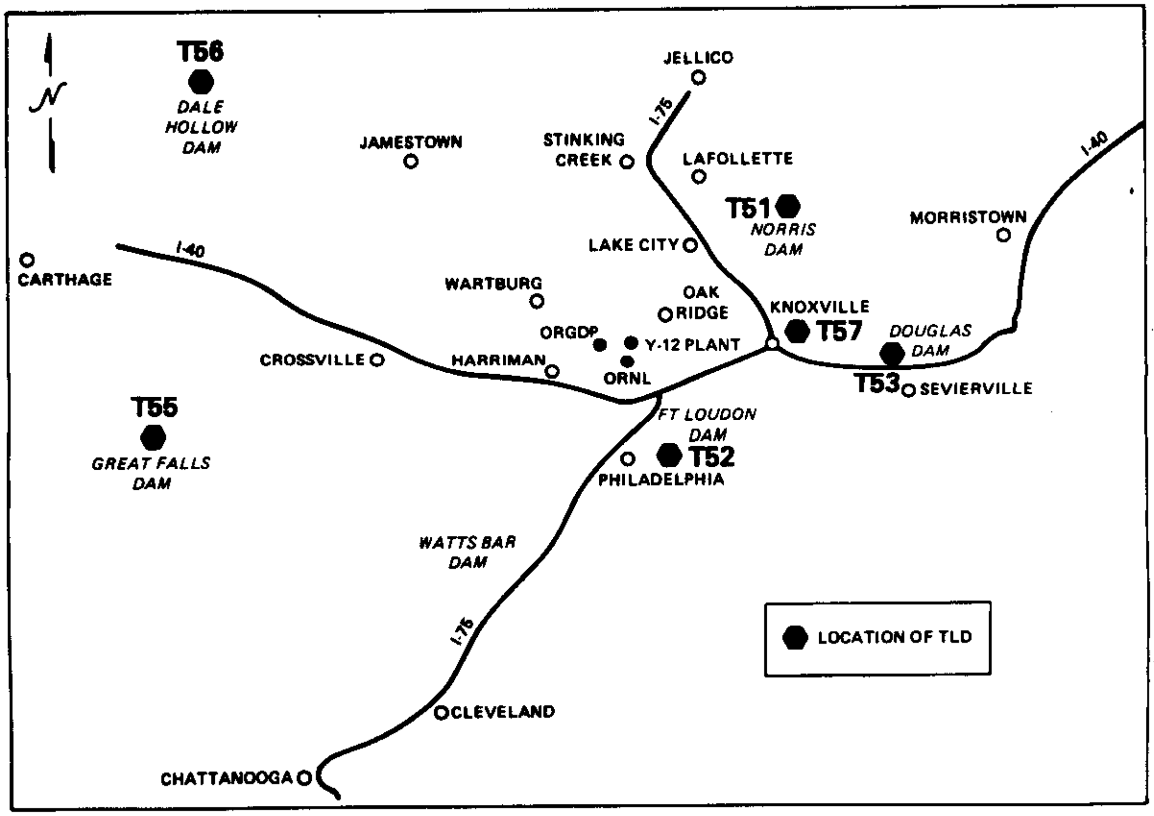

Fig. 7.4. Locations of TLDs at remote locations.

Table 7.1 1986 external gamma radiation measurements

New (old) station ID	Number of measurements[a]	μR/h			
		Max	Min	Av	95% CC[b]
ORNL perimeter stations[c]					
T3 (3)	10	14	3.0	9.2	2.6
T7 (7)	9	13	1.3	8.8	2.3
T9 (9)	10	17	2.3	10	2.8
T21 (21)	10	16	1.3	9.9	2.8
T22 (22)	10	20	3.3	11	3.7
Network summary	49	20	1.3	9.9	1.3
Oak Ridge Reservation stations[d]					
T8 (8)	8	13	1.7	8.2	2.7
T23 (23)	5	16	1.0	7.2	4.8
G31 (31)	204	11	7.3	7.8	0.05
G33 (33)	129	12	6.8	7.7	0.10
G34 (34)	223	12	7.2	9.2	0.12
G36 (36)	246	8.1	6.9	7.4	0.02
G40 (40)	244	9.0	7.5	8.1	0.03
G41 (41)	258	8.8	7.8	8.2	0.02
G42 (42)	256	8.4	7.0	7.5	0.03
G43 (43)	185	8.1	6.3	7.0	0.04
G44 (44)	268	8.2	6.8	7.2	0.03
G45 (45)	221	8.3	6.9	7.3	0.03
G46 (46)	74	9.9	8.9	7.2	0.05
Network summary	2321	16	1.0	7.8	0.03
Remote stations[e]					
T51 (51)	2	7.8	5.3	6.6	
T52 (52)	2	9.1	7.1	8.1	
T53 (53)	2	8.8	6.7	7.8	
T55 (55)	2	5.6	4.5	5.0	
T56 (56)	2	6.3	5.4	5.8	
T57 (57)	2	9.7	5.8	7.7	
Network summary	12	9.7	4.5	6.8	0.98

[a]Individual dosimeters at locations T3, T7, T9, T21, T22, T8, and T23 are averaged for each station. The number of samples for these stations indicates the number of months of data. No data were available for two of the months.

Real-time readings were collected at stations G31, G33, G34, G36, G40–G46 at 10-min intervals. The number of samples indicates the total number of days. Station G46 came on-line in October 1986.

[b]95% confidence coefficient about the average of more than two samples.

[c]See Fig. 7.1.

[d]See Fig. 7.2.

[e]See Fig. 7.3

was used for a short time. All 1985 readings were taken using an Eberline reader. The average background level as determined at the remote stations can be subtracted from the measured levels to obtain an estimate of the increase in external radiation levels due to plant operations.

Measurements along the bank of the Clinch River, from the mouth of White Oak Creek to several hundred yeards downstream, are used to evaluate external gamma radiation levels resulting from ORNL effluent releases and "sky shine" from an experimental radioactive cesium plot located near the river bank. Average annual external gamma radiation levels along the bank of the Clinch range from 14 to 35 μR/h (Table 7.2). Measurements at these locations are used to estimate maximum exposure to an individual. The average radiation level along the Clinch near the cesium field was 23 μR/h, which was slightly higher than the 17 μR/h in 1985 (ESR, 1985).

Table 7.2 1986 external gamma radiation measurements along the Clinch River

New (old) station ID[a]	Number of measurements[b]	μR/h			
		Max	Min	Av	95% CC[c]
T45 (45)	4	29	5.5	14	11
T46 (46)	4	33	8.0	18	11
T47 (47)	4	40	4.0	18	17
T48 (48)	4	35	6.5	18	14
T49 (49)	3	35	14	25	12
T50 (50)	4	56	25	35	15
T51 (51)	4	50	23	34	13
T52 (52)	4	47	16	28	14
T53 (53)	4	47	7.5	22	18
T54 (54)	4	30	4.0	16	13
Network summary	39	56	4.0	23	4.6

[a]See Fig. 7.4.

[b]For each quarter, individual dosimeters are first averaged for each station. The number of samples indicates the number of quarters of data.

[c]95% confidence coefficient about the average.

8. BIOLOGICAL MONITORING

8.1 FISH SAMPLING

During 1986, bluegill were selected for sampling of radionuclides, Hg, and PCB concentrations. Historically, the highest concentrations of radionuclides have been found in bluegill. This is particularly true for ^{90}Sr which is one of the primary contributors to the dose. In addition, bluegill and carp had the highest concentrations of PCBs and Hg. Bluegill were selected because of radionuclide concentrations found in bluegill in the past and because concentrations of Hg and PCBs were also high. In addition, bluegill are favored by sport fisherman in Tennessee (and the the rest of the U.S.), and can be obtained in large numbers required for tissue analysis.

Reinstatement of a sampling location at the mouth of East Fork Poplar Creek (EFPC) is being reviewed. Although catfish are probably better accumulators of PCBs than bluegill, efforts to obtain catfish in sufficient quantities for analysis have not been successful.

Bluegill (*Lepomis macrochirus*) from three Clinch River locations (Fig. 8.1.1) were collected semiannually for tissue analyses of radionuclides, mercury, and polychlorinated biphenyls (PCBs). Sampling locations include the following Clinch River kilometers (CRKs): (1) at CRK 40.0, which is above Melton Hill Dam and serves as a background location because it is above all Oak Ridge DOE installation outfalls; (2) at at CRK 33.3, the ORNL discharge point from White Oak Creek to the Clinch River; and (3) at CRK 8.0, downstream from Oak Ridge Y-12 Plant, ORNL, and ORGDP discharges into the Clinch River.

Tables 8.1.1 through 8.1.3 list the concentrations of radionuclides, mercury, and PCBs in Clinch River bluegill.

The radionuclides of concern from discharges at ORNL are ^{90}Sr and ^{137}Cs. These result in the highest doses to man from ingestion of fish. Radionuclide concentrations were determined on at least one composite of from 6–10 fish per sampling period. Mercury and PCBs were measured in six individual fish from each sampling location. Scales, heads, and entrails were removed from each fish before samples were obtained. Composite samples were ashed and analyzed by gamma spectroscopy and radiochemical techniques for the radionuclides that contribute the most to potential radionuclide dose to humans.

8.2 MILK SAMPLING

Raw milk from nine locations (including one dairy) within a radius of 80 km of Oak Ridge was analyzed for ^{131}I and ^{90}Sr (see Tables 8.2.1 and 8.2.2). Samples were collected every two weeks from six stations near the Oak Ridge area. During 1986, one new location was added (station 6, in the Solway community) about 16 km east of Oak Ridge (Fig. 8.2.1). The cow at station 4 dried up this year, but a replacement from the same area was found late in the year. Other stations remote from the Oak Ridge installations (Fig. 8.2.2) were sampled approximately semiannually. Before October 15, samples were analyzed by ion exchange and low-level beta counting. After October 15, the ^{131}I samples were analyzed using gamma spectroscopy. The results are compared with intake guidelines specified by the Federal Radiation Council (FRC).

8.3. RADIOACTIVITY STUDIES IN WATERFOWL

To determine whether waterfowl might transport radioactivity off site after feeding at the

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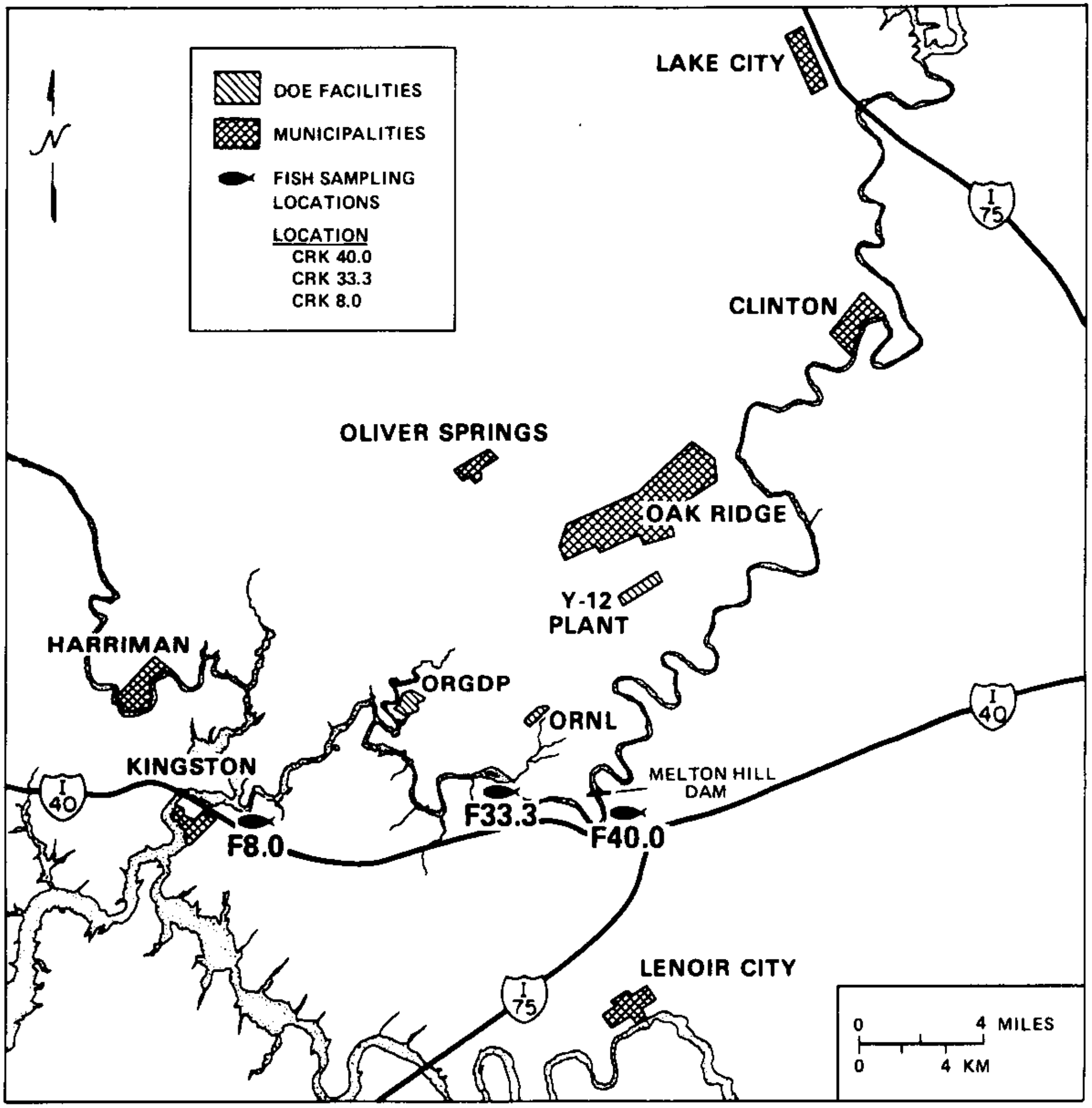

Fig. 8.1.1. 1986 fish sampling locations.

ORR, qualitative and quantitative determinations were made of the radionuclide content of Canada geese residing on three ponds on the ORR and in surrounding communities.

Four geese residing near Pond 3524 at ORNL for about two weeks were tested for radionuclide uptake. Crop contents indicated that the birds had been feeding on root nodules from bottom sediment and on coarse green grass. Analyses of crop, fecal, and tissue samples, shown in Table 8.3.1, indicated a high uptake of ^{137}Cs and ^{90}Sr, especially by the females (probably because of the birds' physiological processes of storing minerals preparatory for egg laying). The analyses also indicated rapid fecal elimination of the great majority of ingested ^{60}Co, ^{152}Eu, ^{154}Eu, and ^{137}Cs and measurable uptake and incorporation of ^{75}Se, ^{241}Am, ^{95}Zr, and ^{106}Rh. As expected, ^{90}Sr was found in bone and muscle tissues, as shown in Table 8.3.2.

A random sample of six geese was taken from the vicinity of both ORGDP and the Oak Ridge

Table 8.1.1. 1986 radionuclide concentrations in tissue from Clinch River bluegill

Sampling ID	Location[a]	Radionuclide	No. of samples[b]	Concentration (pCi/kg wet wt)			
				Max	Min	Av	95% CC[c]
F8	CRK 8.0	^{60}Co	5	9.5	<6	<8	1.8
		^{137}Cs	5	87	67	77	7.5
		^{90}Sr	5	23	7.7	16	5.7
F33.3	CRK 33.3	^{60}Co	4	21	<8	<20	5.5
		^{137}Cs	4	680	170	410	210
		^{90}Sr	4	37	21	29	7.2
F4.0	CRK 40.0	^{60}Co	5	<7	<0.8	<5	2.0
		^{137}Cs	5	12	<0.3	<5	4.1
		^{90}Sr	5	8.9	0.72	5.9	2.8

[a]See Fig 8.1.1.
[b]A sample is composited from 6–10 fish.
[c]95% confidence coefficient about the average.

Table 8.1.2. 1986 mercury concentrations in tissue from Clinch River bluegill

Sampling ID	Location[a]	No. of fish sampled	Concentration (ng/g wet wt)				Percentage of action level[c]
			Max	Min	Av	95% CC[b]	
F8	CRK 8.0	6	180	49	130	37	13
F33.3	CRK 33.3	12	250	30	97	30	9.7
F40.0	CRK 40.0	12	45	17	28	5.2	2.8

[a]See Fig. 8.1.1.
[b]95% confidence coefficient about the average.
[c]Percentage of Food and Drug Administration action level of mercury in fish (1000 ng/g) for the average concentration.

Table 8.1.3. 1986 PCB concentrations in tissue from Clinch River bluegill

Sampling ID	Location[a]	PCB type	No. of fish sampled	Concentration (μg/g wet wt)				Percentage of tolerance[c]
				Max	Min	Av	95% CC[b]	
F8	CRK 8.0	1254	6	0.05	0.02	0.04	0.01	2.0
	1260	6	0.094	<0.01	<0.02	0.01	1.0	
F33.3	CRK 33.3	1254	12	0.11	<0.01	<0.04	0.02	2.0
	1260	12	0.50	0.01	0.07	0.08	3.5	
F40.0CRK 40.0	1254	12	0.05	<0.01	<0.02	0.01	1.0	
	1260	12	0.02	<0.01	<0.01	0.0	0.5	

[a]See Fig. 8.1.1.
[b]95% confidence coefficient about the average.
[c]Percentage of Food and Drug Administration tolerance for total PCBs in fish (2 μg/g) for the average. The percentage of tolerance for each PCB type must be summed at each location to obtain the percentage of tolerance for total PCBs in the fish.

Table 8.2.1. Concentrations of ^{131}I in milk[a]

Station	No. of samples	Concentration (pCi/L)				Comparison with standard[c]
		Max	Min	Av	95% CC[b]	
		Immediate environs[d]				
M1	26	7.3	<3	<3	0.4	Range I
M2	24	7.3	<3	<3	0.43	Range I
M3	26	11	<3	<3	0.75	Range I
M4	7	<3	<3	<3	0.0	Range I
M5	25	2.4	<3	<3	0.02	Range I
M6	3	<3	<3	<3	0.0	Range I
Network summary	111	11	<3	<3	0.11	Range I
		Remote environs[e]				
M11	2	<3	<3	<3	0.0	Range I
M13	2	<3	<3	<3	0.0	Range I
M14	2	<3	<3	<3	0.0	Range I
Network summary	6	<3	<3	<3	0.0	Range I

[a]Raw milk samples; station M1 is a dairy.

[b]95% confidence coefficient about the average.

[c]Applicable FRC standard compared with average, assuming 1 L/d intake: Range I, 0–10 pCi/L, adequate surveillance required to confirm calculated intakes; Range II, 10–100 pCi/L, active surveillance required; and Range III, >100 pCi/L, positive control action required.

[d]See Fig. 8.2.1.

[e]See Fig. 8.2.2.

Y-12 Plant to provide comparison samples for the Pond 3524 study. Tests showed no detectable amounts of man-made radionuclides. Special tests for ^{90}Sr were performed on the bone and muscle tissue. The averaged results are compared with those from the geese captured at Pond 3524 in Table 8.3.3.

Geese from several locations on Watts Bar, Melton Hill, and Chicamauga reservoirs were analyzed as control samples for the ORR study. Analyses showed only natural radioelement concentrations. Strontium-90 concentrations were similar to the values from the ORR birds.

These studies indicate a possibility for radionuclide transport from ORR facilities by migratory waterfowl that might nest at the ORR for any appreciable time. The likelihood that geese would nest at Pond 3524 is small, and the small size of the pond precludes the support of many geese. Further studies will be performed on techniques for assessing the possible off-site transport of radionuclides.

Rapid accumulation of high ^{137}Cs and ^{90}Sr levels indicates a need to study radionuclide transport by waterfowl from White Oak Creek and White Oak Lake.

8.4 DEER STUDIES

Based on the success of the 1985 deer harvest by the 4650 permitted hunters, a similar hunt schedule was used for the 1986 deer season. Additional hunting areas were added for the 1986 hunts. The major additions were for the archery hunts and included lands west of the Clinch River near ORGDP and east of the Tower Shielding Facility (Park City Rd. area). City of Oak Ridge sites in Haw Ridge Park and east of Illinois

Table 8.2.2. Concentrations of ^{90}Sr in milk[a]

Station	No. of samples	Concentration (pCi/L)				Comparison with standard[c]
		Max	Min	Av	95% CC[b]	
		Immediate environs[d]				
M1	26	4.1	0.27	1.3	0.34	Range I
M2	24	3.8	0.27	1.4	0.36	Range I
M3	26	8.4	0.54	2.3	0.63	Range I
M4	7	6.8	0.54	2.5	1.9	Range I
M5	25	7.3	0.54	2.0	0.53	Range I
M6	3	8.1	1.4	4.8	3.9	Range I
Network summary	111	8.4	0.27	1.9	0.29	Range I
		Remote environs[e]				
M11	2	1.6	1.4	1.5	0.27	Range I
M13	2	1.4	0.81	1.1	0.54	Range I
M14	2	1.4	1.1	1.2	0.27	Range I
Network summary	6	1.6	0.81	1.3	0.23	Range I

[a]Raw milk samples; station M1 is a dairy.
[b]95% confidence coefficient about the average.
[c]Applicable FRC standard compared with average, assuming 1 L/d intake: Range I, 0–20 pCi/L, adequate surveillance required to confirm calculated intakes; Range II, 20–200 pCi/L, active surveillance required; and Range III, >200 pCi/L, positive control action required.
[d]See Fig. 8.2.1.
[e]See Fig. 8.2.2.

Avenue and sites belonging to The University of Tennessee that included Pine and Chestnut Ridges were added. The DOE Tennessee Wildlife Resources Agency (TWRA) official checking station was moved to a central location on Bethel Valley Rd. The 1986 hunt map is shown in Fig. 8.4.1.

Five separate weekend hunts were held, with the first two restricted to archers (October 11–12 and 18–19). About 1200 permits were issued for each archery hunt. (There was no way to determine the actual number of hunters participating.) The first hunt yielded a harvest of 98 deer. The second hunt yielded 76 animals. The remaining three hunts were held on weekends of November 15–16, December 13–14, and December 20–21 for shotgun or muzzleloader hunters, and 750 permits were issued for each weekend. The "gun" hunts yielded harvests of 202, 186, and 98 deer for the three respective dates. The total harvest for the 1986 season was 660 deer of which 56.4% were male. There was a slight increase in the proportion of bucks in the 1986 harvest compared with 1985 (56.4 vs 55%). Some slight differences in the weight distributions for bucks in the 1986 harvest were observed when compared with 1985. Only 35% of the bucks weighed more than 100 pounds in 1986, whereas 50% of them exceeded this arbitrary weight in 1985. Weight distributions for does were similar to those of the 1985 harvest. A difference in the age distributions was observed, with the proportion of 1-1/2-year-old bucks to 1-1/2-year-old does being about 3 to 1. Analysis for ^{137}Cs concentrations were conducted for all 660 animals by examining liver or muscle using a sensitive gamma-ray spectrometer system. Over 90% of the harvest contained ^{137}Cs at

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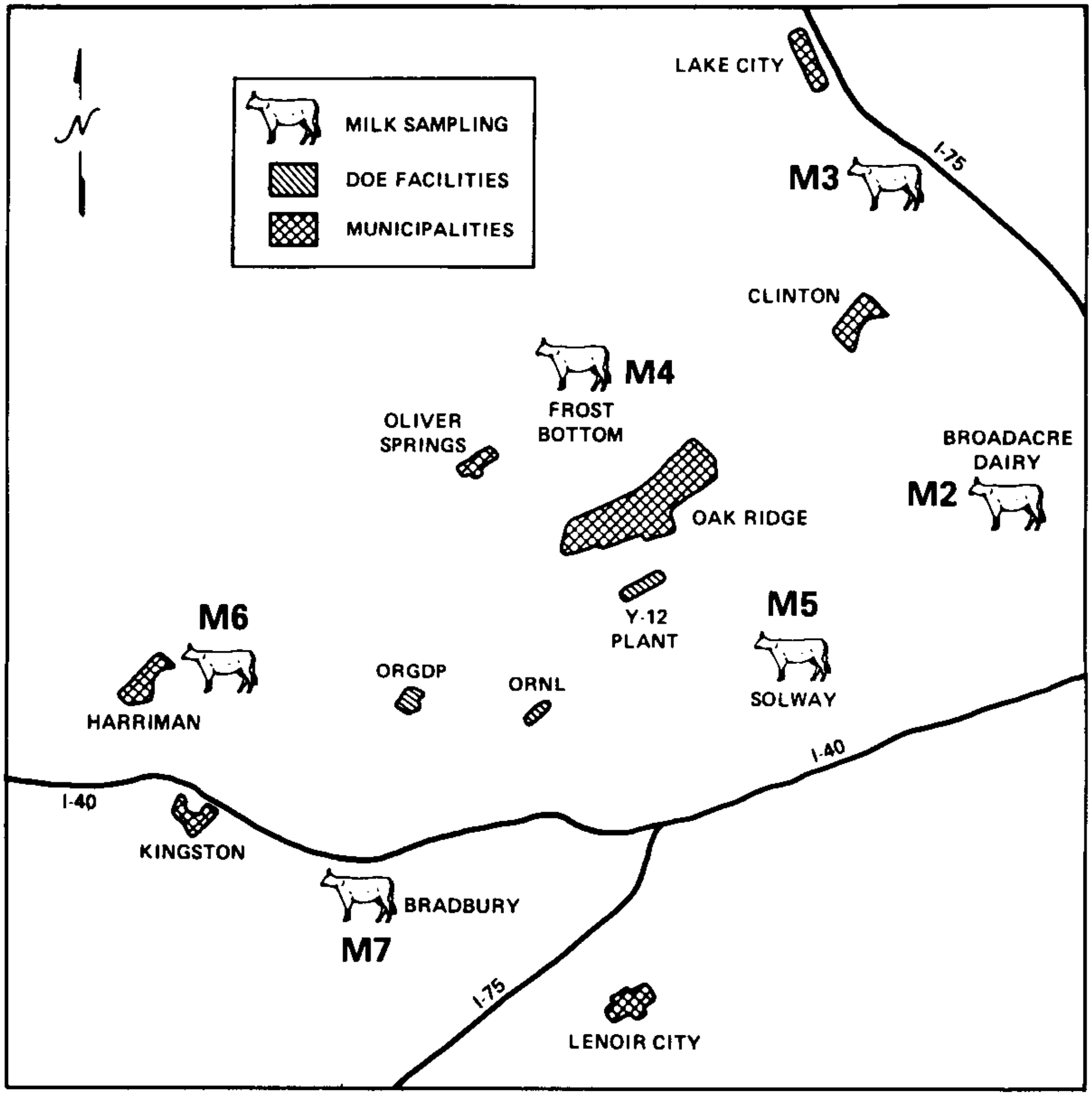

Fig. 8.2.1. 1986 milk sampling locations within 80 km of the ORR.

concentrations less than 0.5 pCi/g, and only 7 animals contained this nuclide at concentrations exceeding 1 pCi/g. The maximum value of any animal was 1.2 pCi/g.

The technique for testing for ^{90}Sr developed during the 1985 hunts was improved by adding the requirement that the release criterion for the harvest be based on a calculated annual dose to the hunter of 25 millirem to bone from the consumption of 50 kg of meat from his deer. Because detection of ^{90}Sr in soft tissue at levels sufficient to produce the 25-millirem dose is virtually impossible with "field" instrumentation, it was necessary to establish a "bone-to-muscle" equivalency (set at 30 pCi/g ^{90}Sr in bone). This 30 pCi/g is based on standard man model of 3% of ^{90}Sr in bone or in tissue (ICRP, 1978). During the 1986 hunts tissue samples were collected in order to establish this percentage based on laboratory analyses for the 1986 hunts.

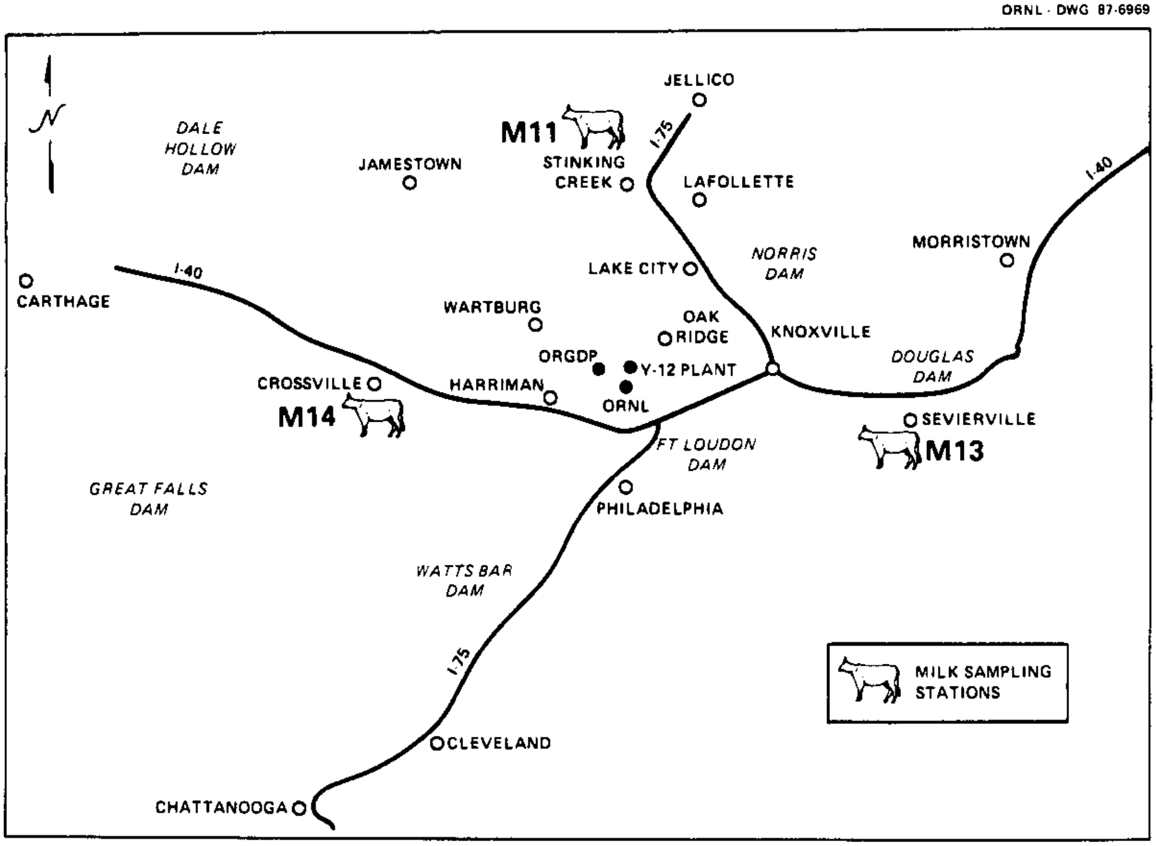

Fig. 8.2.2. 1986 milk sampling locations remote from the ORR.

A thin plastic scintillator optimized for the detection of beta-emitters was coupled to a digital scaler and used to measure a foreleg bone sample from each animal. Technicians performing the test were advised to make sure that a fresh bone surface was placed in close proximity to the detector and that any covering material such as the fascia was removed before the test was performed.

Various techniques were tested to provide greater sensitivity for the field screening procedure. The detector was placed in a fixed holder to ensure a defined geometrical arrangement, and lead bricks outlined a fixed location on the counting table to provide a stable background. Because the screen procedure is based on the detection of beta particles from both the strontium- and yttrium-90, only those betas from the top surface of the bone within the sensitive area of the detector register a count. It was found desirable to increase the surface exposure of the bone presented to the detector. This was done for all bone samples that fell near the "field screen cut off" by striking the bone sample with a hammer. The bone would usually fracture in such a way as to yield an increase of surface by a factor of 2.

With the bone-checking procedure, 29 deer were found to contain elevated levels of ^{90}Sr. These animals were retained, and the hunters were allowed to return to that hunt or to return for a subsequent hunt. Following the checking station measurements, quantitative analyses for ^{90}Sr were performed on bone and muscle samples from some of the confiscated animals. Results of the specific radiochemical analyses of bone samples from the confiscated animals along with the field screening data are presented in Table 8.4.1.

The data were examined statistically to

Table 8.3.1. Gamma-emmitting radionuclide content of 3524 Pond geese

	Concentration (pCi/g fresh weight)				
	^{137}Cs	^{134}Cs	^{60}Co	^{152}Eu	^{154}Eu
Goose 1 (female)					
Muscle[a]	3700	16	2.0	<0.2	<0.1
Liver[b]	1300	7.8	27	<0.2	<0.1
Feces[c]	4000	20	200	100	60
Crop[d]	2000	10	200	80	40
Goose 2 (male)					
Muscle	1400	9.4	1.2	<0.6	<0.4
Liver	1100	8.0	19	<1	<0.7
Feces[e]	1000	8	200	60	30
Crop[f]	2000	20	200	90	50
Goose 3 (male)					
Muscle	1800	9.2	1.7	1.9	0.6
Liver	1150	5.7	21	<0.9	<0.4
Feces[g]	3000	20	60	60	30
Crop	1000	6	9	3	<1
Goose 4 (female)					
Muscle	2900	11	3.0	<0.8	<0.2
Liver[h]	1750	7.9	56	9.1	5.6
Feces	3000	10	50	40	20
Crop	2000	10	6	<1	<1

[a]Leg muscle about 20% higher; breast muscle contains 5 pCi/g ^{75}Se.
[b]15 pCi/g ^{75}Se.
[c]Contains ^{241}Am.
[d]Contains ^{95}Zr, ^{106}Rh, ^{241}Am.
[e]Contains ^{95}Zr, ^{241}Am; Liver has 10 pCi/g ^{75}Se.
[f]Contains ^{95}Zr.
[g]Contains ^{95}Zr; liver has 14 pCi/g ^{75}Se.
[h]Contains 19 pCi/g ^{75}Se.

Table 8.3.2. Alpha- and beta-emitting radionuclide content of 3524 Pond geese

	Concentration (pCi/g fresh weight)			
	^{241}Am	^{244}Cm	^{239}Pu	^{90}Sr
Goose 1				
Muscle	0.001	0.004	0.0008	2.4
Bone	0.01	0.02	0.01	1200
Goose 2				
Muscle	0.002	0.005	0.0003	1.5
Bone	0.01	0.008	0.006	350
Goose 3				
Muscle	0.002	0.002	0.003	1.6
Bone	0.02	0.02	<0.003	560
Goose 4				
Muscle	0.002	0.002	0.006	1.8
Bone	0.07	0.05	0.17	900

Table 8.3.3. Average ^{90}Sr concentration in Canada geese

	Concentration (pCi/g)	
	Pond 3524	ORR
Muscle	1.8	0.2
Bone	750	0.6

determine the correlation between the field screen values and the actual ^{90}Sr concentration in the bone samples. Results of a regression analysis of field screen measurements on the square root of the radiochemical data yielded a reasonably high correlation (r = 0.89). Further analyses of the data showed that there is only a 6% probability of releasing a 50 pCi/g deer if a field screen cutoff of 12 counts per minute is taken as a retention criterion. The estimated release probability for a

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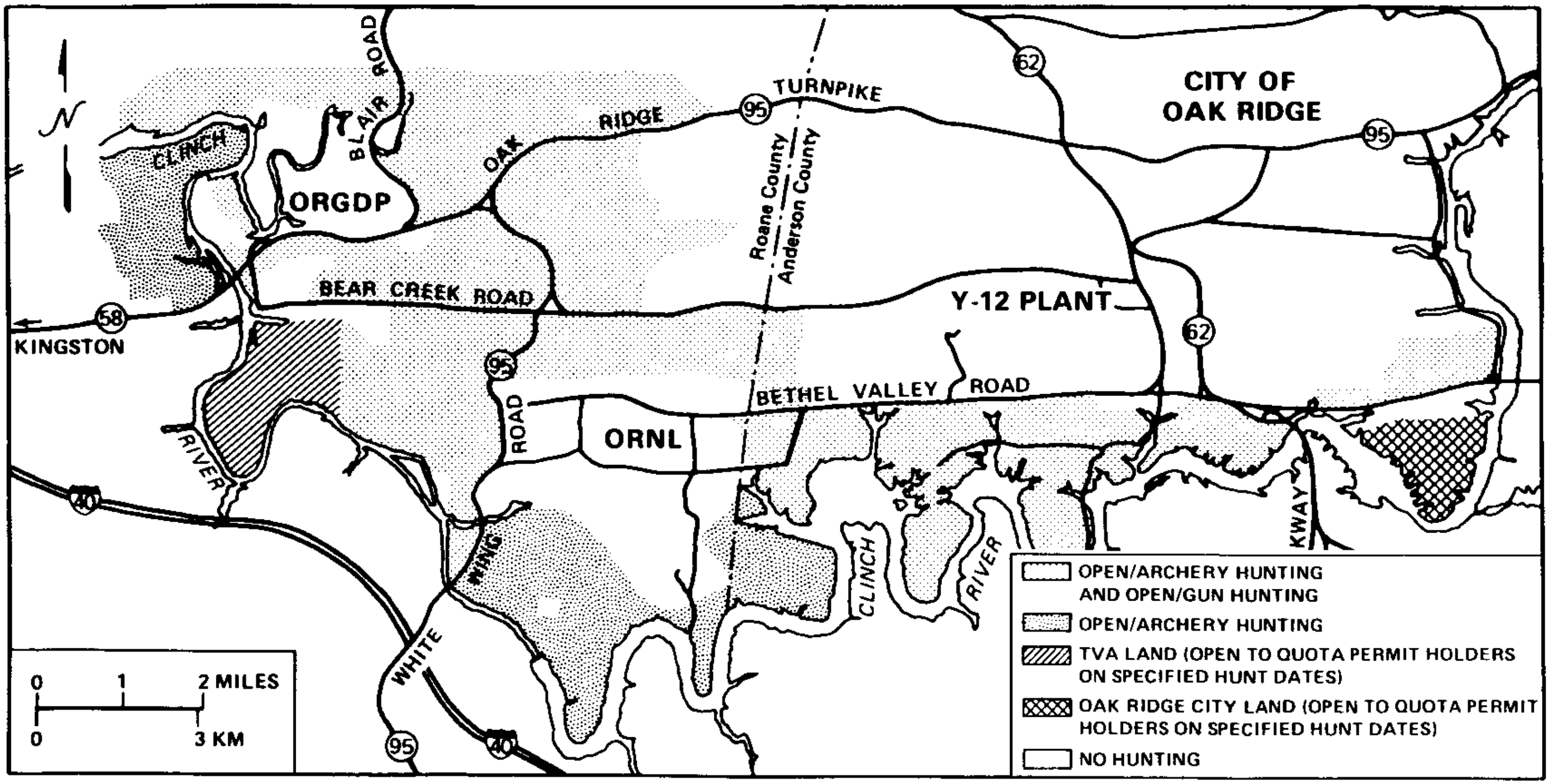

Fig. 8.4.1. 1986 deer hunt map.

Table 8.4.1. Cerenkov and radiochemical analyses of bone compared with field screen values for bone

Deer No.	^{90}Sr (pCi/g bone)	Screen (c/m)
30	4.3	8
32	648	390
37	7.6	8
38	7.6	8
74	140	70
76	259	70
79	4.9	17
84	324	324
101	86	54
109	73	64
139	38	26
140	246	103
145	116	154
154	810	600
165	195	87
167	180	180
264	225	122
293	22	23
330	40	23
332	157	58
358	83	32
430	NA	43
462	NA	295
469	NA	184
519	NA	95
541	NA	24
553	NA	34
613	NA	185
658	NA	33

deer with a bone contamination level of 100 pCi/g using a field screen cutoff of 12 counts per minute is less than 1%. Actual screen measurements were performed with sufficient care and with multiple determinations so that the values presented here are probably upper limits to the release probabilities.

Limited data were collected on deer thyroids from the confiscated animals. The 1986 collection confirmed the trend noted from the 1985 collection—^{129}I concentrations are high in deer with elevated ^{90}Sr concentrations in bones. Quantitative measures of this correlation will be performed following the completion of thyroid analyses.

The effects of the Chernobyl disaster were apparent in the thyroids of deer killed in automobile collisions. For two years before the Chernobyl incident thyroids examined had shown only ^{125}I and ^{129}I. Thyroids of deer killed on May 6 and 8 showed concentrations of <2 pCi/g of ^{131}I. In succeeding weeks, deer killed on the road had 190-, 550-, and 510-pCi/g concentrations as the fallout reached the area, was assimilated, and decayed.

9. VEGETATION, SOIL, AND SEDIMENT SAMPLING

9.1 VEGETATION

Radionuclides and chemical pollutants introduced into the biosphere are affected by the same biogeochemical processes that cycle essential and nonessential elements within and among ecosystems. These processes determine bioaccumulation during transport of radionuclides or chemicals through terrestrial food chains. Concentrations of materials in soil are of great importance in determining the uptake in plants through the roots. Pollutants can bypass the soil and pass directly to the food chain by foliar deposition. The pollutants may then pass directly to grazing animals or humans as superficial contamination or they may be absorbed metabolically from the plant surface. Pollutants absorbed by grazing animals are transferred to the milk and meat of these animals. Foliar contamination can be removed by radioactive decay, volatilization, leaching by rain or other weathering effects, and by dying and dropping of plant parts.

Because of budgetary priorities, no vegetation sampling was performed around the Oak Ridge Y-12 Plant during 1986.

Summary statistics for the ORNL perimeter and the ORR locations are given in Tables 9.1.1 through 9.1.7. There were no statistically significant differences in the concentrations of ^{137}Cs, ^{90}Sr, or ^{239}Pu in grass between the ORNL perimeter stations and the ORR stations (Tables 9.1.1–9.1.3). Plutonium-238 was significantly higher at the ORNL perimeter stations than at the ORR stations, as shown in Table 9.1.4. The highest concentrations were measured at location V7 (see Fig. 9.1.1), which is close to ORNL and is in one of the prevailing wind directions from ORNL. Concentrations of ^{234}U and ^{235}U were significantly higher at the ORR stations than at the ORNL perimeter stations (Tables 9.1.5 and 9.1.6). No significant differences were noted for ^{238}U, probably due to the high variability among the samples from location V45 (Table 9.1.7). Uranium concentrations were highest at the two ORR locations on the east and west ends of the Oak Ridge Y-12 Plant (locations V40 and V45,

Table 9.1.1. 1986 ^{137}Cs in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
		ORNL perimeter stations[b]			
V3 (3)	4	140	42	86	50
V7 (7)	4	<50	<40	<38	4.3
V9 (9)	4	39	32	35	3.2
Network summary	12	140	32	53	21
		Oak Ridge Reservation stations[c]			
V8 (8)	4	<50	<40	<40	3.4
V23 (23)	4	180	<40	<90	65
V31 (31)	4	<70	<30	<50	19
V33 (33)	4	<60	<40	<50	7.1
V34 (34)	4	<70	<40	<60	12
V36 (36)	4	<50	<40	<50	7.5
V40 (40)	4	<70	<30	<50	17
V41 (41)	4	<60	<40	<50	7.6
V42 (42)	4	<60	<40	<50	6.1
V43 (43)	4	<50	<40	<40	4.2
V44 (44)	4	<70	<40	<60	14
V45 (45)	4	51	<40	<50	6.6
V46 (46)	4	<50	<40	<50	6.1
Network summary	52	180	<22	<48	5.8

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

Table 9.1.2. 1986 ^{90}Sr in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	260	160	220	42
V7 (7)	4	220	110	150	48
V9 (9)	4	460	200	310	140
Network summary	12	460	110	230	61
Oak Ridge Reservation stations[c]					
V8 (8)	4	97	38	62	25
V23 (23)	4	160	84	130	32
V31 (31)	4	260	160	230	45
V33 (33)	4	230	76	150	69
V34 (34)	4	130	51	97	34
V36 (36)	4	270	140	200	70
V40 (40)	4	210	110	150	42
V41 (41)	4	240	65	130	75
V42 (42)	4	220	78	160	66
V43 (43)	4	81	35	55	21
V44 (44)	4	160	120	130	20
V45 (45)	4	210	110	160	49
V46 (46)	4	490	230	330	150
Network summary	52	490	35	160	28

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

Table 9.1.3. 1986 ^{239}Pu in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	2.7	<2	<3	0.38
V7 (7)	4	5.4	<0.6	<2	2.3
V9 (9)	4	2.7	<0.9	<2	0.84
Network summary	12	5.4	<0.54	<1.9	0.8
Oak Ridge Reservation stations[c]					
V8 (8)	4	16	<0.9	<6	7.1
V23 (23)	4	<0.9	<0.3	<0.5	0.26
V21 (31)	4	0.81	<0.2	<0.4	0.30
V33 (33)	4	1.3	<0.2	<0.7	0.51
V34 (34)	4	<0.2	<0.2	<0.2	0.035
V36 (36)	4	0.35	<0.03	<0.2	0.16
V40 (40)	4	0.92	<0.3	<0.6	0.28
V41 (41)	4	0.54	<0.03	<0.3	0.21
V42 (42)	4	0.81	<0.3	<0.6	0.24
V43 (43)	4	<0.09	<0.06	<0.07	0.016
V44 (44)	4	<0.9	<0.3	<0.6	0.31
V45 (45)	4	<0.03	<0.03	<0.03	0.0
V46 (46)	4	2.5	<0.3	<0.9	1.1
Network summary	52	16	<0.03	<0.8	0.6

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

Fig. 9.1.2). Concentrations at all stations were similar to those for CY 1985.

Results from the remote stations are given in Table 9.1.8. Concentrations of radionuclides in grass as measured at the remote locations were similar during 1986 to those measured in 1985, with the exception of ^{137}Cs. The fact that values at all stations appear to be higher in 1986 may have been caused by the worldwide fallout from the Chernobyl nuclear fire.

Grass samples were collected from 13 areas around ORGDP, as shown in Fig. 9.1.3, and pine needles were collected at 6 of the locations: PN1, PN2, PN3, PN4, PN5, and PN6. All samples were analyzed for uranium and fluoride, and fluorometric analysis was used to determine concentrations of uranium. A fluoride-selective ion electrode was used to determine the presence of fluorides. Data for ORGDP uranium and fluoride content in grass and pine needles are presented in Tables 9.1.9 and 9.1.10. Concentrations of fluoride in grass ranged from a high of 23 μg/g (V1K) to a low of 0.13 μg/g (V2K). Concentrations of fluoride in pine needles ranged from a high of 11.8 μg/g (PN6) to a low of <0.1 μg/g (PN5). The fluoride concentrations in grass at all sampling points were below the 30-μg/g level considered to produce adverse effects when ingested by cattle with average grazing intakes (AIHA, 1969). The technetium in the grass ranged from low of <0.4 (V10K) to a high of 136.2 (V11K). Around ORGDP, the highest uranium and technetium concentration in grass (Table 9.1.9) was at V1K near the contaminated scrap yard.

Grass samples were also collected semi-annually from 1-m^2 plots at the ORR locations (Fig. 9.1.2), and annually at the remote locations

Table 9.1.4. 1986 ^{238}Pu in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	<3	<2	<3	0.81
V7 (7)	4	14	<0.3	<5	6.3
V9 (9)	4	<3	<2	<2	0.71
Network summary	12	14	<0.3	<2.7	2.0
Oak Ridge Reservation stations[c]					
V8 (8)	4	2.7	<0.6	<2	0.9
V23 (23)	4	0.54	<0.03	<0.3	0.23
V31 (31)	4	1.5	<0.03	<0.6	0.59
V33 (33)	4	0.7	<0.2	<0.5	0.29
V34 (34)	4	0.49	<0.2	<0.3	0.17
V36 (36)	4	0.54	<0.03	<0.3	0.25
V40 (40)	4	0.27	<0.06	<0.3	0.11
V41 (41)	4	0.97	<0.6	<0.6	0.32
V42 (42)	4	1.1	<0.6	<0.5	0.4
V43 (43)	4	<0.08	<0.06	<0.07	0.016
V44 (44)	4	0.54	<0.3	<0.4	0.14
V45 (45)	4	0.3	<0.03	<0.1	0.14
V46 (46)	4	0.57	<0.08	<0.3	0.2
Network summary	52	2.7	<0.03	<0.4	0.1

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

Table 9.1.5. 1986 ^{234}U in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	76	70	73	2.2
V7 (7)	4	95	38	64	23
V9 (9)	4	68	32	50	14
Network summary	12	95	32	62	10
Oak Ridge Reservation stations[c]					
V8 (8)	4	73	41	60	14
V23 (23)	4	150	130	140	9.6
V31 (31)	4	65	35	49	14
V33 (33)	4	54	30	41	11
V34 (34)	4	43	17	29	10
V36 (36)	4	57	30	41	11
V40 (40)	4	570	410	490	94
V41 (41)	4	150	78	110	35
V42 (42)	4	68	43	54	10
V43 (43)	4	49	25	32	11
V44 (44)	4	46	32	39	6.4
V45 (45)	4	700	350	460	160
V46 (46)	4	210	130	170	34
Network summary	52	700	17	130	44

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

(Fig. 9.1.4). After initial preparation (DEM, 1984) the samples were analyzed by gamma spectrometry and radiochemical techniques for a variety of radionuclides.

9.2. SOIL

9.2.1 Reservation Soils

The ORR is overlain with residual soils and, to a much lesser extent, by alluvial soils. The alluvium (water-deposited soil) occurs on low terraces and floodplains along streambeds. Residual soils are formed in place by the weathering of underlying rock. Rock decomposition occurs as a result of physical weathering and chemical action. The nature of a residual soil depends on the type and solubility of the source rock, degree of weathering, climate, vegetation, and drainage. Soils also exhibit different characteristics after being disturbed by excavation and recompaction.

The bedrock underlying the ORR is part of the Ridge and Valley Province of the eastern overthrust belt. The ridges of dolomite and limestone have weathered over time to form fine-grained reddish soils with depths of up to 27.5 m and well-developed internal drainage. The valley soils are generally more shallow and are a mix of clays, silts, and weathered shale fragments.

Though some generalizations may be made about the nature of the ORR soils, the characteristics of soils are highly localized, and soil properties vary widely even within a soil series. ORR residual soils are generally cohesive, fine-grained clays and silty clays of medium to high plasticity. The in-situ material has a moisture content near or higher than optimum for compaction. It has generally adequate strength, but it is highly compressible, and settlement

Table 9.1.6. 1986 ^{235}U in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	4.9	1.1	3.0	1.8
V7 (7)	4	8.4	1.9	4.5	3.1
V9 (9)	4	3.0	1.1	2.0	0.78
Network summary	12	8.4	1.1	3.2	1.3
Oak Ridge Reservation stations[c]					
V8 (8)	4	3.0	0.54	2.2	1.1
V23 (23)	4	16	7.3	11	4.1
V31 (31)	4	5.7	2.7	4.2	1.4
V33 (33)	4	5.1	1.0	2.7	1.7
V34 (34)	4	3.0	0.65	2.0	0.98
V36 (36)	4	4.9	0.054	28	2.2
V40 (40)	4	41	14	26	12
V41 (41)	4	20	7.8	12	5.8
V42 (42)	4	9.7	6.5	7.8	1.4
V43 (43)	4	8.4	2.7	5.6	2.8
V44 (44)	4	3.2	2.2	2.7	0.53
V45 (45)	4	41	18	26	10
V46 (46)	4	16	7.3	12	3.7
Network summary	52	41	0.054	8.9	2.5

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

Table 9.1.7. 1986 ^{238}U in grass from ORNL perimeter and Oak Ridge Reservation stations

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[a]
ORNL perimeter stations[b]					
V3 (3)	4	38	15	27	11
V7 (7)	4	41	19	27	9.9
V9 (9)	4	21	13	15	3.4
Network summary	12	41	13	24	5.6
Oak Ridge Reservation stations[c]					
V8 (8)	4	38	12	22	12
V23 (23)	4	30	22	25	3.3
V31 (31)	4	21	6.8	14	6.5
V33 (33)	4	17	7.6	13	4.0
V34 (34)	4	13	5.4	9.8	3.1
V36 (36)	4	15	9.2	11	2.6
V40 (40)	4	73	38	52	15
V41 (41)	4	76	9.7	36	29
V42 (42)	4	25	9.5	18	8.0
V43 (43)	4	12	7.0	8.7	2.2
V44 (44)	4	27	13	17	6.5
V45 (45)	4	620	68	210	270
V46 (46)	4	97	38	64	25
Network summary	52	620	5.4	39	24

[a]95% confidence coefficient about the average.
[b]See Fig. 9.1.2.
[c]See Fig. 9.1.3.

under load is often the limiting soil characteristic. The ORR contains no naturally occurring concentrations of sand or gravel.

9.2.2 Soil and Environmental Pathways

Most of the food consumed by humans is grown on soils of complex chemical and ecological balance. Radionuclides that occur in soil can be incorporated metabolically into plants and can ultimately find their way into the tissue of animals or they may remain in roots. In addition to root uptake, direct deposition may occur on foliar surfaces, from which contaminants may be absorbed metabolically by the plants or may be transferred directly to animals that consume the contaminated foliage. Foliar deposition is potentially a major source of foodchain contamination by both nonradioactive and radioactive substances.

Soils consist of mineral and organic matter, water, and air arranged in a complicated physicochemical system that provides the mechanical foothold for plants in addition to supplying their nutritive requirements (USDA, 1957 and Hillel, 1971). When a radionuclide is added in soluble form, it can adsorb on clays and organic matter, precipitate as an oxide or hydroxide, chelate with organic compounds, or (somewhat unlikely) remain in solution. The manner in which the radionuclide is distributed among these various fractions will determine how long it will remain at the site of deposition and the extent to which it will be available for uptake by plants (Shulz, 1965). Uptake of a radionuclide by plants depends to a considerable degree on whether it remains within reach of the roots of plants and the extent to which it is chemically available. The relative uptake (Nishita, Romney, and Larson, 1961) of various radioelements from

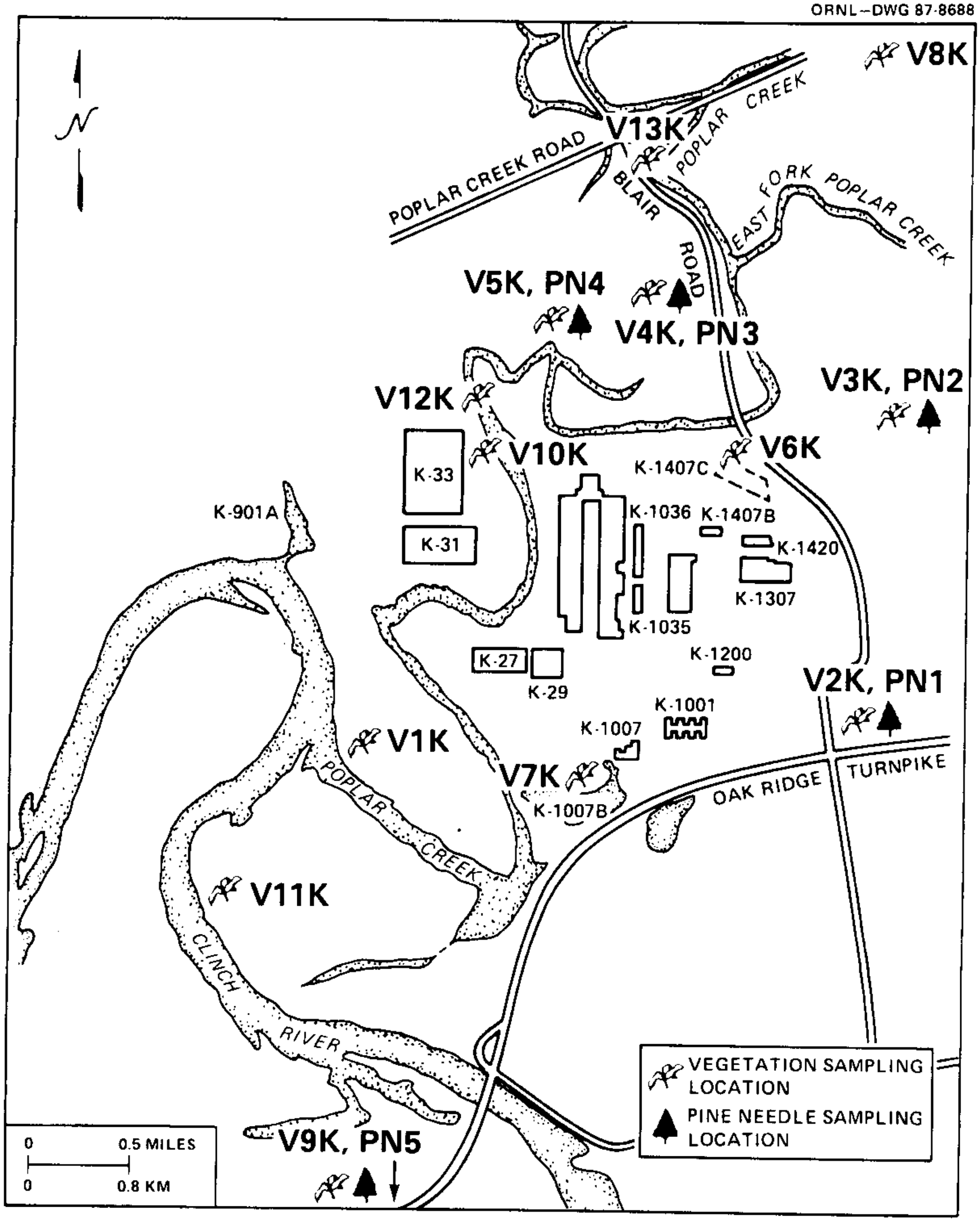

Fig. 9.1.1. ORGDP pine needle and grass sampling locations.

ORNL-DWG 87-9292

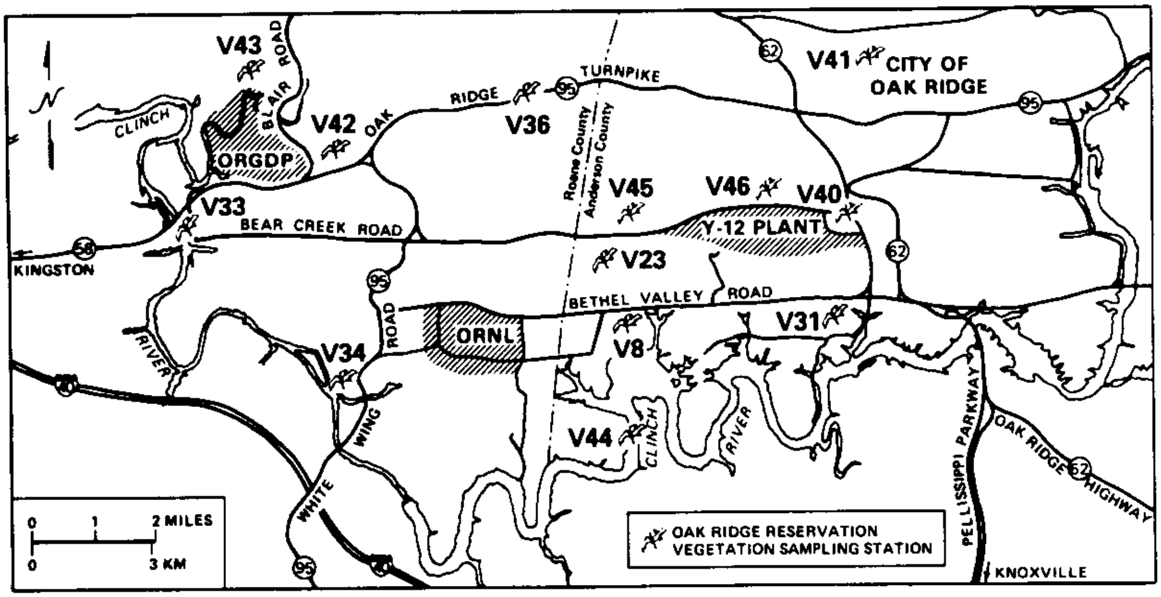

Fig. 9.1.2. ORNL grass sampling locations.

Table 9.1.8. 1986 radioactivity in grass samples from the remote locations[a]

New (old) station ID	Concentrations (pCi/kg dry wt)						
	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
V51 (51)	110	42	<0.3	<0.3	30	4.1	12
V52 (52)	460	130	<0.3	<0.3	92	1.8	16
V53 (53)	140	<30	0.3	<0.2	30	1.8	10
V55 (55)	230	100	<0.3	0.1	65	3.8	21
V56 (56)	210	160	<0.3	0.7	350	23	130
V57 (57)	240	85	0.2	<0.1	68	13	13
V58 (58)	160	<40	<0.3	<0.3	62	4.1	14
Network average	220	<84	<0.3	<0.2	100	7.4	31

[a]See Fig. 9.1.4.

soils is Sr >> I > Ba > Cs, Ru > Ce > Y, Pm, Zr, Nb > Pu, U.

Guidelines for soil radionuclide concentrations are limited. Where they are available, they are defined as the limiting concentration of a radionuclide in the soil below which specified dose limits will not be exceeded (DOE, 1983). Source-to-dose conversion factors for individual sites may need to be developed based on site-specific data; however, generic values have been developed (DOE, 1983). The dose parameter of interest is the dose equivalent to the whole body, tissue, or organ expressed in millirems.

The environmental pathways by which radioactive materials in soils reach humans form a complex, interconnected network (e.g., soil → foliage → animals → humans). The most direct pathway to humans is the ingestion of soil, by a child, for example.

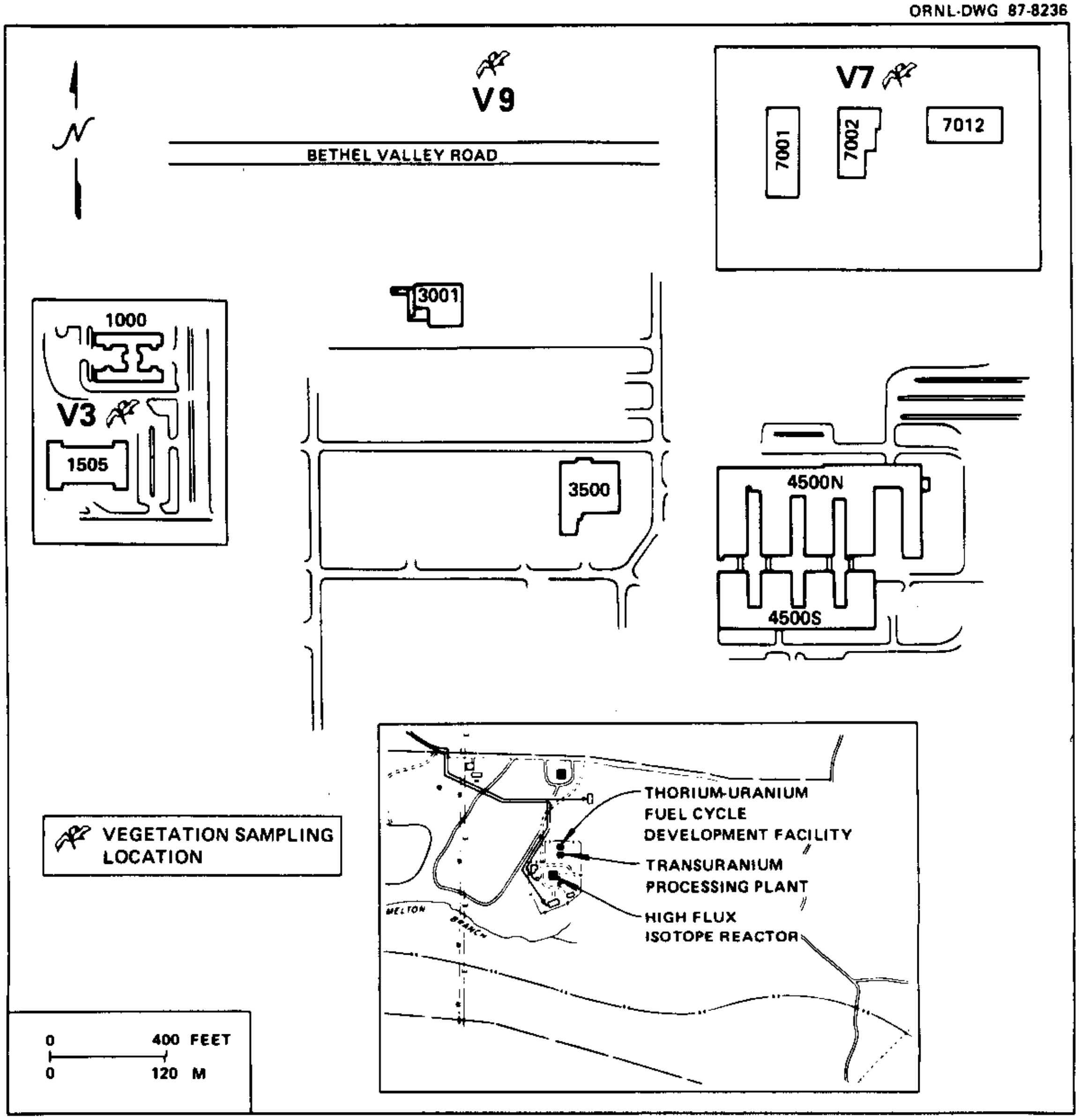

Fig. 9.1.3. ORR grass sampling locations.

Table 9.1.9. 1986 grass sampling data[a]

Station[b]	F⁻ concentration (μg/g dry wt) Feb.	July	Av	U (total) concentration (μg/g dry wt) Feb.	July	Av	U (total) concentration (pCi/g dry wt) Feb.	July	Av	^{99}Tc concentration (pCi/g dry wt) Feb.	July	Av
V1K	1.5	23.0	12.3	0.1	0.12	0.113	0.08	0.095	0.0875	0.4	0.9	0.65
V2K	0.13	5.4	2.77	0.7	0.19	0.447	0.05	0.147	0.0985	<0.4	<0.4	<0.4
V3K	2.0	3.8	2.9	0.1	0.24	0.171	0.08	0.183	0.1315	<0.6	2.6	<1.6
V4K	1.7	2.4	2.1	0.1	0.05	0.077	0.08	0.041	0.0605	0.7	<0.4	<0.37
V5K	2.7	8.7	5.7	<0.1	0.03	0.064	<0.08	0.021	<0.0505	0.5	<0.4	<0.45
V6K	2.2	7.1	4.7	0.2	0.07	0.14	0.15	0.055	0.1025	0.9	1.4	1.15
V7K	5.9	3.8	4.9	0.1	0.05	0.076	0.08	0.039	0.0595	0.9	0.7	0.8
V8K	4.0	3.0	3.5	0.1	0.097	0.0985	0.08	0.074	0.077	0.6	<0.4	0.5
V9K	2.3	9.2	5.8	0.1	0.07	0.084	0.08	0.152	0.066	<0.4	<0.4	<0.4
V10K	8.3	5.8	7.1	0.1	0.17	0.137	0.08	0.132	0.106	<0.4	6.1	3.3
V11K	11.3	7.8	9.6	10.4	3.2	6.83	7.9	2.470	5.185	36.0	136.2	86.1
V12K	3.1	5.1	4.1	0.2	0.17	0.18	0.02	0.126	0.073	0.7	7.4	4.1
V13K	4.0	3.0	3.5	0.1	0.03	0.066	0.08	0.024	0.052	<0.4	<0.4	<0.04

[a]An ingestion by cattle of 30 μg of fluoride per gram (dry weight) of grass for average grazing intake is considered to produce no adverse effect on the cattle.
[b]See Fig. 9.1.3.

Table 9.1.10. 1986 pine needle sampling data

Station[a]	F⁻ concentration (μg/g dry wt) Feb.	July	Av	U (total) concentration (μg/g dry wt) Feb.	July	Av	U (total) concentration (pCi/g dry wt) Feb.	July	Av	^{99}Tc concentration (pCi/g dry wt) Feb.	July	Av
PN1	6.9	6.3	6.6	1.2	0.126	0.66	0.11	0.096	0.103	<0.4	<0.4	<0.4
PN2	3.0	5.8	4.4	<0.1	0.045	<0.07	<0.08	0.034	<0.057	<1.2	<1.2	<1.2
PN3	3.9	7.1	5.5	0.1	0.095	0.10	0.08	0.072	0.076	<0.4	<0.4	<0.4
PN4	2.6	3.0	2.8	0.1	0.085	0.09	0.08	0.065	0.072	<0.4	<1.0	<0.7
PN5	<0.1	4.5	<2.3	0.2	0.077	0.14	0.15	0.059	0.104	1.4	0.6	1.0
PN6	11.8	6.5	9.2	0.6	0.060	0.33	0.46	0.053	0.256	0.5	<0.4	<0.45

[a]See Fig. 9.1.3.

9.2.3 Soil Radionuclide and Fluoride Data on the ORR

Soil samples were collected at 3 locations 4 times a year around ORNL, 13 locations around ORGDP semiannually, 13 locations 4 times a year on the Oak Ridge Reservation, and at 7 remote locations 4 times a year.

ORNL, ORR, and remote soil samples were collected during the same time period and from the same 1-m plots where the grass samples were taken. Soil sampling is performed to allow examination of atmospheric deposition of radionuclides and fluoride. Only the top 2 cm (except at those locations around ORGDP, which are 1 cm) of the soil sample was analyzed for radionuclides. About 450 g of soil is collected from each location at a maximum depth of 1 cm. Fluorometric analysis is used to determine uranium levels, and a fluoride-ion-selective electrode is used to determine fluoride levels. The soil sampling locations for ORNL, ORGDP, ORR, and remotes are shown in Figs. 9.2.1 through 9.2.4.

Tables 9.2.1 through 9.2.7 give summary statistics for concentrations of radionuclides in

ORNL–DWG 87-7050

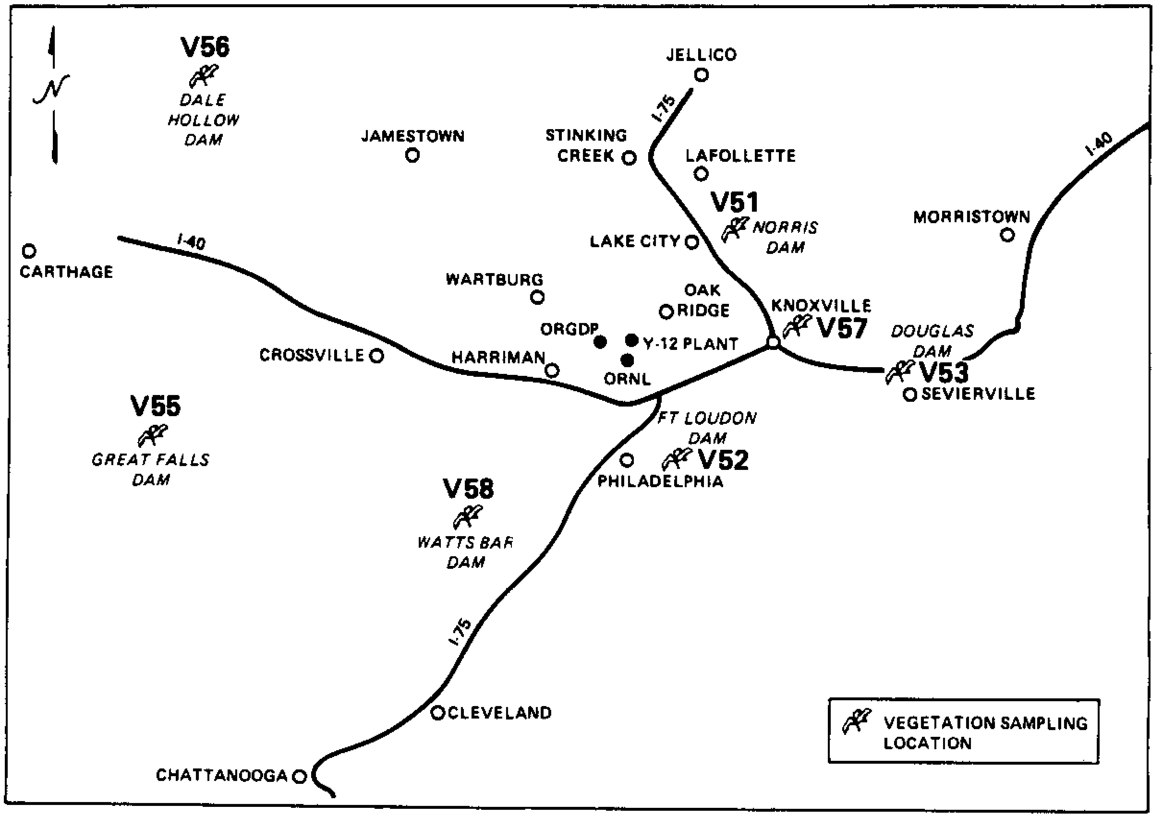

Fig. 9.1.4. Remote grass sampling locations.

soil samples from ORNL perimeter locations. Table 9.2.8 gives data on the ORGDP samples, and Tables 9.2.9 through 9.2.15 give summary data for the ORR samples. There were no statistically significant differences in the soil concentrations of ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{235}U, and ^{238}U between the ORNL perimeter and the ORR locations. There were significantly higher concentrations of ^{234}U at the ORR locations. Uranium concentrations in soil were highest around the two Oak Ridge Y-12 Plant stations (S10 and S15, Fig. 9.2.3). Concentrations of ^{239}Pu in soil were significantly higher at the ORNL perimeter station (S1), just west of ORNL.

Table 9.2.16 gives the results from sampling at the remote locations. The ^{238}Pu concentrations at most of the remote locations appeared higher during 1986 than in 1985. All other radionuclide levels were similar to those of 1985.

Table 9.2.17 shows ORR and remote concentrations from 1982 through 1986.

Uranium concentrations in the soil at ORGDP changed little from 1985 to 1986. Average background uranium concentration in soil, as measured at remote stations, was about 0.9 pCi/g dry wt. High uranium concentrations at S28K result from contamination of the soil from the contaminated scrapyard rather than from atmospheric releases from ORGDP.

9.3. SEDIMENT

A sediment sampling program was initiated near ORGDP in 1975 to determine concentrations of various metals in the sediment

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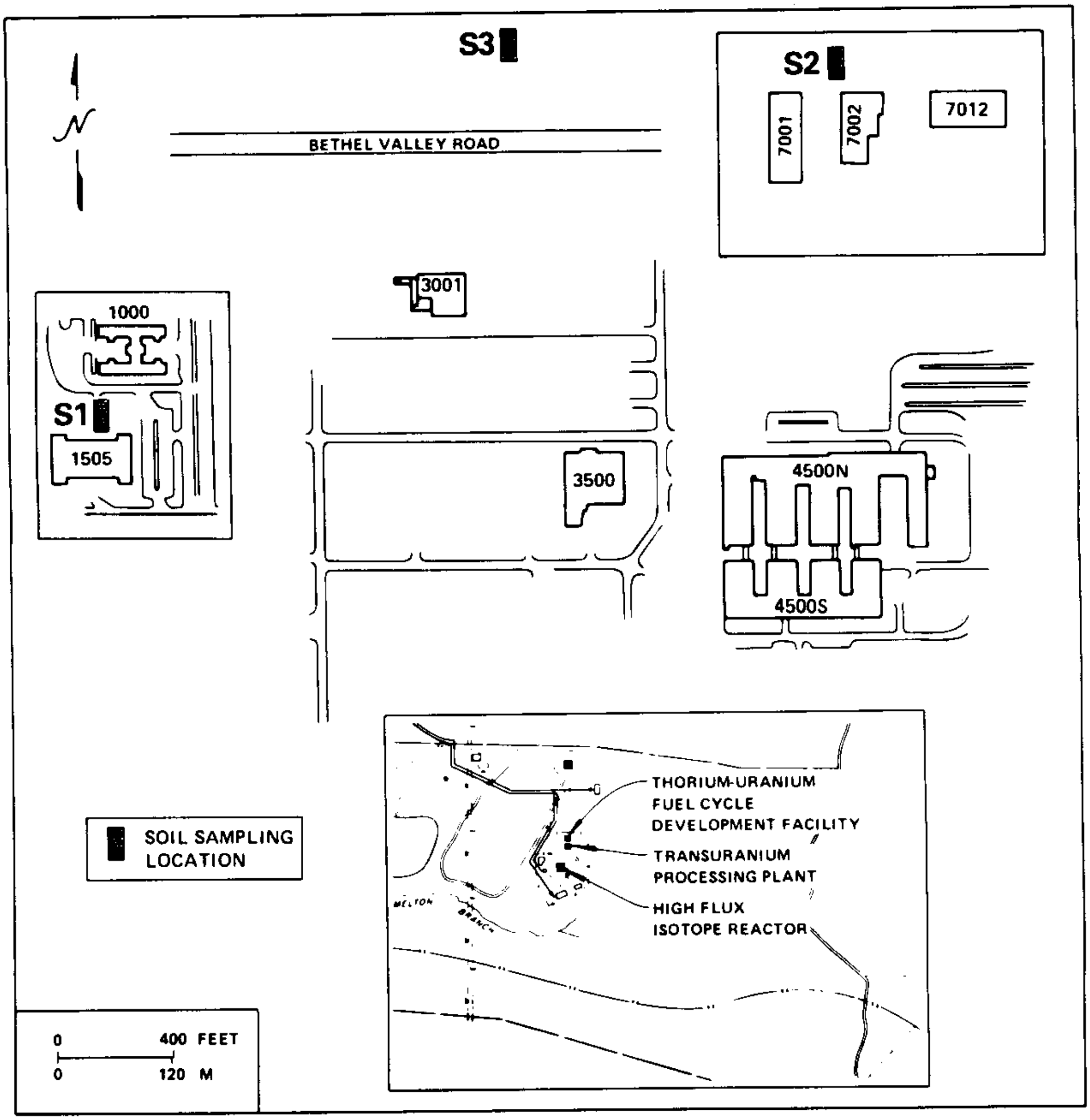

Fig. 9.2.1. Soil sampling locations around ORNL.

ORNL–DWG 87-8687

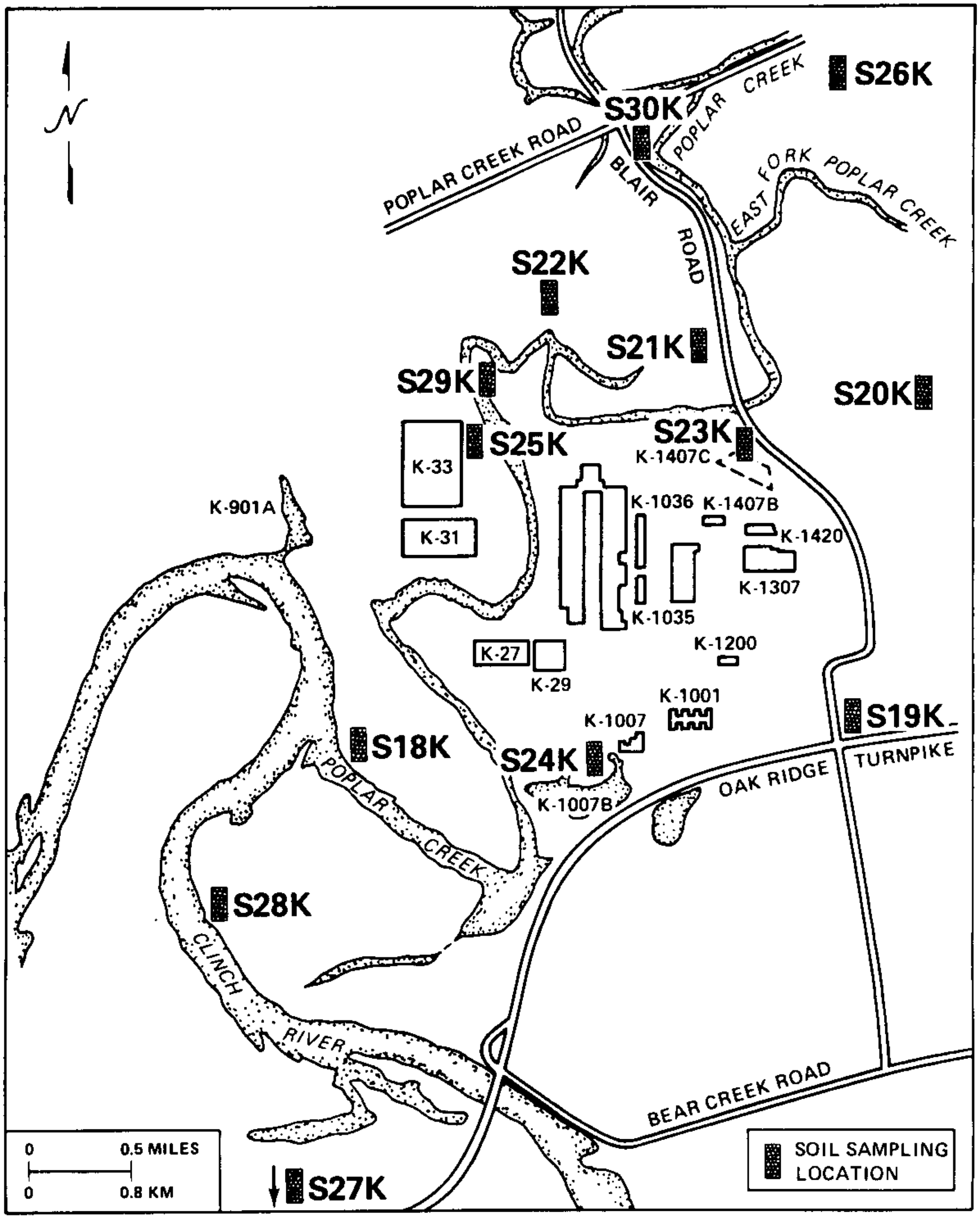

Fig. 9.2.2. Soil sampling locations around ORGDP.

ORNL-DWG 87-6971

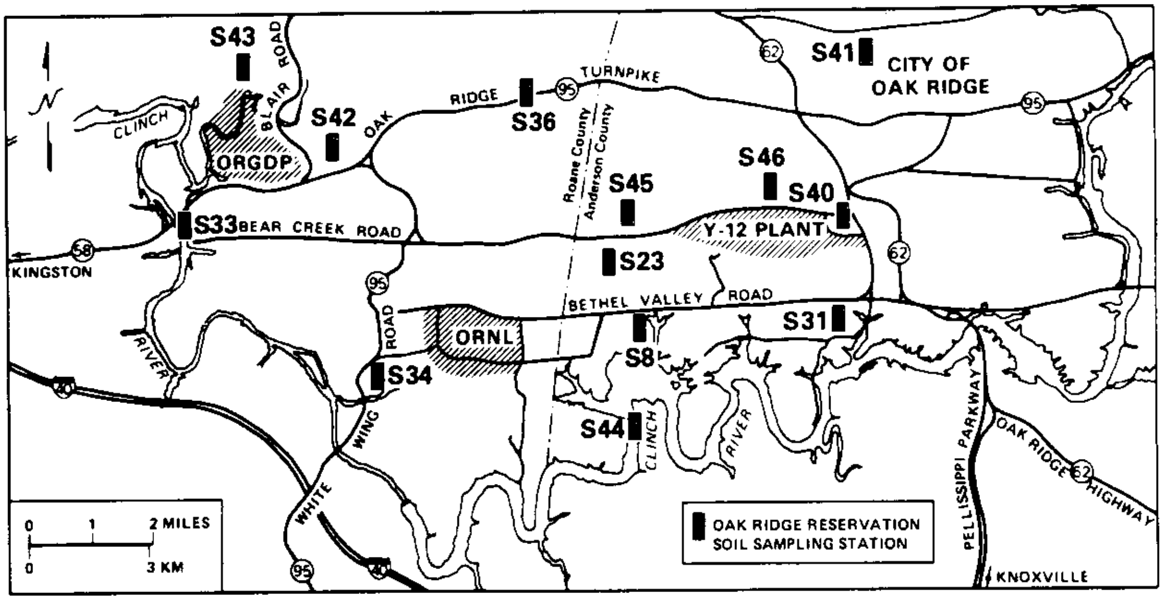

Fig. 9.2.3. Locations of ORR soil sampling areas.

ORNL-DWG 87-6972

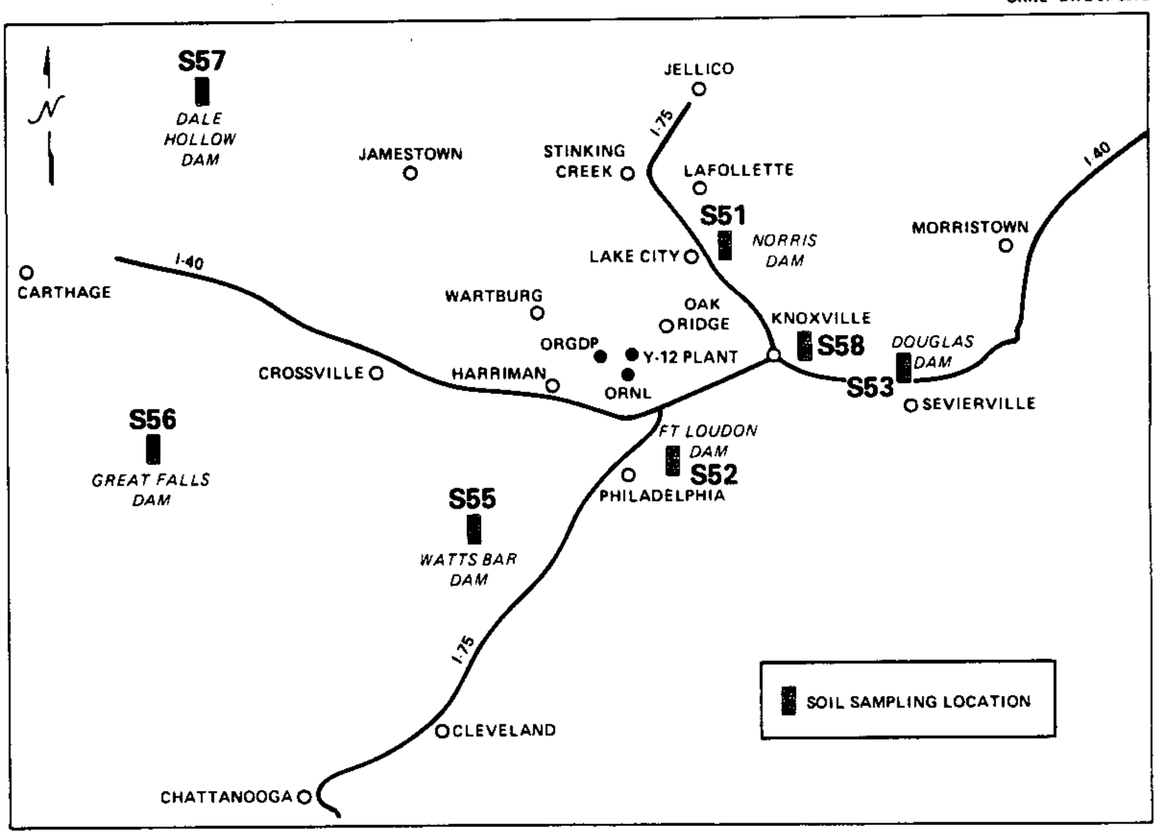

Fig. 9.2.4. Locations of remote soil sampling areas.

Table 9.2.1. 1986 ^{234}U in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	510	410	470	46
S7 (7)	4	430	300	350	58
S9 (9)	4	430	320	360	47
Network summary	12	510	300	390	41

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.2. 1986 ^{235}U in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	73	25	47	25
S7 (7)	4	62	19	35	19
S9 (9)	4	51	13	28	17
Network summary	12	73	13	37	12

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.3. 1986 ^{238}U in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	410	320	360	35
S7 (7)	4	350	250	290	45
S9 (9)	4	320	250	280	37
Network summary	12	410	250	310	31

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.4. 1986 ^{238}Pu in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	6.8	1.0	2.7	2.7
S7 (7)	4	2.3	0.027	1.0	1.1
S9 (9)	4	2.5	0.27	0.97	1.0
Network summary	12	6.8	0.017	1.5	1.1

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.5. 1986 ^{239}Pu in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	78	7.6	53	33
S7 (7)	4	22	0.14	9.6	9.6
S9 (9)	4	32	22	29	4.9
Network summary	12	78	0.14	31	15

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.6. 1986 ^{90}Sr in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	210	110	160	56
S7 (7)	4	190	73	120	55
S9 (9)	4	430	270	340	68
Network summary	12	430	73	210	65

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

Table 9.2.7. 1986 ^{137}Cs in soil from ORNL perimeter stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S3 (3)	4	2500	380	1400	1100
S7 (7)	4	3000	400	1100	1300
S9 (9)	4	1900	920	1400	450
Network summary	12	3000	380	1300	520

[a]See Fig. 9.2.1.
[b]95% confidence coefficient about the average.

of Poplar Creek and the Clinch River. The current sampling program consists of eight sampling locations, shown in Fig. 9.3.1. All of these sediment sampling areas can be affected by effluents from the three major ORR plants because of the complex hydrology associated with hydroelectric operations at Melton Hill Dam and Watts Bar Dam. Samples were collected semiannually and analyzed by atomic absorption, inductively coupled plasma, and other methods.

Table 9.2.8. 1986 fluoride and uranium in soil from ORGDP and ORGDP perimeter[a]

New station ID	Number of samples	Concentration (μg/g dry wt) F⁻ Feb.	July	Av	U (total) Feb.	July	Av	U (pCi/g dry wt) Feb.	July	Av
S18K	2	380	200	290	1.8	2.4	2.1	1.37	1.8	1.585
S19K	2	881	750	816	2.8	2.0	2.4	2.13	1.5	1.815
S20K	2	306	50	178	2.9	3.4	3.2	2.2	2.6	2.4
S21K	2	446	150	298	1.8	2.3	2.1	1.4	1.7	1.55
S22K	2	445	550	498	2.6	3.0	2.8	2.0	2.3	2.15
S23K	2	196	<50	<123	2.1	2.1	2.1	1.6	1.6	1.6
S24K	2	514	50	282	2.2	2.4	2.3	1.7	1.8	1.75
S25K	2	449	700	575	3.8	3.4	3.6	2.9	2.6	2.75
S26K	2	333	150	242	1.9	2.4	2.2	1.4	1.8	1.6
S27K	2	600	650	625	1.8	2.2	2.0	1.4	1.7	1.55
S28K	2	380	550	465	14.2	24.6	19.4	10.8	18.7	14.75
S29K	2	590	500	545	5.7	2.2	4.0	4.3	1.7	3.0
S30K	2	370	200	285	1.6	1.2	1.4	1.2	0.9	1.05

[a]See Fig. 9.2.2.

Table 9.2.9. 1986 ^{234}U in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt) Max	Min	Av	95% CC[b]
S8 (8)	4	760	490	620	130
S23 (23)	4	1200	490	750	310
S31 (31)	4	1000	380	610	280
S33 (33)	4	460	270	350	85
S34 (34)	4	300	230	260	32
S36 (36)	4	410	300	350	49
S40 (40)	4	5400	2700	3900	1200
S41 (41)	4	410	300	340	56
S42 (42)	4	540	320	390	100
S43 (43)	4	430	320	370	56
S44 (44)	4	300	95	230	95
S45 (45)	4	4100	510	1700	1700
S46 (46)	4	920	490	760	200
Network summary	52	5400	95	820	310

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.10. 1986 ^{235}U in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt) Max	Min	Av	95% CC[b]
S8 (8)	4	35	23	27	5.4
S23 (23)	4	46	30	38	7.4
S31 (31)	4	46	22	31	11
S33 (33)	4	30	14	22	7.6
S34 (34)	4	11	1.1	7.3	4.2
S36 (36)	4	18	13	15	2.0
S40 (40)	4	410	120	250	130
S41 (41)	4	43	13	21	15
S42 (42)	4	32	15	23	7.6
S43 (43)	4	23	12	18	4.5
S44 (44)	4	25	7.0	16	7.8
S45 (45)	4	380	16	140	160
S46 (46)	4	73	35	50	16
Network summary	52	410	1.1	51	24

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.11. 1986 ^{238}U in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S8 (8)	4	600	250	390	150
S23 (23)	4	1400	510	890	350
S31 (31)	4	620	240	360	180
S33 (33)	4	350	190	260	77
S34 (34)	4	230	170	200	25
S36 (36)	4	320	200	260	51
S40 (40)	4	1400	730	1100	370
S41 (41)	4	270	170	230	46
S42 (42)	4	320	230	270	37
S43 (43)	4	300	220	250	36
S44 (44)	4	240	62	170	83
S45 (45)	4	5900	300	2200	2600
S46 (46)	4	590	350	470	120
Network summary	52	5900	62	540	240

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.12. 1986 ^{238}Pu in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S8 (8)	4	2.4	0.65	1.4	0.79
S23 (23)	4	0.70	<0.06	<0.3	0.32
S31 (31)	4	0.89	<0.09	<0.5	0.35
S33 (33)	4	0.86	0.011	0.46	0.35
S34 (34)	4	<0.6	<0.6	<0.6	0.0
S36 (36)	4	0.76	<0.06	<0.6	0.32
S40 (40)	4	3.0	<0.3	<2	1.4
S41 (41)	4	<0.9	<0.3	<0.6	0.22
S42 (42)	4	4.9	<0.06	<3	2.5
S43 (43)	4	6.5	<0.2	<4	3.1
S44 (44)	4	0.92	<0.06	<0.6	0.40
S45 (45)	4	2.3	<0.4	<1	0.95
S46 (46)	4	1.3	<0.5	<0.8	0.39
Network summary	52	6.5	0.011	<1.1	0.41

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.13. 1986 ^{239}Pu in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S8 (8)	4	41	9.7	25	13
S23 (23)	4	23	8.1	15	6.1
S31 (31)	4	30	11	17	8.7
S33 (33)	4	35	9.2	22	11
S34 (34)	4	19	<0.06	<9	9.5
S36 (36)	4	24	1.1	13	9.5
S40 (40)	4	8.9	4.3	7.3	2.0
S41 (41)	4	1.9	<0.6	<1	0.64
S42 (42)	4	17	4.6	8.4	5.8
S43 (43)	4	25	0.084	8.4	11
S44 (44)	4	18	0.95	6.1	8.1
S45 (45)	4	35	<0.3	<14	17
S46 (46)	4	14	5.7	9.5	4.4
Network summary	52	41	<0.054	<12	2.9

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.14. 1986 ^{90}Sr in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S8 (8)	4	180	38	140	68
S23 (23)	4	300	170	230	63
S31 (31)	4	400	140	290	120
S33 (33)	4	270	150	210	52
S34 (34)	4	320	95	230	120
S36 (36)	4	230	68	150	74
S40 (40)	4	250	110	170	60
S41 (41)	4	120	22	76	43
S42 (42)	4	350	76	210	140
S43 (43)	4	220	16	95	86
S44 (44)	4	120	41	74	35
S45 (45)	4	200	27	100	76
S46 (46)	4	220	46	150	72
Network summary	52	410	16	160	27

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.15. 1986 ^{137}Cs in soil from Oak Ridge Reservation stations[a]

New (old) station ID	Number of samples	Concentration (pCi/kg dry wt)			
		Max	Min	Av	95% CC[b]
S8 (8)	4	2500	680	1700	740
S23 (23)	4	1400	380	770	430
S31 (31)	4	1600	730	1000	400
S33 (33)	4	1700	590	1200	470
S34 (34)	4	1200	<30	<520	560
S36 (36)	4	1300	140	660	480
S40 (40)	4	600	300	470	140
S41 (41)	4	170	43	90	60
S42 (42)	4	730	150	380	280
S43 (43)	4	1200	76	480	500
S44 (44)	4	1400	78	450	620
S45 (45)	4	1600	30	670	760
S46 (46)	4	680	230	440	190
Network summary	52	2500	<30	<680	160

[a]See Fig. 9.2.3.
[b]95% confidence coefficient about the average.

Table 9.2.16. 1986 radioactivity in soil samples from remote monitoring stations

New (old) station ID	Concentration (pCi/kg dry wt)						
	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
S51 (51)	170	730	<3	9.7	260	16	220
S52 (52)	200	590	0.12	8.9	460	59	380
S53 (53)	200	1400	0.51	25	700	32	600
S55 (55)	240	1100	1.5	17	350	15	300
S56 (56)	120	620	0.78	10	260	57	240
S57 (57)	120	730	0.32	13	380	49	270
S58 (58)	220	1100	<0.3	15	380	24	300
Network average	180	890	<0.8	14	400	36	330

Table 9.2.17. Concentration of radionuclides in soil samples from ORR and remote stations

Year/ location	Concentration (pCi/g dry wt)						
	^{90}Sr	^{137}Cs	^{234}U	^{235}U	^{238}U	^{238}Pu	^{239}Pu
1982							
ORR stations[a,b]	0.28	1.2	0.48	0.074	0.34	0.00080	0.023
Remote stations[c,d]	0.23	1.3	0.45	0.063	0.410	0.015	0.021
1983							
ORR stations	0.23	1.1	0.87	0.11	0.46	0.00090	0.014
Remote stations	0.15	1.7	0.55	0.065	0.45	0.0013	0.016
1984							
ORR stations	0.18	0.70	0.62	0.060	0.33	<0.001	<0.009
Remote stations	0.2	1.2	0.40	0.058	0.34	<0.002	<0.02
1985							
ORR stations	0.17	0.83	1.3	0.080	0.60	0.0020	0.015
Remote stations	0.14	1.1	0.47	0.028	0.39	0.0017	0.017
1986							
ORR stations	0.16	<0.68	0.82	0.05	0.54	<0.0011	<0.02
Remote stations	0.18	0.89	0.40	0.036	0.33	<0.0008	0.014

[a]See Fig. 9.2.3.
[b]Average of two samples until 1986 when average is of four.
[c]See Fig. 9.2.4.
[d]Single sample until 1986 when four samples were collected.

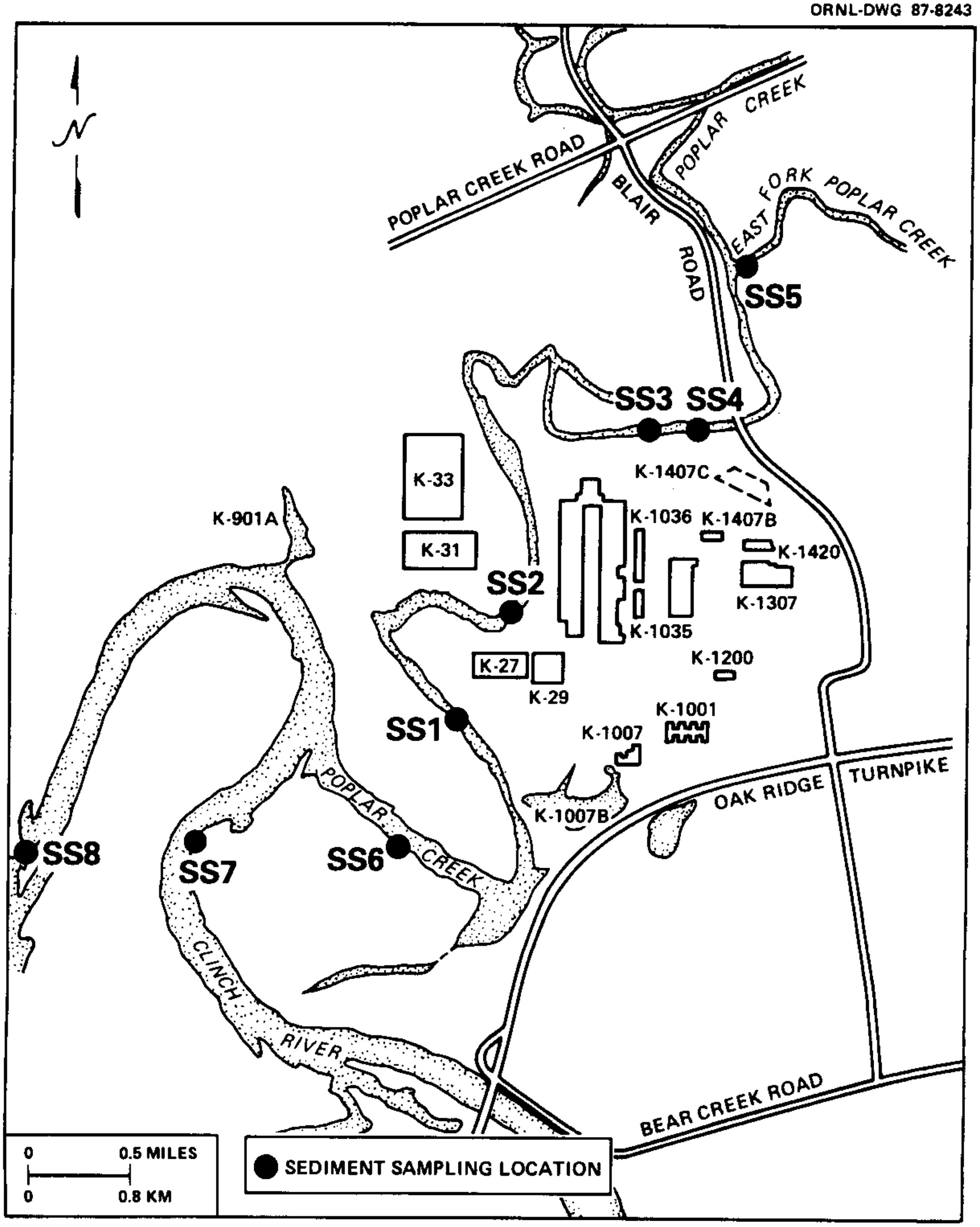

Fig. 9.3.1. Sediment sampling locations.

The concentrations of metals in the stream sediment samples (Table 9.3.1) generally exceeded background levels of metals in remote streams (ORTF, 1985). An examination of the data shows SS7 and SS8 to have the lowest metal concentrations of the sampling stations. Location SS2 at East Fork Poplar Creek had the highest concentrations of mercury and lead. For most of the metals, the highest concentrations occurred at stations in the creek close to or above ORGDP: SS5, SS4, SS2, and SS6. Concentrations of nickel and copper in sediments were higher in 1986 than in 1985, while concentrations of zinc declined. The reason for the increase is unknown. Many factors may influence sediment metal concentrations, including particle size distribution, content of organic matter, and input from industrial and other sources. Particle size distribution and organic matter content of sediment in rivers and creeks can vary greatly from time to time and from place to place. Thus, temporal and spatial trends must be regarded cautiously unless particle size and organic matter are homogeneous among all samples being compared.

Table 9.3.1. 1986 concentrations of various elements in stream sediment samples near ORGDP

Station[a]	Concentration (μg/g dry wt)											
	Aug.	Nov.	Av.	Aug.	Nov.	Av.	Aug.	Nov.	Av.	Aug.	Nov.	Av
		Hg			Pb			Ni			Cu	
SS1	10.9	8.66	9.78	0.22	<50	<41	50	<30	<40	32	12	22
SS2	4.79	957.0	480.9	0.36	<50	<39	40	310	175	27	150	89
SS3	4.28	23.4	13.84	0.54	<50	<50	180	61	121	51	67	59
SS4	<1.0	5.19	<3.1	0.28	<50	<25	21	340	181	12	150	81
SS5	15.5	1.72	8.61	0.47	<50	<25	31	<30	<30	62	44	53
SS6	7.04	37.3	22.17	0.28	<50	<25	42	120	81	21	160	91
SS7	<1.0	<1.0	<1.0	0.28	<50	<25	21	<30	<26	15	12	14
SS8	<1.0	<1.0	<1.0	0.36	<50	<25	11	<30	<21	6.3	7.2	6.8
		Zn			Cr			Mn			Al	
SS1	93	39	66	83	23	53	270	240	255	12,000	13,000	12,500
SS2	130	280	205	25	170	98	740	600	670	14,000	25,000	19,500
SS3	140	160	150	29	40	35	870	960	915	14,000	16,000	15,000
SS4	60	180	120	18	61	40	670	590	630	16,000	19,000	17,500
SS5	140	84	112	38	29	34	730	800	765	14,000	29,000	21,500
SS6	80	120	100	46	120	83	540	650	595	10,000	25,000	17,500
SS7	72	52	62	20	15	18	530	1700	1115	20,000	9,400	14,700
SS8	42	50	46	11	10	11	620	770	695	7,900	8,700	8,300
		Th			Cd			Uranium			Uranium (pCi/g dry wt)	
SS1	<20	<40	<30	0.010	<3.0	1.5	<3.0	9.0	<6.0	<2.3	6.8	<4.55
SS2	<20	<40	<30	0.040	16	8.0	<3.0	269.0	<136.0	<2.3	204.4	<103.4
SS3	<20	<40	<30	0.040	<3.0	<1.5	<3.0	11.0	<7.0	<2.3	8.4	<5.35
SS4	<20	<40	<30	0.003	<3.0	<1.5	<3.0	161.0	<82.0	<2.3	122.4	<62.35
SS5	<20	<40	<30	0.04	<3.0	<1.5	<3.0	29.0	<16.0	<2.3	22	<12.15
SS6	<20	<40	<30	0.008	<3.0	<1.5	<3.0	29.0	<16.0	<2.3	22	<12.15
SS7	<20	<40	<30	0.002	<3.0	<1.5	<3.0	3.0	<3.0	<2.3	2.3	<2.3
SS8	<20	<40	<30	0.002	<3.0	<1.5	<3.0	3.0	<3.0	<2.3	2.3	<2.3

[a]See Fig. 9.3.1.

10. ENVIRONMENTAL SURVEILLANCE AND MONITORING OF THE OAK RIDGE COMMUNITY PROVIDED BY OAK RIDGE ASSOCIATED UNIVERSITIES

10.1 HISTORICAL PERSPECTIVE

Wastewater discharges from Oak Ridge Y-12 Plant into East Fork Poplar Creek (EFPC) have resulted in the floodplain's becoming contaminated with materials such as mercury, uranium, thorium, chromium, zinc, and various other inorganic and organic compounds. Because the soil was not known to be contaminated, floodplain soils and creek sediments were used throughout the Oak Ridge community (primarily in 1982), as topsoil for portions of the new Oak Ridge sewer system.

In 1983, two activities were initiated to define the potential problem with this contamination. In response to citizens' requests a sampling program was undertaken to determine whether soil, vegetables, or well water was contaminated. This effort also was directed toward defining the extent of contamination in the community, particularly along the sewer beltway. The second activity was the establishment of the interagency Oak Ridge Task Force (ORTF), which collects toxicological and environmental data to evaluate the potential long-term public health impact of the residual contamination and cost versus benefit of remedial measures.

The general sampling effort through 1985 focused on (1) sampling of private residences, (2) rapid scan of the entire length of the sewer beltway, (3) participation in an interim cleanup effort at the Oak Ridge Civic Center, (4) cleanup of two small contaminated areas in the city, (5) removal of contaminated soil from a private residence, (6) rapid scan for preliminary determination of the contamination distribution in the EFPC floodplain, (7) monitoring for radioactivity and other contaminants in the city's sewage, and (8) sampling of a salvage yard to determine the composition and distribution of contamination on this property.

10.2 CURRENT ACTIVITIES

During 1986, private property and EFPC floodplain sampling continued. In addition to routine Oak Ridge community sampling, Oak Ridge Associated University (ORAU) cooperated with the U.S. Geological Survey (USGS), ORNL, the Oak Ridge Task Force—Task V, and Advanced Sciences Inc. (a local consulting firm), in sampling in surrounding communities.

10.2.1 Oak Ridge Community Sampling

Fairbanks Road area. Forty samples (Table 10.2.1 and Fig. 10.2.1) were collected in response to a request to determine whether any of the properties surrounding a contaminated salvage yard were contaminated. Although this study is still in progress, to date, only 1 of the 40 samples exceeded the TDHE's interim guideline for soil mercury of 12 ppm.

Illinois Avenue area. Three hundred seventy-four samples were collected from seven properties (Table 10.2.1 and Fig. 10.2.1), all from the EFPC environs. Two hundred and sixteen samples were collected on the EFPC floodplain in conjunction with the USGS shallow groundwater studies. A second group of samples included properties adjacent to and encroaching on the floodplain where fill material was used to raise

Table 10.2.1. Summary of soil sampling in the Oak Ridge community for 1986

Area	Number of properties	Garden	Yard	Floodplain	Other	Soil mercury concentration range (ppm)	Number of samples exceeding state guidelines[a]
Cedar Hill	0	0	0	0	0		
Country Club	0	0	0	0	0		
East Village	0	0	0	0	0		
Elm Grove	0	0	0	0	0		
Fairbanks Road	2	0	0	0	40	0.02–15	1
High School	0	0	0	0	0		
Illinois Avenue	7	0	0	216	118	0.02–4300	174
Linden School	0	0	0	0	0		
Oak Hills	0	0	0	0	0		
Robertsville	3	0	0	0	139	0.02–69	44
Scarboro	3	31	32	0		0.03–21	7
West End Water Treatment Plant	2	0	0	242	0	0.02–2500	136
Woodland	1	0	0	0	15	0.05–0.35	0

[a]Interim State of Tennessee guideline for soil mercury is 12 ppm.

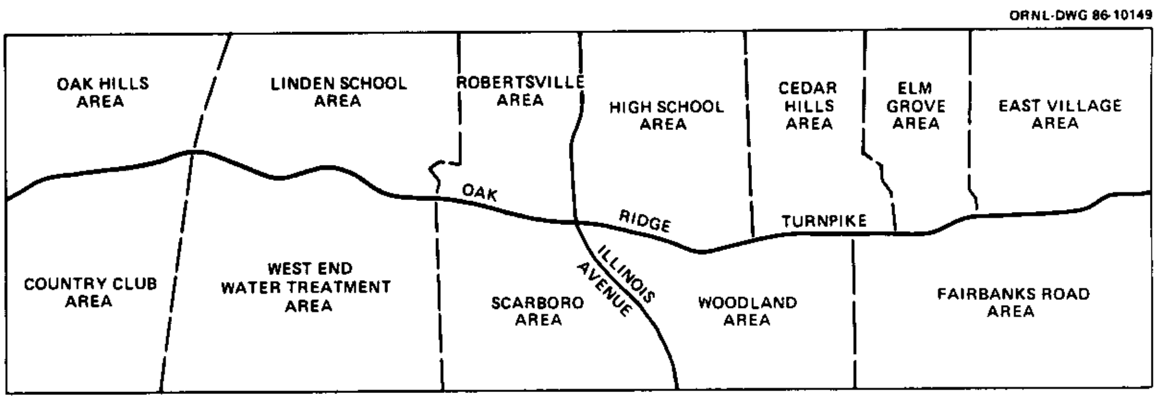

Fig. 10.2.1. Private property areas in the Oak Ridge community.

the surface elevation. In one case, the fill material was contaminated with mercury. The final sampling location in this area was the sandbars where EFPC crosses under Oak Ridge Turnpike near Illinois Avenue. This sandbar sampling was in anticipation of future creek sediment removal for flood control. Soil mercury concentration for this area ranged from 0.02 to 4300 ppm, with 176 samples exceeding state guidelines.

Robertsville area. One hundred thirty-nine samples were collected from three properties in the Robertsville area (Table 10.2.1 and Fig. 10.2.1), the first, at the sandbars at the bridge where East Fork Poplar Creek flows under Oak Ridge Turnpike near Jefferson Avenue. Forty-four of 45 samples exceeding the state interim guideline in this area were collected. The USGS shallow groundwater site at the YWCA was sampled to determine the vertical distribution of mercury in the soil. No samples exceeded the state interim guideline. Previous sampling had demonstrated that contamination was present in the Robertsville Junior High School athletic field. Subsequent remedial action was taken in the form of covering this contamination with clean soil. The purpose of sampling efforts there was to determine whether the covered contamination had migrated to the surface. Sampling of surface soils and boreholes through the overlying cover down to the original soil revealed only one soil sample from the athletic field with mercury contamination greater than the state guideline. That sample was collected 8–15 inches below the surface, at the depth of the original contamination. No surface samples exceeded the state guideline.

Scarboro area. Sixty-two samples were collected from two properties in the Scarboro area (Table 10.2.1 and Fig. 10.2.1). The soil mercury concentration ranged from 0.03 to 21 ppm, with seven samples exceeding the state interim guideline. The first property was a riding stable where the manager was concerned that possible contamination might affect the health of the horses. No elevated soil mercury levels were found on this property. The second property was the garden at a private residence where the owner felt that contaminated soil might have been brought in as a soil amendment. Seven soil samples from this garden exceeded the state guideline with a maximum value of 12 ppm.

West End Water Treatment Plant area. Two hundred forty-two samples were collected from a property located on the EFPC floodplain (Table 10.2.1 and Fig. 10.2.1). The soil mercury concentrations ranged from 0.03 to 2500 ppm, and 136 samples exceeded the state interim guideline. Many of these samples were collected in conjunction with the USGS shallow groundwater study.

Woodland area. Fifteen samples were collected on the Oak Ridge Civic Center property (Table 10.2.1 and Fig. 10.2.1), which was selected as a potential background area for future study. The soil mercury concentration range for this area was 0.05 to 0.35 ppm.

No other areas in the Oak Ridge community were sampled.

10.2.2. East Fork Poplar Creek Floodplain Studies

Soil mercury studies. Seven hundred twenty-six soil samples for depth profile studies were collected from the EFPC floodplain to characterize contaminants released from Oak Ridge Y-12 Plant operations to this area. This study partitioned the creek into four reaches (Table 10.2.2 and Fig. 10.2.2): Reach 1 from the point where the creek reenters the DOE Reservation in the west part of the city proceeding upstream to Wiltshire Drive; Reach 2 beginning at Wiltshire Drive to where the creek crosses the Oak Ridge Turnpike at Jefferson Avenue; Reach 3 beginning at the Jefferson Avenue crossing and ending at Vanderbilt Drive; and Reach 4 from Vanderbilt Drive to where the creek first emerges from the Oak Ridge Y-12 Plant site. Based on the data (Table 10.2.2), Reach 2 and Reach 4 appear to be two distinct areas of higher contamination. These areas have been targeted for investigation for remedial action. Figure 10.2.3 shows that the majority of the higher levels of contamination (greater than 100 ppm) are found at <70 cm from the surface. This may prove to be an important consideration in the selection of future remedial actions.

Multielement analysis. In addition to mercury, several other metals were released into the EFPC floodplain by Oak Ridge Y-12 Plant activities. The metals of concern and their descriptive statistics for the floodplain soils in this area are presented in Table 10.2.3. Because the analysis of each sample for all the identified constituents represents a substantial effort, it was felt that a single representative parameter should be used as a screen for others of concern. The indicator parameters which show greatest promise are mercury and uranium. Table 10.2.4 presents a Pearson multiple correlation coefficient matrix for all metals analyzed in EFPC floodplain soils. These data demonstrate a statistically significant correlation between mercury and all other metals present except lead. This correlation does not imply a common geochemistry, but indicates a common release source and deposition mechanism. The Pearson correlation shows how well the uncertainty in the data set is accounted

Table 10.2.2. Depth profile of soil mercury from selected areas along East Fork Poplar Creek

Reach	Sampling soil/depth (cm)		Hg concentration (ppm)			Number >50 ppm	% >50 ppm	Number >100 ppm	% >100 ppm
	Mean	Range	Mean	Range	n[a]				
1 (0–9,200 m)[b]	19.5	2.5–23	53.2	0.47–260	48	18	37.5	7	14.5
	34	25–43	72.6	0.6–188	9	5	55.5	2	22.2
	56	46–69	57.96	0.1–550	58	15	25.8	11	18.9
	90	71–112	56	0.15–300	31	9	29	7	22.5
	114	114–114	78	78–78	1	1	c	0	c
2 (9,201–11,500 m)	18	5–23	351	2.4–2800	56	42	75	37	66
	33	25–43	890	0.28–3900	56	41	73.2	40	71.4
	58	46–69	240	0.11–3000	53	21	39.6	17	32
	89	71–112	10	0.03–240	48	2	4.2	1	2.1
	145	114–226	1.8	0.06–11	39	0	0	0	0
3 (11,501–13,500 m)	18	10–23	36	0.02–190	17	6	35.3	1	5.9
	36	28–43	140	0.1–650	24	11	45.8	9	37.5
	58	46–69	95	0.11–530	17	6	35.3	5	29.4
	91	71–112	22	0.07–190	16	2	12.5	2	12.5
	152	114–196	3.3	0.02–45	15	0	0	0	0
4 (13,501–15,850 m)	15	2.5–23	305	0.41–2400	77	52	67.5	42	54.5
	33	25–43	386	0.03–2920	55	25	45.5	19	34.5
	58	46–69	113	0.03–2500	57	14	43.9	8	14
	90	71–109	4.4	0.02–73	46	1	2.1	0	0
	127	114–142	0.37	0.20–0.67	3	0	0	0	0

[a]n = sample size.
[b]0 meter position is at the reentry of East Fork Poplar Creek into the DOE Reservation in western Oak Ridge (Fig. 10.2.2). Distances proceed upstream from this point.
[c]Sample size of 1.

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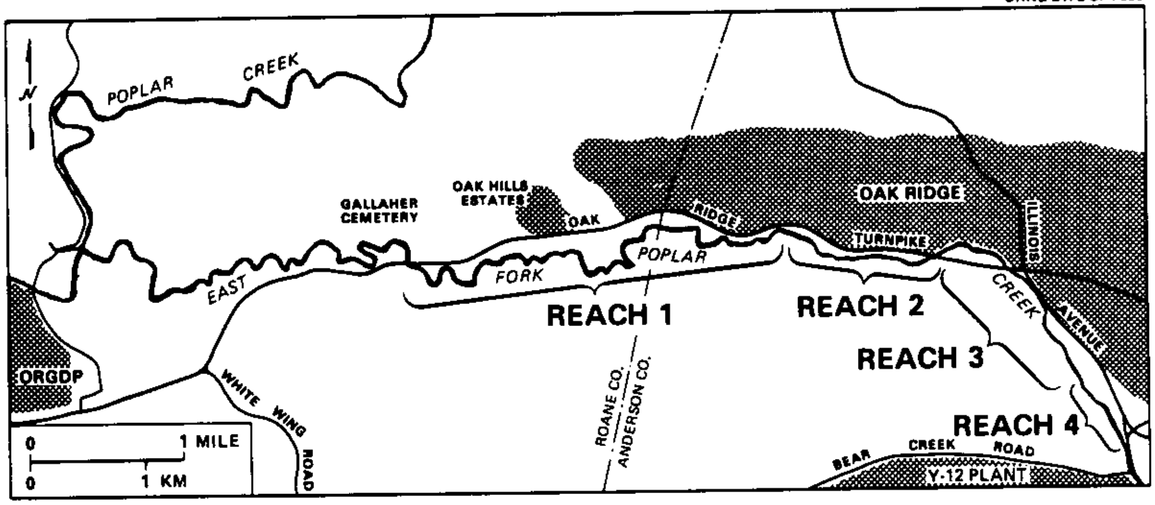

Fig 10.2.2. Reaches of East Fork Poplar Creek.

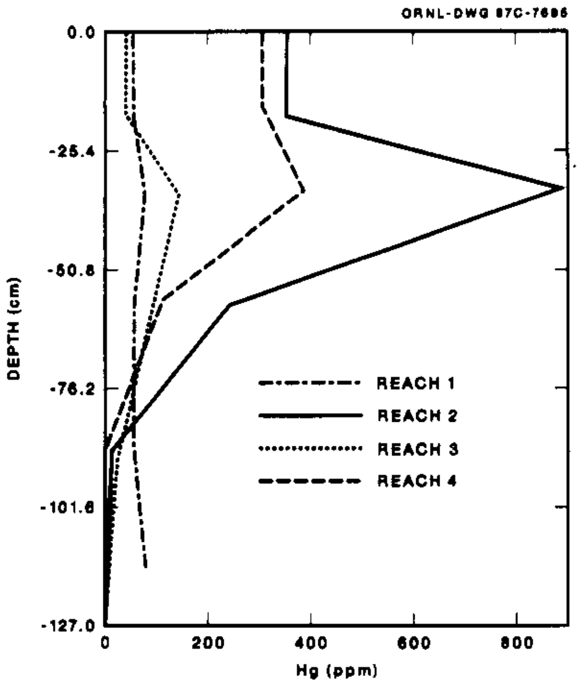

Fig. 10.2.3. Concentrations of mercury in soil as a function of depth.

for by the linear model and represents a level of sophistication in predictability not required for this effort. In effect, the question addressed by the Pearson approach is, "If one parameter is changed by some fraction (for instance 10%), how much will a correlated parameter change?" A simpler binary approach is suggested if one asks, "If an indicator parameter is elevated, will the other parameters be elevated also?" Table 10.2.5 presents the results of such an approach. In this table, the indicator parameter is mercury, and the two elevated levels used are 50 and 100 ppm. The reference level (the level above which the other metals are considered contamination) for the other metals is background. For example, from Table 10.2.5, if the soil mercury concentration is <50 ppm, then the chromium will be above background 7.5% of the time. Therefore, one would wrongly state 7.5% of the time that the chromium value was at background level when it was actually higher. The same interpretation of the row labeled Hg < 100:High Element may be made in this table. Table 10.2.6 presents the outcome if one uses twice background as contamination. In this case, one would wrongly conclude that the chromium is not elevated based on the mercury values <1% of the time. A similar approach is currently under investigation for uranium.

10.2.3 Terrestrial Food Chain Studies

The purpose of this effort is to determine whether the terrestrial food chain might be an important pathway for the intake of contaminants found on the EFPC floodplain. Paired soil and plant samples were collected to estimate the transfer of these contaminants from the soil to various parts of the plant. The uptake of contaminants from the soil by plants is species-specific, contaminant-specific, and related to the concentration of the contaminant in the soil.

The animal portion of the terrestrial food chain is represented by white-tailed deer, selected because it is consumed by humans and its assimilation of contaminants is similar to that of domestic livestock, both being ruminants. The animals analyzed were killed in automobile collisions in the vicinity of East Fork Poplar Creek.

10.2.4 Oak Ridge Water Treatment Plant

Routine quarterly samples of sewage sludge from the Oak Ridge Water Treatment Plant were collected and analyzed for the contaminants of concern. In addition, samples were collected from water treatment plants in Knoxville and Lenoir City for comparative purposes. The results are presented in Table 10.2.7.

10.2.5 Cooperative Studies

United States Geological Survey. At the request of the Oak Ridge Task Force, the USGS initiated a shallow groundwater study below the floodplain of East Fork Poplar Creek. The purpose of this study was to determine whether contamination in the soils on the floodplain has migrated into the groundwater. Several candidate sites suspected to contain high levels of soil contamination were selected. ORAU then collected and analyzed soil samples from these areas to characterize the

Table 10.2.3. Summary statistics for multielemental analysis of the soils from the East Fork Poplar Creek floodplain

	As	Ba	Be	Cd	Cr	Cu	Pb	Li	Hg	Ni	Se	Ag	Th	U	Zn
Number of observations	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242
Minimum concentration[a]	1.5	200	0.2	0.95	27	2.7	1.0	1.0	0.03	1.0	1.0	0.7	6.6	2.6	1.0
Maximum concentration[a]	20	2900	3.6	71	220	2600	3900	140	3700	500	15	82	160	240	510
Mean concentration[a]	8.4	461	1.1	8.0	76	89	84	17	280	56	2.2	5.5	21	29	131

[a]Units in ppm.

Table 10.2.4. Multiple correlations between various metals in the East Fork Poplar Creek floodplain soils
(242 observations)

	As	Ba	Be	Cd	Cr	Cu	Pb	Li	Hg	Ni	Se	Ag	Th	U	Zn
As	1.0														
Ba	0.55	1.0													
Be	0.38	0.29	1.0												
Cd	0.70	0.64	0.32	1.0											
Cr	0.71	0.38	0.37	0.59	1.0										
Cu	0.33	0.22	0.15	0.27	0.31	1.0									
Pb	0.08	−0.005	−0.06	0.05	0.08	0.03	1.0								
Li	0.74	0.75	0.36	0.84	0.58	0.38	0.06	1.0							
Hg	0.64[a]	0.63[a]	0.21[a]	0.83[a]	0.41[a]	0.22[a]	0.03	0.77[a]	1.0						
Ni	0.69	0.66	0.28	0.70	0.57	0.16	0.06	0.78	0.62[a]	1.0					
Se	0.61	0.74	0.25	0.66	0.39	0.43	0.02	0.74	0.76[a]	0.54	1.0				
Ag	0.57	0.52	0.38	0.61	0.61	0.20	0.05	0.59	0.46[a]	0.55	0.38	1.0			
Th	0.75	0.68	0.39	0.87	0.71	0.30	0.05	0.81	0.75[a]	0.68	0.66	0.67	1.0		
U	0.76	0.74	0.51	0.74	0.75	0.30	0.05	0.81	0.59[a]	0.74	0.61	0.71	0.85	1.0	
Zn	0.52	0.15	0.22	0.41	0.69	0.20	0.43	0.38	0.21[a]	0.43	0.12	0.46	0.44	0.5	1.0

[a]Significant correlation with mercury at 0.95 level.
Note: $r_{0.95} = 0.104$.

Table 10.2.5. Binary correlations between mercury and background levels of other metals in the East Fork Poplar Creek floodplain soils
(242 observations)

Comparison	As	Ba	Be	Cd	Cr	Cu	Pb	Li	Ni	Se	Ag	Th	U	Zn
Hg > 50:[a] Low element[b]	30 (12%)[c]	85 (35%)	21 (8.6%)	0 (0%)	101 (42%)	0 (0%)	1 (0.4%)	1 (0.4%)	103 (43%)	39 (16%)	4 (1.7%)	117 (48%)	0 (0%)	25 (10%)
Hg > 50: High element	87 (36%)	33 (14%)	96 (40%)	117 (48%)	16 (6.6%)	117 (48%)	116 (49%)	116 (49%)	14 (5.8%)	78 (32%)	113 (47%)	0 (0%)	117 (48%)	92 (38%)
Hg < 50: Low element	94 (39%)	2 (1%)	10 (4.1%)	82 (34%)	107 (44%)	50 (21%)	62 (26%)	82 (34%)	93 (38%)	51 (21%)	80 (33%)	101 (42%)	53 (22%)	97 (40%)
Hg < 50: High element	31 (13%)	123 (51%)	115 (47%)	43 (18%)	18 (7.5%)	75 (31%)	63 (26%)	43 (18%)	32 (13%)	74 (30%)	45 (19%)	24 (10%)	72 (30%)	28 (11%)
Hg > 100:[a] Low element	17 (7%)	63 (26%)	84 (35%)	0 (0%)	12 (4.9%)	0 (0%)	0 (0%)	0 (0%)	7 (2.9%)	24 (9.9%)	2 (0.01%)	2 (0.01%)	0 (0%)	21 (8.7%)
Hg > 100: High element	79 (33%)	33 (14%)	12 (4.9%)	96 (40%)	84 (35%)	96 (40%)	96 (40%)	96 (40%)	89 (37%)	72 (30%)	94 (39%)	94 (39%)	96 (40%)	75 (31%)
Hg < 100: Low element	107 (44%)	144 (59%)	19 (7.9%)	82 (34%)	111 (46%)	50 (21%)	63 (26%)	83 (34%)	100 (41%)	66 (27%)	82 (34%)	108 (45%)	53 (22%)	101 (42%)
Hg < 100: High element	39 (16%)	2 (0.8%)	127 (52%)	64 (26%)	35 (14%)	96 (40%)	83 (34%)	63 (26%)	46 (19%)	80 (33%)	64 (26%)	38 (16%)	93 (38%)	45 (19%)

[a] 50 and 100 are soil mercury concentrations in ppm.
[b] Low element is the background level of that element, and high element is any value exceeding background.
[c] Percent values may not add to 100% due to round-off errors.

Table 10.2.6. Binary correlations between mercury and twice background levels of other metals in the East Fork Poplar Creek floodplain soils
(242 observations)

	As	Ba	Be	Cd	Cr	Cu	Pb	Li	Ni	Se	Ag	Th	U	Zn
Hg > 50:[a] Low element[b]	106 (44%)[c]	115 (47%)	106 (44%)	16 (6.6%)	107 (44%)	113 (47%)	48 (20%)	37 (15%)	58 (24%)	41 (17%)	6 (2.5%)	41 (17%)	1 (0.4%)	103 (43%)
Hg > 50:[a] High element	11 (4.5%)	2 (0.8%)	11 (4.5%)	101 (42%)	10 (4.1%)	4 (1.6%)	69 (29%)	80 (33%)	59 (24%)	76 (31%)	111 (46%)	76 (31%)	116 (48%)	14 (5.8%)
Hg < 50: Low element	125 (52%)	125 (52%)	121 (50%)	112 (46%)	124 (51%)	71 (29%)	97 (40%)	109 (45%)	113 (47%)	69 (29%)	101 (42%)	84 (35%)	68 (28%)	123 (51%)
Hg < 50: High element	0 (0%)	0 (0%)	4 (1.7%)	13 (5.4%)	1 (0.4%)	54 (22%)	28 (11%)	16 (6.6%)	12 (4.9%)	56 (23%)	24 (9.9%)	41 (17%)	57 (23%)	2 (0.8%)
Hg > 100:[a] Low element	85 (35%)	94 (39%)	85 (35%)	6 (2.5%)	86 (35%)	3 (1.2%)	37 (15%)	22 (9.1%)	43 (18%)	26 (11%)	2 (0.8%)	54 (22%)	0 (0%)	83 (34%)
Hg > 100:[a] High element	11 (4.5%)	2 (0.8%)	11 (4.5%)	90 (37%)	10 (4.1%)	93 (38%)	59 (24%)	74 (31%)	53 (22%)	70 (29%)	94 (39%)	42 (17%)	96 (40%)	13 (5.4%)
Hg < 100:[a] Low element	146 (60%)	146 (60%)	142 (59%)	122 (50%)	145 (60%)	71 (29%)	108 (45%)	124 (51%)	128 (53%)	84 (35%)	105 (43%)	145 (60%)	69 (29%)	143 (59%)
Hg < 100: High element	0 (0%)	0 (0%)	4 (1.6%)	24 (9.9%)	1 (0.4%)	75 (31%)	38 (16%)	22 (9%)	18 (7.4%)	62 (26%)	41 (17%)	1 (0.04%)	77 (32%)	3 (1.2%)

[a]50 and 100 are soil mecury concentrations in ppm.
[b]Low element is twice background of the element, and high element is any value exceeding these levels.
[c]Percent values.

Table 10.2.7. Analysis of sewage sludge from Oak Ridge, Knoxville, and Lenoir City
(values except solids are ppm)[a]

Element	Oak Ridge (01/31/86)	Oak Ridge (04/18/86)	Oak Ridge (07/02/86)	Oak Ridge (10/03/86)	Knoxville (10/22/86)	Lenoir City (10/22/86)
Solids (%)	2.42	2.92	1.54	1.03	3	17
As	4.5	4.6	4.1	4.8	8.1	6.0
Ba	1000	850	650	860	480	590
Be	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cd	7.4	7.9	4.8	7.4	6.1	6.7
Cr	420	330	360	700	210	160
Cu	650	720	530	610	300	320
Pb	190	170	110	140	110	230
Li	3.6	4.5	3.4	3.0	3.9	2.6
Hg	20	25	20	13	2.2	5.5
Ni	45	55	33	40	45	30
Se	7.0	6.7	6.0	7.0	2.3	4.4
Ag	100	115	90	110	50	27
Th	2.3	2.5	1.8	1.8	3.7	3.0
U	46	49	49	90	2.3	3.2
Zn	2200	2100	1900	2000	900	1700

[a]Concentrations on a dry weight basis.
Note: Sludge averaged ~3% solids.

amount and vertical distribution of the contamination. Based on the results, 13 shallow wells were placed in the floodplain. Two background shallow wells were placed in an uncontaminated location at the Civic Center. Two additional wells were established in Knoxville to serve as urban "background" wells. The soils at these sites were analyzed to ensure their suitability for background sampling. All wells are now in place.

EP toxicity sampling. ORAU assisted Ralph Turner of ORNL's Environmental Sciences Division in identifying areas where specific contaminants were elevated so that samples could be collected for toxicity testing. Details are given in Vol. I of this report (Sect. 12.1.5).

Engineering aspects of remedial action. DOE has contracted with Advanced Sciences Incorporated (ASI) to develop a Remedial Alternatives Engineering Evaluation on the EFPC floodplain. ORAU assisted in this effort by identifying areas with the highest levels of contamination. ORAU also participated in reviewing preliminary documents produced in this study.

10.2.6 Sampling in Surrounding Communities

Harriman/Kingston area. Several residents in the Harriman/Kingston area who expressed concern that DOE activities would result in contamination of their well water supplies requested sampling of their groundwater. Sampling was performed in the general area of Sugar Grove Valley Road and Gallagher Road. The Sugar Grove Valley Road residents' request was for mercury and strontium-90 only. The analytical results showed concentration ranges of <0.01–0.07 ppb for mercury and <0.5–0.75 pCi/L) for strontium-90. The regulatory limits for these two parameters in community water systems are given in 40 CFR Pt. 141.11 and 40 CFR Pt. 141.16 as 2 ppb for mercury and 8 pCi/L for ^{90}Sr. The Gallagher Road residents' request was for mercury, arsenic, lead, cadmium, PCBs, chromium, beryllium, cyanide, lithium, uranium, nickel, selenium, strontium-90, tritium, and gross alpha and beta activity. The mercury, PCBs, and cyanide analyses have been completed. The mercury values ranged from 0.04–0.23 ppb, and the PCBs were below detection limit of

5 ppb. The cyanide values were below the detection limit of 22 ppb, which is 100 times less than maximum concentration levels defined by EPA (EPA, 1980).

Knoxville area. Three locations in the Knoxville area were sampled—Ebenezer Road, First Creek, and Peters Road. These sites will serve as urban background sites for future studies. The analytical results for soil mercury are summarized in Table 10.2.8.

Table 10.2.8. Summary of the soil mercury concentrations found in the Knoxville sampling sites

Location	Number of observations	Range (ppm)	Mean (ppm)
Ebenezer Road	8	0.08–0.20	0.13
First Creek	3	0.13–0.40	0.23
Peters Road	25	0.03–0.18	0.08

11. RADIATION AND CHEMICAL DOSES TO THE PUBLIC AND RISK CALCULATIONS

11.1 INTRODUCTION

The International Commission on Radiological Protection (ICRP) has stated that when one or more body organs are exposed to radiation, the irradiation of one particular organ or tissue is likely to be of greatest importance because of (1) the dose it received, (2) its sensitivity to radiation, or (3) the importance to health of any damage that results. That tissue or organ was referred to as the critical organ. The ICRP now recommends a procedure that takes into account the total risk attributable to the exposure of all tissues irradiated. This dose is now referred to as the effective dose equivalent. General terms applicable to the discussion are:

- 50-year committed dose equivalent—the dose equivalent that will be delivered to a specified organ over the 50 years post intake of radionuclide. These can be calculated for all organs and tissues.
- (commited) effective dose equivalent—the weighted sum of dose equivalents to a person's organs and tissues as specified (both the organs and their weighting factors) by the ICRP.

Exposures to radionuclides that originate in the effluents released from the DOE installations in Oak Ridge were converted to estimates of radiation dose to individuals using models and data presented in publications of the ICRP (ICRP, 1975a, 1975b, 1977, 1978), other recognized literature on radiation protection (Hine and Brownell, 1972; Morgan and Turner, 1967; Snyder et al., 1973), and computer programs incorporating some of these models and data (Turner et al., 1968; Trubey and Kaye, 1973). Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until it is removed by processes of metabolism or radioactive decay; thus, the estimates for internal dose are called "committed dose equivalents" because they are obtained by integrating over the assumed remaining lifetime (50 years) of the exposed individual.

Radiation doses to the total body and to the internal organs from external exposure to penetrating radiation are approximately equal, but vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation to the major organs such as (but not limited to) thyroid, lungs, and bone were considered for various pathways of exposure. These estimates were based on parameters applicable to an average adult (ICRP, 1975b). The collective effective dose estimate is the sum of the committed effective dose equivalents to exposed individuals within an 80-km radius of the DOE Oak Ridge installations.

Gaseous effluents are discharged from several locations within each DOE installation in Oak Ridge. For purposes of calculation, the gaseous discharges are assumed to occur from only one vent each at Oak Ridge Y-12 Plant and ORNL and two vents at ORGDP. As suggested by the EPA, no plume rise resulting from momentum (zero velocity stack discharge) was incorporated into the modeling program for Oak Ridge Y-12 Plant, which has caps or vents out the sides of buildings. Meteorological data collected at the ORNL and Oak Ridge Y-12 Plant sites in 1986 were used for dispersion calculations for the two sites. Meteorological wind data at ORGDP collected in 1986 were used for the ORGDP site. Concentrations of radionuclides in air and deposited on the ground were estimated at distances up to 80 km from the DOE installations (Pasquill, 1962; Gifford, 1962; Moore et al., 1979; Begovich et al., 1981; Dunning et al., 1980; Sullivan et al., 1981).

11.1.1 Calculation of Potential Radiation Dose to the Public from Airborne Releases

Potential radiation doses to the nearest resident off-site individual, to the nearest population groups, and to the population within 80 km of the Oak Ridge Y-12 Plant were calculated. The calculations were made using computerized dispersion modeling techniques developed under the sponsorship of the EPA. The computer codes utilize Oak Ridge Y-12 Plant radioactivity emission data for 1986, local meteorological data from the meteorological tower at Oak Ridge Y-12 Plant, and dose conversion factors based on guidelines of the EPA. Organ weighting factors used in estimating committed effective dose equivalents are also based on ICRP recommendations. A whole-body dose equivalent was estimated for comparison with the NESHAP regulatory limit of a 25-millirem whole-body dose. The whole-body dose equivalent resulting from radionuclides that are not deposited throughout the body is zero for internal exposure (United Nations, 1982). The 50-year dose conversion factors for inhalation are given in Table 11.1.1 and for ingestion are given in Table 11.1.2. The dose-rate conversion factors for air immersion are given in Table 11.1.3 and for ground surfaces are given in Table 11.1.4.

A total of 0.13 Ci of uranium was released by the Oak Ridge Y-12 Plant in 1986. Because the chemical composition and assay are unavailable, it is assumed that the uranium was all ^{234}U with one-third of the total release chemically soluble in the lung (D-solubility), one-third moderately soluble (W-solubility), and one-third insoluble (Y-solubility). The uranium was released at a height of 20 m.

The whole-body dose equivalents are shown in Table 11.1.5. The whole-body dose is estimated to be 0.00026 millirem (well below the 25-millirem limit).

Also included in Table 11.1.5 are the effective 50-year dose commitments and various organ doses that result from both internal and external exposure. The committed effective dose equivalent from the Oak Ridge Y-12 Plant is 2 millirem for inhalation and ingestion of airborne releases. Ingestion doses were calculated assuming that, for the nearest resident (located approximately 570 m north-northwest), one-third

Table 11.1.1. Committed effective dose equivalent—inhalation[a]

Radionuclide (solubility)		rem/μCi		
		Bone[b]	Lung	Thyroid
^{3}H		0.000099	0.000125	0.000124
^{85}Kr		0.00000049	0.000002	0.00000049
^{99}Tc		0.000176	0.00132	0.00454
^{131}I		0.000198	0.0025	1.08
^{133}Xe		0.00000050	0.0000014	0.000000571
^{234}U	(D)	39.7	1.2	0.0986
	(W)	11.9	60	0.0432
	(Y)	4.05	1098	0.00985
^{235}U	(D)	40.2	1.11	0.096
	(Y)	3.95	1016	0.0155
^{238}U	(D)	36.1	1.06	0.0886
	(Y)	3.53	978	0.0105

[a]Dose factors as they appear in EPA Clean Air Act tapes. Note: Number of significant figures is based on what was used from the tapes.

[b]Endosteal tissue of the bone.

Table 11.1.2. Committed effective dose equivalent—ingestion[a]

Radionuclide (solubility)		rem/μCi		
		Bone[b]	Lung	Thyroid
^{3}H		0.0000656	0.0000836	0.0000828
^{85}Kr		*c*	*c*	*c*
^{99}Tc		0.000231	0.000231	0.00598
^{131}I		0.000288	0.000367	1.67
^{133}Xe		*c*	*c*	*c*
^{234}U	(D)	4.06	0.0096	0.0096
	(W)	4.06	0.0096	0.0096
	(Y)	0.163	0.000384	0.000384
^{235}U	(D)	3.93	0.0094	0.0094
	(W)	3.93	0.0094	0.0094
	(Y)	0.157	0.000387	0.000376
^{238}U	(D)	3.52	0.0087	0.0087
	(W)	3.52	0.0087	0.0087
	(Y)	0.141	0.000346	0.000346
^{244}Cm	(W)	40.0	0.050	0.050

[a]Dose factors as they appear in EPA Clean Air Act tapes. Note: Number of significant figures is based on what was used from the tapes.

[b]Endosteal cells of the bone.

[c]Dose factor of 0.

Table 11.1.3. Committed effective dose equivalent—air immersion[a]

Radionuclide (solubility)	rem/μCi		
	Bone[b]	Lung	Thyroid
^{3}H	c	c	c
^{85}Kr	11,400,000	9,730,000	12,100,000
^{99}Tc	3,650	2,090	3,070
^{131}I	2,020,000,000	1,640,000,000	2,070,000,000
^{133}Xe	230,000,000	130,000,000	200,000,000
^{234}U	710,000	411,000	607,000
^{235}U	936,000,000	632,000,000	851,000,000
^{238}U	451,000	250,000	377,000

[a]Dose factors as they appear in EPA Clean Air Act tapes. Note: Number of significant figures is based on what was used from the tapes.

[b]Endosteal cells of the bone.

[c]Dose factor of 0.

Table 11.1.4. Committed effective dose equivalent—ground surface[a]

Radionuclide	rem/μCi		
	Bone[b]	Lung	Thyroid
^{3}H	c	c	c
^{85}Kr	2,350	2,010	2,490
^{99}Tc	0.862	0.492	0.725
^{131}I	429,000	347,000	437,000
^{133}Xe	62,900	35,600	57,000
^{234}U	295	174	231
^{235}U	207,000	139,000	188,000
^{238}U	209	121	157

[a]Dose factors as they appear in EPA Clean Air Act tapes. Note: Number of significant figures is based on what was used from the tapes.

[b]Endosteal cells of the bone.

[c]Dose factor of 0.

Table 11.1.5. Calculated dose from airborne releases and risks to the nearest resident

Dose[a] millirem (millisievert)					Fatal cancer risk[d]
Whole-body dose	Effective[b] dose	Bone[c]	Lung	Thyroid	
		Y-12 Plant[e,f]			
0.00026 (0.0000026)	2.0 (0.020)	1.03 (0.0103)	15.9 (0.159)	0.003 (0.00003)	0.00000025
		ORNL[g,h]			
0.5 (0.005)	0.5 (0.005)	0.42 (0.0042)	0.5 (0.005)	0.51 (0.0051)	0.00000006
		ORGDP[i,j]			
0.0000000~~023~~ 67	0.0000~~2~~9 7	0.000~~0099~~ 57	0.0000~~097~~ 24	0.00024	0.00000000000~~3~~ 1
		Max			
~0.5 (0.005)	2.5 (0.02)	~1 (0.01)	<16 (0.16)	<0.6 (0.006)	0.00000031

[a]Fifty-year dose commitment.

[b]Weighted sum dose.

[c]Endosteal cells of the bone.

[d]Risk from one-year exposure was calculated to be 1.25×10^{-7} per millirem using methods from (United Nations, 1982).

[e]Nearest resident is 570 m NNW.

[f]Whole-body doses for uranium are from external doses only because it is not deposited throughout the body. Uranium considered one-third chemically soluble in lung (D-solubility), one-third moderately soluble (W-solubility), and one-third insoluble (Y-solubility).

[g]Nearest resident is 3048 m WSW.

[h]Whole-body doses for iodine, xenon, and krypton are from external doses only since they are not deposited throughout the body. The dose from ^{3}H includes internal as well as external pathways.

[i]Nearest resident is 3000 m WSW.

[j]Whole-body doses are from external doses only since they are not deposited throughout the body.

of his food was grown in his own backyard and two-thirds was imported from outside the 80-km region (i.e., uncontaminated). The primary pathway of exposure is inhalation.

For population doses, it was again assumed that one-third of the food consumed was grown locally and two-thirds was imported. The whole-body dose equivalent to the population within 80 km was estimated to be 0.006 millirem (external dose only). The committed effective dose equivalent to the population is shown in Table 11.1.6 to be 28 millirem, due primarily to inhalation.

Table 11.1.6. Collective committed (50-year) dose equivalents to population within 80 km

Installation	Person-rem	Person-sievert	Risk
Y-12 Plant	28	0.28	0.0035
ORNL	16.5	0.165	0.0021
ORGDP	0.003	0.00003	0.0000004
Total	<45	0.45	0.0056

The whole-body dose equivalents from ORNL releases are included in Table 11.1.5. The whole-body dose equivalent from all radionuclides except ^{3}H is from external exposure only. The whole-body dose equivalent from ^{3}H includes both external and internal pathways since hydrogen is considered to be deposited throughout the body.

The whole-body dose for inhalation and ingestion of airborne releases is estimated to be 0.5 millirem (well below the 25-millirem limit). This dose includes external doses from all of the nuclides released plus the internal contribution from ^{3}H. Ingestion doses were calculated assuming that, for the nearest resident (located approximately 3048 m west-southwest), one-third of the food consumed was grown in his own backyard and two-thirds was imported from outside the 80-km region. The effective 50-year dose commitment is also estimated to be 0.5 millirem. The primary pathways of exposure are ingestion and air immersion. The radionuclides contributing to the effective dose are ^{3}H and ^{133}Xe.

For population doses, it was again assumed that one-third of the food consumed was grown locally and two-thirds was imported. The whole-body dose equivalent to the population within 80 km was estimated to be 16.4 millirem (external dose from all nuclides plus the internal dose from ^{3}H). The effective 50-year dose commitment to the population is shown in Table 11.1.6 to be 16.5 millirem, due primarily to inhalation.

The whole-body dose equivalent from all radionuclide releases at ORGDP results from external exposure only (i.e., ground deposition and immersion in air), since uranium does not deposit throughout the body. Stacks K-1420 and K-1421 were treated as separate release points. The estimated source terms for each stack are included in Table 11.1.7.

The whole-body dose equivalents from radionuclides released from both stacks are included in Table 11.1.5. The total whole-body dose is estimated to be 0.0000000023 (2.3×10^{-9}) millirem (well below the 25-millirem limit). This dose is from external exposure from all of the nuclides released.

Table 11.1.7. 1986 stack and release data for ORGDP[a]

Stack	Height (m)	Assay[b] (%)	Emissions (Ci/year)			
			^{234}U	^{235}U	^{238}U	^{99}Tc
K-1420	16.15	1.0	5.5×10^{-9}	2.7×10^{-9}	4.2×10^{-8}	c
K-1421	7.6	1.0	8.5×10^{-5}	4.2×10^{-6}	6.5×10^{-5}	3.8×10^{-3}

[a] Uranium considered chemically soluble in lung (D-solubility).
[b] Percent enrichment of ^{235}U.
[c] No ^{99}Tc released.

Ingestion doses were calculated assuming that, for the nearest residents (located approximately 3000 m west-southwest), one-third of their food was home grown and two-thirds was imported from outside the 80-km region. The total 50-year committed dose equivalent for inhalation and ingestion of airborne releases is estimated to be 0.000027 (2.7×10^{-5}) millirem. The primary pathway of exposure is ingestion; inhalation and air immersion also contributes. The radionuclides contributing to the dose are primarily ^{99}Tc from stack K-1421 and ^{234}U from stack K-1420. The effective 50-year dose commitment within the 80-km region is shown to be 0.009 millirem (weighted sum dose).

11.1.2 National Emission Standards for Hazardous Air Pollutants (NESHAP)—Radionuclides

The EPA recently issued final NESHAP regulations under Section 112 of the Clean Air Act (CAA) for the control of airborne radionuclide emissions, as was ordered by a 1983 U.S. district court decision. Although the EPA had concluded that current emission controls and operational practices at DOE installations provide an adequate margin of safety in protecting the public health from the hazards associated with exposure to airborne radionuclide emissions, it was forced by the 1983 court decision to issue hazardous air pollution regulations for radionuclides.

Recently issued regulations for airborne radionuclide emissions limit total installation off-site radiological dosages to a dose equivalent rate no greater than 25 millirem/year whole body, 75 millirem/year to any organ of any person. This represents a substantial reduction over the DOE prevailing standards of 100 millirem/year whole body, 500 millirem/year maximum critical organ. The final NESHAP regulations omitted all the originally proposed requirement for strict individual emission source control; compliance with the new NESHAP radionuclide standards is based solely on the ability of the installation to meet the 25/75 dose equivalent limits. The annual radionuclide air emission report per 40 CFR Pt. 61.94 for Oak Ridge Y-12 Plant, ORNL, and ORGDP is given in Table 11.1.8.

Table 11.1.8. 1986 annual radionuclide air emission report 40 CFR pt 61.94

Y-12 Plant[a]

SECTION I: Air emissions

Radionuclide	*Quantity (Ci/year)*
Uranium	0.019

SECTION II: Methods for dose assessment

Methods used in evaluating the doses from air emissions: AIRDOS-EPA and RADRISK

SECTION III: Dose estimates

External and uniform irradiation

EPA air emission standard—25 millirem/year
Whole body dose equivalent 0.00026 millirem/year

Internally deposited radionuclides

EPA air emission standard—75 millirem/year

Organ No. 1
15.9 millirem/year lung

Organ No. 2
1.03 millirem/year bone

ORNL[b]

SECTION I: Air emissions

Radionuclide	*Quantity (Ci/year)*
^{131}I	<0.035
^{3}H	31,000
^{133}Xe	51,000
^{85}Kr	10,600

SECTION II: Methods for dose assessment

Methods used in evaluating the dose from the air emissions: AIRDOS-EPA and RADRISK and thermoluminescent dosimetry and dose assessment

SECTION III: Dose estimates

External and uniform irradiation

EPA air emission standard—25 millirem/year
Whole-body dose equivalent 0.5 millirem/year

Internally deposited radionuclides

EPA air emission standard—75 millirem/year

Organ No. 1
0.42 millirem/year bone

Organ No. 2
0.5 millirem/year lung

Organ No. 3
0.51 millirem/year thyroid

Table 11.1.8 (continued)

ORGDP[c]

SECTION I: Air emissions

Radionuclide	*Quantity (Ci/year)*
^{234}U	8.08×10^{-8}
^{235}U	4.14×10^{-7}
^{238}U	6.50×10^{-8}
^{99}Tc	0.0038

SECTION II: Methods for dose assessment

Methods used in evaluating the dose from air emissions: AIRDOS-EPA and RADRISK

SECTION III: Dose estimates

External and uniform irradiation

EPA air emission standard—25 millirem/year
Whole-body dose equivalent 0.0000000~~025~~ (67) millirem/year

Internally deposited radionuclides

EPA air emission standard—75 millirem/year

Organ No. 1
0.000~~0099~~ (57) millirem/year bone
Organ No. 2
0.0000~~097~~ ([illegible]24) millirem/year lung
Organ No. 3
0.00024 millirem/year thyroid

[a]Owner: U.S. Department of Energy; Operations Office: Oak Ridge, Tennessee; Site operator: Martin Marietta Energy Systems, Inc.; Site address: ORY-12 Plant, Bear Creek Road, Oak Ridge, TN 37831.
[b]Owner: U.S. Department of Energy; Operations Office: Oak Ridge, Tennessee; Site operator: Martin Marietta Energy Systems, Inc.; Site address: Oak Ridge National Laborabory, P.O. Box X, Oak Ridge, TN 37831.
[c]Owner: U.S. Department of Energy; Operations Office: Oak Ridge, Tennessee; Site operator: Martin Marietta Energy Systems, Inc.; Site address: Post Office Box P, Oak Ridge, TN 37831.

11.1.3 Doses from Drinking Water

Water is sampled at White Oak Dam to determine discharges of radionuclides to the Clinch River. Based on radionuclide concentrations measured at White Oak Dam and the dilution afforded by the Clinch River (assuming complete mixing), a 0.1-millirem calculated effective dose equivalent results from consumption of Clinch River water at CRK 33.3. Water is also sampled at the inlet to the ORGDP water plant, which is the closest (14 km) nonpublic water supply downstream from DOE discharges. Assuming that (1) the water is consumed at a rate of a 730 L/year and (2) the treated water contains the same amount of radionuclides as the sampled inlet water, the calculated committed effective dose equivalent would be 0.26 millirem. The public water supply closest to the DOE installations' liquid discharges is located about 26 km downstream at Kingston, Tennessee. The intake to the water filtration plant is located on the Tennessee River about 0.8 km upstream from the confluence of the Clinch and Tennessee rivers. Normally, Tennessee River water is used for the Kingston water supply, but under certain conditions backflow can occur. Under backflow conditions, Clinch River water may move upstream in the Tennessee River and be used as the source of water for the Kingston filtration plant (see Table 11.1.9). Measurements of treated river water samples taken at the Kingston filtration plant indicate that the maximum dose resulting from the ingestion of the adult daily requirement (730 L/year) is 0.11

Table 11.1.9. Dose from drinking water[a]

Location	Dose[b] (millirem)			
	Effective total-body[c]	Endosteal bone[b]	Kidneys	Stomach wall
Melton Hill Dam (W1)	0.94	7.4	1.7	0.38
Confluence of White Oak Creek and Clinch (W2)	1.4	9.1	2.0	0.82
Gallaher process water (W36)	0.26	1.8	0.10	0.35
ORNL tap water	0.081	0.69	0.0074	0.17
Kingston Water Plant (W55)	0.11	0.083	0.03	0.25
Bear Creek (W46)	18	23	44	1.9
East Fork Poplar Creek (W45)	18	23	38	1.0

[a]Ingestion of 730 L of water per year.
[b]Fifty-year dose commitment.
[c]Weighted sum dose.
[d]Endosteal cells of the bone.

millirem effective total body and 0.25 millirem to the stomach wall. The annual effective dose equivalent from drinking ORNL tap water (derived from Melton Hill Lake) was 0.69 millirem to the bone's endosteal cells and 0.081 millirem for the committed effective dose equivalent. Estimated radiation doses from ingestion of water are given in Table 11.1.9. The highest effective total-body dose (18 millirem) assumed drinking 730 L/year of water from East Fork Poplar Creek and 44 millirem from Bear Creek. No one is known to drink any water from East Fork Poplar Creek or Bear Creek—this is the worst-case assumption.

11.1.4 Calculation of Potential Radiation Dose to the Public from Ingestion of Clinch River Fish

Fish were collected and analyzed, and results are given in Sect. 8.1. The calculations were based on concentrations of eight radionuclides in the flesh of bluegill. The calculated doses depend on the multiplication of an assumed rate of ingestion of 21 kg of fish in a year and the dose conversion factors given in Table 11.1.1 for the ingestion of each of the eight radionuclides. The 50-year committed effective dose equivalents from consumption of Clinch River fish are given in Table 11.1.10. These results indicate that the highest doses are at Clinch River kilometer (CRK) 33.3.

From the analysis of edible parts of the fish, the maximum effective total-body dose to an individual is estimated to be 0.77 millirem. Dose to the endosteal cells of the bone is estimated to be 1.2 millirem.

11.1.5 Dose from Consumption of Milk

An important contribution to dose from radioactivity within the terrestrial food chain is through the atmosphere→pasture→cow→milk pathway. Measurements of ^{90}Sr, the principal radionuclide entering this pathway, indicate that the maximum effective dose to an individual in the immediate area from ingestion of 310 L of milk per year is 0.14 millirem effective total-body and 1.0 millirem to the critical organ, bone endosteal cells. Another radionuclide of concern in milk is ^{131}I, which would result in 1.6 millirem to the thyroid. The dose from drinking milk is given in Table 11.1.11.

11.1.6 Maximum Direct Radiation Exposure

The point of maximum potential ("fence-post") direct radiation exposure on a site boundary is located along the bank of the Clinch River at external gamma radiation measurement location

Table 11.1.11. Dose from drinking milk[a]

Station	Dose (millirem)		
	Effective total-body	Endosteal bone	Thyroid
M1	0.076	0.35	1.3
M2	0.079	0.37	1.3
M3	0.11	0.61	1.6
M4	0.11	0.67	1.2
M5	0.092	0.53	1.2
M6	0.14	1.0	1.2
M11	0.078	0.40	1.2
M13	0.067	0.29	1.2
M14	0.070	0.31	1.2

[a]Ingestion of 310 L of milk per year.

Table 11.1.10. Dose from eating fish[a]

Location	Dose (millirem)			
	Effective total-body	Endosteal bone	Liver	Stomach wall
CRK 8.0	0.16	0.42	0.13	0.036
CRK 33.3	0.77	1.2	0.68	0.19
CRK 40.0	0.020	0.11	0.0093	0.0028

[a]Ingestion of 21 kg of fish per year.

T50. The maximum dose results primarily from "sky shine" from an experimental plot in the ^{137}Cs field (0800 area). This dose equivalent was calculated to be 310 millirem, assuming that an individual remained at this point 24 h/d for the entire year (worst case). The probability of exposure at this location is considered remote because the area is normally accessed only by boat. The total-body dose to a "hypothetical maximally exposed individual" at the same location was calculated using the more realistic upper limit residence time of 250 h/year. The calculated dose equivalent under these conditions was 8.8 millirem, which represents a probable upper limit of exposure (assuming 5 h/week fishing at this location). The results are given in Table 11.1.12. The doses from ORR and remote locations are given in Table 11.1.13.

11.1.7 Doses from Air Monitoring Data

Air concentrations of radionuclides are determined at various locations in Oak Ridge. Assuming an inhalation rate of 8000 m^3/year, the doses are given in Table 11.1.14.

11.1.8 1986 Summary of Effective and Critical Organ Doses

A summary of the 1986 effective and critical organ doses from each of the pathways is given in Table 11.1.15.

Table 11.1.12. Dose from external gamma radiation along the Clinch River

	Dose (millirem)	
	Worst case (24 h/d)	Hypothetical maximally exposed individual[a]
T45	120	3.5
T46	160	4.5
T47	160	4.5
T48	160	4.5
T49	220	6.2
T50	310	8.8
T51	310	8.8
T52	245	7.0
T53	190	5.5
T54	140	4.0

[a]250 h/year assuming 5 h/week fishing at this location.

Table 11.1.13. External doses at locations on and off the ORR

Station	Dose (millirem)[a] total-body dose
ORR locations	
T6	71.9
T7	63.1
G31	68.4
G33	67.5
G34	80.6
G36	64.9
G40	71.0
G41	71.9
G42	65.7
G43	61.4
G44	63.1
G45	64.0
G46	63.1
Remote	
T19	57.9
T20	71.0
T21	68.4
T22	43.8
T23	50.8
T24	67.5

[a]Assuming at this location 24 h/d.

Table 11.1.14. Doses from air monitoring data[a]

Station	Dose (millirem)			
	Effective total-body	Lungs	Kidneys	Endosteal bone
A36	0.46	3.2	0.0095	2.2
A41	0.74	5.4	0.018	3.3
A46	0.85	6.0	0.016	2.2

[a]Inhalation rate of 8000 m^3/year; radionuclide particulates assumed to be 1 μ in diameter and lung solubility class Y.

11.2 CALCULATIONS OF POTENTIAL CHEMICAL DOSE TO THE PUBLIC

Health criteria for water were set such that chemical intake from consumption of 2 L of water per day would not exceed the acceptable daily intake (ADI). For noncarcinogenic toxic chemicals, the safe level of exposure is the intake of a toxicant (measured in micrograms per day) that is not anticipated to result in any adverse

Table 11.1.15. Summary of the estimated radiation dose to an adult during 1986 at locations of maximum exposure

Pathway	Location	Effective dose (millirem)[a]	Critical organ (millirem)[a]
Gaseous effluents	Nearest resident to Y-12 Plant (570 m NNW)	2.0	15.9 (Lung)
Inhalation plus direct	Nearest resident to ORNL (3048 M WSW)	0.5	0.51 (Thyroid)
radiation from air, ground,	Nearest resident to ORGDP (3000 M WSW)	0.000027	0.00024 (Thyroid)
and food chains	Maximum from all three facilities	2.5	16 (Lung
Air monitoring data	A36, A41, A46	0.85	6.0 (Lung) 1.6 (Endosteal bone)
Terrestrial food chain (milk)	Milk sampling stations (^{90}Sr, ^{131}I)	0.14	1.0 (Endosteal bone) 1.6 (Thyroid)
Liquid effluents			
Aquatic food chain	Clinch River System		
Flesh		0.77	1.2 (Endosteal bone)
Drinking water	Clinch River km 40.0	0.94	7.4 (Endosteal bone) 1.7 (Kidneys) 0.38 (Stomach wall)
	Clinch River km 33.3	1.4	9.1 (Endosteal bone) 2.0 (Kidneys) 0.82 (Stomach wall)
	Clinch River km 19.2	0.26	1.8 (Endosteal bone) 0.10 (Kidneys) 0.35 (Stomach wall)
	ORGDP ORNL tap water	0.081	0.69 (Endosteal bone) 0.0074 (Kidneys) 0.17 (Stomach wall)
	Kingston	0.11	0.083 (Endosteal bone) 0.03 (Kidneys) 0.25 (Stomach wall)
Direct radiation along water, shores, and mud flats	Clinch River km 33.3 to 33.0	8.8 (250 h/year)	

[a]Millisievert = 100 millirem.

effects after chronic exposure to the general human population including sensitive subgroups (Hoffman et al., 1984). For carcinogenic chemicals, there is no accepted threshold limit. For the purposes of this document, a specific risk of developing cancer over a human lifetime of 1 in 100,000 was used to establish acceptable levels of exposure to carcinogens (Hoffman et al., 1984). The term ADI represents an allowable daily intake for both carcinogens and noncarcinogens. For example, in establishing water quality criteria for the priority pollutants, EPA used the following relationship:

$$C_w = ADI/I_w$$

where

C_w = water quality criteria level ($\mu g/L$),

ADI = EPA-established value for an "acceptable daily intake" ($\mu g/d$), and

I_w = EPA-assumed value for the daily water consumption (2 L/d);

The review of water quality criteria documents appears in Sitting, 1980.

Table 11.2.1 lists the calculated daily intake (CDI) of chemicals from surface water on and off the ORR. One of the normal assumptions used for these types of calculations is the consumption of 2 L/d of raw water taken from a

Table 11.2.1. Occurrences when the calculated daily intake[a] of chemicals from ORR surface water would have exceeded the acceptable daily intake[b]

Chemical[c,d]	Sampling period	Calculated daily intake (mg/d)	Acceptable daily intake (mg/d)	CDI/ADI
		Outfall 304		
Be	First Qtr.	0.0020	0.0002	10.00
Be	Fourth Qtr.	0.0004	0.0002	2.00
Be	3/19/86	0.0020	0.0002	10.00
Be	12/18/86	0.0004	0.0002	2.00
		Upper Bear Creek		
Be	9/8/86	0.0004	0.0002	2.00
Be	9/15/86	0.0004	0.0002	2.00
Be	9/22/86	0.0014	0.0002	7.00
Be	9/29/86	0.0004	0.0002	2.00
Be	9/20/86	0.0004	0.0002	2.00
Be	10/27/86	0.0004	0.0002	2.00
Be	11/17/86	0.0004	0.0002	2.00
Be	12/8/86	0.0004	0.0002	2.00
		Y-12 Sanitary Sewer		
Hg	January	0.1060	0.0235	4.51
Hg	March	0.0360	0.0235	1.53
Hg	April	0.0640	0.0235	2.72
Be	March	0.0014	0.0002	7.00
Cr	August	0.110	0.100	1.1
		Discharge Point 302		
Hg	November	0.0800	0.0235	3.40
Hg	December	0.0920	0.0235	3.91
		Discharge Point 303		
Be	July	0.0014	0.0002	7.00
Be	December	0.0004	0.0002	2.00
		Discharge Point 306		
Ag	September	0.232	0.016	14.5
		Discharge Point 501		
Pb	May	0.18	0.100	1.8
Ni	January	1.2	0.294	4.08
Ni	February	0.62	0.294	2.11
Ni	March	1.04	0.294	3.54
Ni	April	5.80	0.294	19.73
Ni	May	1.86	0.294	6.33
Ni	June	1.12	0.294	3.81
Ni	July	1.58	0.294	5.37
Ni	August	7.24	0.294	24.63
Ni	September	2.50	0.294	8.50
Ni	October	0.78	0.294	2.65
Ni	December	0.84	0.294	2.86
Cd	January	0.28	0.0574	4.88
Cd	August	<0.06	0.0574	1.05
Be	May	0.0094	0.0002	47
Be	October	0.0008	0.0002	4
Be	December	0.0010	0.0002	5

Table 11.2.1 (continued)

Chemical[c,d]	Sampling period	Calculated daily intake (mg/d)	Acceptable daily intake (mg/d)	CDI/ADI
		Discharge Point 507		
Ni	June	0.60	0.294	2.04
Ni	September	0.84	0.294	2.86
Ni	October	0.888	0.294	3.02
		Discharge Point 502		
Ni	October	0.88	0.294	2.99
Ni	November	1.34	0.294	4.56
		Discharge Point 152		
Hg	Second Qtr.	0.76	0.0235	32.34
		Discharge Point 197		
Hg	Second Qtr.	0.028	0.0235	1.19
		Discharge Point 247		
Hg	Second Qtr.	0.030	0.0235	1.28
		Discharge Point 626		
Cr	Third Qtr.	0.106	0.100	1.06
		Discharge Point 616		
Cr	Third Qtr.	6.968	0.100	69.68
Cu	Third Qtr.	9.74	2.000	4.87
		Discharge Point X02		
Ni	1986	0.32	0.294	1.09
Pb	1986	0.28	0.100	2.8
		Discharge Point X03		
Cr	1986	0.24	0.100	2.4
Pb	1986	0.24	0.100	2.4
		Discharge Point X04		
Pb	1986	0.24	0.100	2.4
		Discharge Point X06		
Cr	1986	0.140	0.100	1.4
Pb	1986	0.24	0.100	2.4
		Discharge Point X07		
Cr	1986	0.28	0.100	2.8
Pb	1986	0.24	0.100	2.4
		Discharge Point X08		
Cr	1986	0.32	0.100	3.2
Pb	1986	0.40	0.100	4.0

Table 11.2.1 (continued)

Chemical[c,d]	Sampling period	Calculated daily intake (mg/d)	Acceptable daily intake (mg/d)	CDI/ADI
		Discharge Point X09		
Cd	1986	0.070	0.0574	1.22
Cr	1986	0.168	0.100	1.68
Pb	1986	0.24	0.100	2.4
		Discharge Point X10		
Cr	1986	1.14	0.100	11.4
Ni	1986	0.96	0.294	3.27
Pb	1986	0.92	0.100	9.2
		Discharge Point X11		
Cr	1986	0.172	0.100	1.72
Pb	1986	0.24	0.100	2.4
		Discharge Point 001		
Th	November	0.02	0.01256	1.59
		Discharge Point 003		
Ni	September	3.40	0.294	11.56
Ni	October	2.60	0.294	8.84
Ni	November	1.720	0.294	5.85
Ni	December	0.54	0.294	1.84
		Discharge Point 005		
Ag	August	0.02	0.016	1.25
Ag	December	0.034	0.016	2.1

[a]Calculated on the basis of drinking 2 L of the water at the outfall (without dilution) when the maximum concentrations of the pollutant were emitted. No one drinks 2 L of groundwater or surface water at the outfalls; therefore, this analysis should be looked at as a screening technique only.

[b]Using EPA standard values and criteria as explained in Hoffman et al. (1984).

[c]No calculations of the CDI to ADI ratio were made for arsenic because the concentrations of all samples were below the limits of detection.

[d]For some discharges other than those listed here, the minimum level of detection of beryllium, lead, nickel, silver, and thorium is higher than the maximum allowable daily intake at a consumption of 2 L/d.

stream (which is unlikely). Therefore, the values given in Table 11.2.1 are overestimates of the intake. Table 11.2.2 lists the calculated daily intake of chemicals from air on the ORR. Chemicals with analytical detection limits below the EPA ADI are not included in these tables.

If the CDI/ADI ratio is >1, then an unacceptable level of risk would result from exposure to ORR surface water or air.

This analysis was also used for groundwater. However, no one drinks 2 L/d of groundwater in the disposal areas. Therefore, this analysis for groundwater should be used for screening purposes. It indicates those chemicals that require more detailed review: beryllium, lead, nickel, silver, zinc, PCBs, chloroform, methylene chloride, tetrachloroethane, and mercury, as shown in Table 11.2.3. Chemicals with analytical

Table 11.2.2. Calculated daily intake of chemicals from ORR air

Chemical	Acceptable daily intake (ADI) (mg/d)	Calculated daily intake (CDI) (mg/d)	CDI/ADI ratio
Chromium	0.1	0.00015	0.0015
Lead	0.1	0.01	0.1

Table 11.2.3. Occurrences when the calculated daily intake[a] of chemicals from ORR groundwater would have exceeded acceptable levels

Chemical	Well ID	Sampling period	Calculated daily intake (mg/d)	Acceptable daily intake (mg/d)	CDI/ADI
		Chestnut Ridge Security Pits			
Pb	GW-173	First Qtr.	0.146	0.100	1.46
Cr	GW-174	First Qtr.	0.148	0.100	1.48
Pb	GW-174	First Qtr.	0.130	0.100	1.30
Pb	GW-176	First Qtr.	0.438	0.100	4.38
Cd	GW-179	First Qtr.	0.44	0.0574	7.7
Cr	GW-179	First Qtr.	0.138	0.100	1.38
		New Hope Pond			
Cr	GW-148	First Qtr.	0.176	0.100	1.76
Pb	GW-148	First Qtr.	0.154	0.100	1.54
Cr	GW-150	First Qtr.	0.26	0.100	2.6
Cr	GW-150	Second Qtr.	0.174	0.100	1.74
Pb	GW-152	First Qtr.	4.42	0.100	44.2
Pb	GW-152	Second Qtr.	0.6	0.100	6
Pb	GW-152	Third Qtr.	0.128	0.100	1.28
Hg	GW-154	Second Qtr.	0.0304	0.0235	1.30
		Chestnut Ridge Sludge Disposal Basin			
Pb	GW-155	First Qtr.	0.104	0.100	1.04
		United Nuclear Corporation Site			
Pb	Y-GMW-24	First Qtr.	0.4	0.100	4
Pb	Y-GMW-25	First Qtr.	0.4	0.100	4
		S-3 Ponds			
Cd	GW-115	First Qtr.	<1.0	0.0574	<17
Cd	GW-115	Third Qtr.	<1.0	0.0574	<17
Cr	GW-115	First Qtr.	<1.0	0.100	<10
Cr	GW-115	Third Qtr.	<1.0	0.100	<10
Se	GW-115	Third Qtr.	<1.0	0.023	<43
Ag	GW-115	First Qtr.	<1.0	0.016	<63
Ag	GW-115	Third Qtr.	<1.0	0.016	<63
Cr	Y-GMW-2	Fourth Qtr.	0.106	0.100	1.06
Cd	Y-GMW-3	First Qtr.	0.098	0.0574	1.707
Cd	Y-GMW-3	Second Qtr.	0.096	0.0574	1.672
Cd	Y-GMW-3	Third Qtr.	0.098	0.0574	1.707
Cd	Y-GMW-3	Fourth Qtr.	0.098	0.0574	1.707
Cr	Y-GMW-3	First Qtr.	0.322	0.100	3.22
Pb	Y-GMW-3	First Qtr.	<0.2	0.100	<2
Pb	Y-GMW-3	Third Qtr.	0.54	0.100	5.4
Pb	Y-GMW-3	Fourth Qtr.	1.08	0.100	10.8
Ag	Y-GMW-3	First Qtr.	<0.04	0.016	<2.5

Table 11.2.3 (continued)

Chemical	Well ID	Sampling period	Calculated daily intake (mg/d)	Acceptable daily intake (mg/d)	CDI/ADI
		Bear Creek Valley Waste Disposal Area			
Ag	Y-GMW-9	Fourth Qtr.	0.4	0.100	4
Cr	GW-89	Third Qtr.	0.148	0.100	1.48
Pb	GW-89	Third Qtr.	0.24	0.100	2.4
Cd	GW-90	Second Qtr.	<0.2	0.0574	<3.5
Cd	GW-90	Third Qtr.	0.186	0.0574	3.24
Pb	GW-90	Third Qtr.	0.64	0.100	6.4
Pb	GW-90	Fourth Qtr.	0.22	0.100	2.2
Cr	GW-234	First Qtr.	0.42	0.100	4.2
Cr	GW-234	Third Qtr.	0.598	0.100	5.98
Cr	GW-234	Fourth Qtr.	0.180	0.100	1.80
Pb	GW-234	Third Qtr.	0.26	0.100	2.6
Pb	GW-234	Fourth Qtr.	0.32	0.100	3.2
		3539-3540 Area			
Pb	31-011	1986	1.56	0.100	15.6
Pb	GW-234	1986	2.4	0.100	24
Pb	31-011	1986	2.4	0.100	24
		3524, 3539-3540, and 7900 Area			
Pb		1986	1.56	0.100	15.6
		3513 Impoundment			
Cd	Downgradient	1986	<20.0	0.0574	<350
Cr	Downgradient	1986	0.36	0.100	3.6
Ag	Upgradient	1986	<0.06	0.016	<3.75
Ag	Downgradient	1986	<0.06	0.016	<3.75
Cr	1A	First Qtr.	0.28	0.100	2.8
Cr	2	First Qtr.	2.40	0.100	24.0
Cr	3	First Qtr.	0.14	0.100	1.4
Pb	3	Second Qtr.	2.8	0.100	28
Cr	4	First Qtr.	1.38	0.100	13.8
		Old Hydrofracture Facility			
Ag		1986	<0.084	0.016	<5.25
Ag		1986	<0.072	0.016	<4.50
Pb		Third Qtr.	0.20	0.100	2.0
Pb		Second Qtr.	0.16	0.100	1.6
		Homogeneous Reactor Experiment No. 2			
Cr	Upgradient	1986	<0.130	0.100	<1.30
Ag	Upgradient	1986	<0.070	0.016	<4.375
Ag	Downgradient	1986	<0.12	0.016	<7.50
Pb	1	1986	0.14	0.100	1.4
Pb	3	1986	0.18	0.100	1.8
		ORGDP			
Pb	UNW-11	First Qtr.	0.248	0.100	2.48

[a]Calculated on the basis of drinking 2 L of the water at the outfall (without dilution) when the maximum concentrations of the pollutant were emitted. No one drinks 2 L of groundwater or surface water at the outfalls; therefore, this analysis should be looked at as a screening technique only.

detection limits below the EPA ADI are not included in these tables.

11.3 REVIEW OF ASSUMPTIONS FOR HEALTH EFFECTS

A key assumption in this analysis is that cancers are statistical in nature. That is, a particular person cannot be identified as having contracted cancer as a result of emissions from the Oak Ridge facilities. All that can be stated is that there may be X deaths, where X is the number or numbers in the main body of this report.

In this sense, the problem is the same as that facing those who have estimated the risk associated with smoking cigarettes. In general, those who will fall victim to cigarette-induced lung cancer, heart disease, or other ailments cannot be named. In some extreme cases, when, for example, someone who has been smoking 4 packs a day for 40 years contracts lung cancer, it can be said with virtual certainty that cigarettes are the cause. But there are other instances where an extremely heavy cigarette smoker does not contract lung cancer. As a result, there is no list of names of those who have been felled by cigarettes.

Because the health effects due to radionuclide inhalation or ingestion are not peculiar to those radionuclides, the cancer cases that are due to this source cannot be identified. If cancer were both rare and attributable mostly to radiation, it could be done. At present, it cannot.

In this report, the final results in terms of health effects are expressed as partial or fractional fatal cancers. The number of health effects due to releases may be shown as 0.7 to 0.9, for example. This fractional value comes about because of the nature of the mathematical model.

Obviously, there is no such thing as a partial death. In terms of this report, the meaning of these numbers can be visualized as follows: suppose that the radioactive releases producing 0.1 death for a given site had been duplicated in ten sites, each with exactly the same geography, meteorology, and so on. Within these ten sites, there would have been a strong chance that almost all would have shown no extra cancer resulting from radionuclide releases, a slight chance that one or two sites would have shown one extra cancer, and an almost vanishing chance that one site would have shown two or more. In the language of the mathematician, the fractional values represent the average of a Poisson distribution.

There is considerable uncertainty in the results and conclusions of health effects studies. In most instances, if not all, these uncertainties probably overestimate rather than underestimate the health effects.

A thorough discussion of all the potential uncertainties would take up considerable space and require much technical detail. For brevity, just a few major sources of uncertainty are noted.

(1) The single number chosen for converting millirem into fatal cancers (0.000125 deaths per millirem) and genetic effects (0.000040 deaths per millirem) is 0.000165 deaths per millirem (UN, 1982), which may give the illusion of precision. Radiation scientists working on International Commission on Radiological Protection committees generally believe that this value forms an upper limit (ICRP, 1978). The lower limit is unknown, although some scientists feel it may be as low as zero. While the band of uncertainty cannot be defined mathematically as yet, the fact that it exists makes the overall results less than precise. The number of cancer deaths estimated in this report is only an estimate—all historic radioactive releases are not known.

(2) The entire mathematical modeling process is itself subject to uncertainty. The physical spread of radionuclides through air and water and into bodies and specific organs is a complicated process. The uncertainties include population questions, shielding of humans from radiation, the degree of radiation in food, how body organs react to radiation, the solubility of radionuclides in the body, etc. It is nearly impossible to estimate the overall degree of uncertainty produced as a result of these individual uncertainties. Scientists consulted on this question feel that because of the stringent (or

conservative) assumptions used in the model, it will almost certainly yield an overestimate of the population dose.

(3) Many of the data on emissions to air, water, and land are uncertain. In the past, the present level of measurement and analysis was sometimes not achieved. This in turn led to estimates, rather than measurements, being made occasionally.

While past measurements are not always up to today's standards because of technical capabilities, these values must be estimates. Unfulfillable desires, or annoying uncertainties, were, are, and will be with us in these measurements.

(4) Similar statements about uncertainty can be made about environmental, as contrasted to effluent, measurements. Over the years, measurement techniques have improved dramatically. These improvements have made earlier measurements relatively uncertain in retrospect. Since the samples are no longer available, there is no way the measurements can be redone using more precise and accurate techniques.

(5) Three isotopes of uranium, with atomic weights of 234, 235, and 238, can be emitted from DOE installations. The dose incurred by the public will depend largely on their proportion. In some cases, especially in air emissions, these proportions are or were not precisely known.

(6) There is a time delay associated with cancers induced from the calculated radiation dose. This uncertainty in terms of time is not of the same nature as those that deal with quantity, yet it produces uncertainty in the conclusions to be drawn. The implication may have been given in the calculations that any health effects occur shortly after the radionuclides enter the body of the person who will eventually die. This is not the case. While the time delay in the effect depends on the type of cancer induced, specialists have estimated a delay of between 5 and 30 years between the time the dose is received and when the fatal cancer appears. A fatal cancer produced as a result of a dose in 1946, by this estimation, may have shown up as early as 1951 or as late as 1976. Similarly, a dose of today may show up in cancer mortality tables as early as 1990 or as late as 2015. The type of fatal cancer that will be produced, or when it will occur, is not known. Because a natural way of thinking is to assume that effects follow shortly after cause, the question of time delays produces uncertainty in linking the two.

In summary, these are some of the major and minor sources of uncertainties in both the data and the calculations based on them. Some, such as those associated with modeling and the ratio of dose to health effects, probably overlap. Others, such as changes in instrumentation and measurement over the years, probably are smaller areas of uncertainty. While it would be desirable to be able to say, as the statisticians do, that the results have a plus-or-minus of so much attached to them, it cannot be done. The uncertainties are of such a disparate nature that at present they cannot be combined mathematically.

The number of cancer deaths varies strongly from year to year and place to place (Riggan, 1983). Table 11.3.1 shows the variation in cancer mortality among both white and non-white males around Anderson and Roane counties, Tennessee (the site of the Oak Ridge Y-12 Plant, ORNL, and ORGDP), for the years 1960–69 and 1970–79. Note that this is the total mortality, including dozens of specific types of cancer. This is not the *incidence* of cancer, which would include both fatal and non-fatal cases. It is likely that about the same conclusions would be drawn for data on cancer incidence among the same two groups.

Statistical tests can be performed to estimate how variable these numbers are with respect to the estimated fatal cancers due to the DOE facilities. However, a mere scanning of the numbers shows that trying to detect one death caused by radionuclides from these facilities would be futile, given the apparently natural variation in cancer mortality. The number of deaths often changes substantially from one decade to the next. The variation would be even greater if particular years were compared with each other rather than decades.

Because of the low radiation dose calculated, the mathematical model cannot be used to predict

Table 11.3.1. Total cancers around Anderson and Roane counties, Tennessee[a]

Counties	White males		Non-white males		Population (thousands)	
	1960–69	1970–79	1960–69	1970–79	1960	1970
Anderson	332	523	18	29	60	60
Blount	344	560	26	37	58	64
Campbell	247	347	6	2	28	26
Claiborne	169	219	3	3	19	19
Jefferson	152	200	11	8	21	25
Knox	1677	2430	228	296	251	276
Loudon	173	235	9	7	24	24
Morgan	91	133	0	0	14	14
Roane	233	355	14	18	39	39
Scott	91	149	2	0	15	15
Sevier	168	298	1	2	24	28
Union	51	64	0	0	8.5	9.1

[a]*Source*: W. B. Riggan et al., *U.S. Cancer Mortality Rates and Trends, 1950–1979,* Vols. 1–3, EPA-600/1-83-015a, 1983.

which county or counties would suffer one or fewer cancer deaths. It is then close to impossible, on the basis of Table 11.3.1 to detect mathematically an increase in cancer deaths of the order of one or fewer, or to identify in which county or counties this increase occurred.

It may be contended that this conclusion is drawn only because the total number of cancer deaths was considered. If the cancer or cancers produced by radionuclide discharges were concentrated in one or more body organs that otherwise had a low incidence of cancer mortality, detection of changes in rates resulting from discharges of radionuclides from DOE facilities would be easier, in principle. For example, lip cancers produced about 1 in 915 U.S. cancer deaths from 1950 to 1969 (Riggan, 1983). If cancers caused by discharges from the Oak Ridge facilities were concentrated on a specific organ like this, which constitutes a small part of total cancer mortality, it would be possible to detect more easily the statistical effect of these facilities.

On the basis of present knowledge, this is highly unlikely. For example, the AIRDOS mathematical model predicts that most cancers caused by airborne releases of radioactivity will occur in the lung. About 14%, or 1 in 7, of all cancer deaths from 1950 to 1969 occurred in the trachea, bronchus, and lung.

Table 11.3.2 shows data similar to those of Table 11.3.1, except that only lung cancer deaths are considered. The total number of deaths is substantially smaller than shown in Table 11.3.1 because lung (and related) cancer deaths are only one segment of total cancer deaths. However, the same difficulty in identifying cancer deaths of the order of one recurs. There is so much natural variation in the numbers that we cannot state with any degree of certainty how many excess lung cancer deaths have occurred, or where they occurred. For example, Sevier County lung cancer deaths for white males rose by 63 during the course of one decade. It should be noted that lung cancer deaths throughout the entire country went up substantially during this period. Table 11.3.1 reflects this national increase. Subdividing the total cancer death rate by sites in the body where cancers occur will still not allow a definitive conclusion that these rates have changed as a result of ORR discharges.

Table 11.3.2. Lung, trachea, and bronchus cancer deaths around Anderson and Roane counties, Tennessee[a]

Counties	White males		Non-white males		Population (thousands)	
	1960–69	1970–79	1960–69	1970–79	1960	1970
Anderson	112	215	6	9	60	60
Blount	104	204	5	12	58	64
Campbell	74	157	1	0	28	26
Claiborne	63	83	2	1	19	19
Jefferson	28	62	1	1	21	25
Knox	489	922	60	113	251	276
Loudon	50	86	3	0	24	24
Morgan	20	64	0	0	14	14
Roane	72	142	2	7	39	39
Scott	18	63	1	0	15	15
Sevier	41	104	1	0	24	28
Union	12	26	0	0	8.5	9.1

[a]*Source*: W. B. Riggan et al., *U.S. Cancer Mortality Rates and Trends, 1950–1979*, Vols. 1–3, EPA-600/1-83-015a, 1983.

12. QUALITY ASSURANCE

Analytical laboratories at Energy Systems installations continue a long tradition of quality assurance (QA). Such terms as sound methodology, safe practices, analytical recovery, precision, accuracy, and quality control (QC) are well established. Since the beginning of each installation's operation, the laboratories have been involved in the handling and analyzing hazardous materials, materials for which strict accountability is required, and materials of high purity. Quality assurance is, therefore, a daily responsibility.

12.1 INTERNAL QUALITY CONTROL

A key feature in analytical QA is quality control. Each installation participates in both internal and external QC programs. All analytical activities are supported by the use of standard materials or reference materials; e.g., materials of known composition which are used in calibration of instruments, methods standardization, spike additions for recovery tests, and other practices. Certified standards from the National Bureau of Standards (NBS), EPA, or from other DOE laboratories are used for such work.

These internal programs are the mainstay of analytical QC and form the basis for ensuring reliable results on a day-to-day and batch-to-batch basis. The total effort in these programs is at least 10% of the laboratory effort, in accord with EPA expectations, and probably reaches 20% in some activities.

The analytical laboratory at each installation has an appointed QC officer. In addition to monitoring the general quality in the output of analytical data, the QC officer administers a program generating QC samples of known composition and submitting these to the operating laboratories periodically. The program at ORNL is well developed and has features similar to those at the other installations. In 1986, the QC officer for the ORNL Analytical Chemistry Division prepared and submitted to the analytical laboratories quality control samples for analysis along with routine monitoring samples. These controls were prepared quarterly using EPA- and NBS-traceable materials and matched with the types of samples submitted by the monitoring program. Control sample values were unknown to the analysts. Three ORNL laboratories that analyzed the monitoring samples were: Chemical and Physical Analysis, Environmental Analysis, and Low-Level Radiochemistry. All principal analytical techniques were covered by these controls: inductively coupled plasma, flame emission, atomic absorption, graphite furnace atomic absorption, cold vapor atomic absorption, ion chromatography, alpha, beta, and gamma counting, and radiochemical separations. Eighty-eight parameters were covered by the control program in CY 86. Based on the previous year's performance, control limits of ± 2 standard deviations were set. For 1986, 6267 quality control results were reported with 97% of the values within the control limits.

Internal quality control programs have become a major factor in the environmental analysis functions because of the low levels of pollutants measured and the relationship of the measured values to regulatory limits. These QC programs also facilitate the programs for laboratory analyst training and qualification in the many procedures involved. Day-to-day QC data are stored in a retrievable fashion so that they can be related to the analytical results which they support.

12.2 EXTERNAL QUALITY CONTROL

All Energy Systems installations are directed by DOE and by EPA regulators to participate in external quality control programs. These programs generate data that are readily recognizable as objective packets of results which permit participating laboratories and government agencies a periodic view of performance. While participation is expected, the degree of participation by each laboratory is voluntary, so the analytical parameters selected are of particular interest to that plant. The sources of these programs are laboratories in EPA, DOE, and even the commercial sector. All DOE Oak Ridge installation laboratories participate in these external programs and have given examples of their participation for 1986 in both radiological and nonradiological areas.

12.2.1 EPA Radionuclide Intercomparison Studies at Oak Ridge Y-12 Plant

An intercomparison studies program on radionuclide measurements is administered by the EPA Environmental Monitoring Systems Laboratory at Las Vegas (EMSL-LV). Typical results from the Oak Ridge Y-12 Plant radiochemical laboratory for 1986 are listed in Table 12.2.1. Reports have not been received for results in the latter part of the year. Table 12.2.1 shows good agreement between the reported and the true values.

12.2.2 EPA Radionuclide Performance Evaluation Study at Oak Ridge Y-12 Plant

Samples in a radionuclide performance evaluation study are received annually from EPA EMSL-LV. Oak Ridge Y-12 Plant laboratory results are shown in Table 12.2.2. Results compare well with true values.

12.2.3 DOE Environmental Measurements Laboratory (EML) Radionuclide QA Program at Oak Ridge Y-12 Plant

The Oak Ridge Y-12 Plant radiochemical laboratory also participated in an external QA program administered by the DOE-EML. Various matrix samples such as soil, water, air filters, and vegetation are analyzed semiannually for a variety of radioactive isotopes, with a statistical report submitted by EML for each period. Table 12.2.3 illustrates the performance of the laboratory in 1986.

12.2.4 EPA Intercomparison Radionuclide Control Program at ORGDP

The EPA Radionuclide Control Program is administered by the EPA EMSL-LV. The State of Tennessee requires participation in this control program for laboratory certification of

Table 12.2.1. Y-12 Plant performance in EPA radionuclide intercomparison study: 1986

Date	Measurement and matrix	Reported value	True value
January 1986	Pu-239 in water	6.8 pCi/L	7.1 pCi/L
February 1986	Co-60 in water	18 pCi/L	18 pCi/L
February 1986	Zn-65 in water	44 pCi/L	40 pCi/L
February 1986	Cs-134 in water	25 pCi/L	30 pCi/L
February 1986	Cs-137 in water	22 pCi/L	22 pCi/L
February 1986	U-nat in water	9 pCi/L	9 pCi/L
March 1986	Ra-226 in water	4.5 pCi/L	4.1 pCi/L
March 1986	Ra-228 in water	14 pCi/L	12 pCi/L
April 1986	Alpha on air filter	24 pCi/filter	15 pCi/filter
April 1986	Beta on air filter	46 pCi/filter	47 pCi/filter
April 1986	Sr-90 on air filter	17 pCi/filter	18 pCi/filter
April 1986	Cs-137 on air filter	14 pCi/filter	10 pCi/filter
May 1986	Gross alpha in water	8 pCi/L	8 pCi/L
May 1986	Gross beta in water	24 pCi/L	15 pCi/L
June 1986	Co-60 in water	64 pCi/L	66 pCi/L
June 1986	Zn-65 in water	85 pCi/L	86 pCi/L
June 1986	Ru-106 in water	39 pCi/L	50 pCi/L
June 1986	Cs-134 in water	40 pCi/L	49 pCi/L
June 1986	Cs-137 in water	10 pCi/L	10 pCi/L
June 1986	H-3 in water	2960 pCi/L	3125 pCi/L
August 1986	U-nat in water	5 pCi/L	4 pCi/L

Table 12.2.2. Y-12 Plant results in EPA performance evaluation study: 1986

Water samples[a]	Reported value	True value
Gross alpha	14 pCi/L	17 pCi/L
Gross beta	30 pCi/L	35 pCi/L
Ra-226	2.0 pCi/L	2.9 pCi/L
Ra-228	2.7 pCi/L	2.0 pCi/L
U-Nat	5 pCi/L	5 pCi/L
Co-60	11 pCi/L	10 pCi/L
Cs-134	5 pCi/L	5 pCi/L
Cs-137	6 pCi/L	5 pCi/L

[a]Samples received and analyzed in April 1986.

radionuclide analysis. All data showed excellent performance by the ORGDP laboratory during 1986. The results are shown in Table 12.2.4.

12.2.5 EPA Radionuclide Control Program at ORNL

Samples in this radionuclide control program are available throughout the year. An effort is made to provide a minimum of two sets of certain sample types during the year; others are annual samples. ORNL participation in 1986 is summarized in Table 12.2.5; results and known values are generally in good agreement.

Table 12.2.3. Y-12 Plant laboratory participation in the EML (DOE) radionuclide QA program: 1986[a]

Sample type	Isotope	Y-12 Plant reported value[b]	EML value[b]	Ratio Rp/EML	±[c]
Air	Be-7	0.210×10^{4}	0.198×10^{4}	1.06	0.08
Air	Mn-54	0.240×10^{3}	0.238×10^{3}	1.01	0.08
Air	Co-60	0.240×10^{3}	0.210×10^{3}	1.14	0.08
Air	Sr-90	4.30	4.52	0.95	0.18
Air	Cs-137	0.230×10^{3}	0.221×10^{3}	1.04	0.08
Air	Pu-239	2.80	2.39	1.17	0.17
Air	Am-241	2.80	2.60	1.08	0.20
Air	U (total)	3.00	2.30	1.30	0.19
Soil	Sr-90	1.80	1.99	0.90	0.10
Soil	Cs-137	0.870	0.810	1.07	0.15
Soil	Pu-239	0.900×10^{-2}	0.100×10^{-1}	0.90	0.41
Soil	Am-241	0.400×10^{-2}	d		
Soil	U (total)	0.270	1.09	0.25	0.03
Tissue	U (total)	0.900×10^{-2}	0.100×10^{-1}	0.90	0.50
Vegetation	Sr-90	3.80	3.33	1.14	0.16
Vegetation	Cs-137	1.70	1.39	1.22	0.22
Vegetation	Pu-239	0.400×10^{-1}	0.170×10^{-1}	2.35	1.21
Vegetation	Am-241	0.100×10^{-1}	0.100×10^{-1}	1.00	0.51
Vegetation	U (total)	0.400×10^{-1}	0.239×10^{-1}	1.67	0.72
Water	H-3	0.200×10^{2}	0.218×10^{2}	0.92	0.09
Water	Mn-54	2.40	2.30	1.04	0.10
Water	Co-60	2.30	2.30	1.00	0.10
Water	Sr-90	0.490	0.430	1.14	0.05
Water	Cs-137	2.50	2.43	1.03	0.10
Water	Pu-239	0.500×10^{-1}	0.560×10^{-1}	0.89	0.06
Water	Am-241	0.700×10^{-1}	0.720×10^{-1}	0.97	0.15
Water	U (total)	0.700×10^{-1}	0.650×10^{-1}	1.08	0.08

[a]Results through June 1986; the next semiannual report was not available.

[b]Units for air are pCi/filter; for water, pCi/mL; for all others, pCi/g.

[c]This is the standard error of the EML mean of replicate determinations used in assigning the EML value.

[d]EML value not verified.

Table 12.2.4. ORGDP participation in EPA EMSL-LV intercomparison studies—1986[a]

Parameter	Results	Average of results	Known value
Uranium in water	4.0 4.0 4.0	4.00	4.00 pCi/L
Plutonium in water	10.7 10.7 10.1	10.50	10.10 pCi/L
Alpha on air filters	19.0 18.0 16.0	17.66	22.00 pCi/filter
Beta on air filters	65.0 68.0 58.0	63.67	66.00 pCi/filter
Cs-137 on air filters	20.0 23.0 21.0	21.33	22.00 pCi/filter
Gross alpha in water	4.0 5.0 4.0	4.33	6.00 pCi/L
Gross beta in water	18.0 17.0 17.0	17.33	18.00 pCi/L

[a]These are typical of the sample types and results obtained within a year. There are a minimum of two sets of each type each calendar year.

12.2.6 EML Radionuclide QA Program at ORNL

The EML QA Program provides samples semiannually in five different media. The range of radionuclides is broad and is the result of occasional communication by the DOE-EML in New York with the participant DOE laboratories. The statistics, provided by EML, are issued twice a year. Participation by ORNL during the first half of 1986 is shown in Table 12.2.6. Results generally agree well with the EML values.

12.2.7 Environmental Resource Associates (ERA) QC Program at the Oak Ridge Y-12 Plant

During part of 1986, the Oak Ridge Y-12 Plant laboratory participated in an external measurement program for water samples provided by ERA, a commercial supplier. Samples from a single batch of control material were supplied to the laboratory on a monthly basis. The true values for each parameter were unknown to the analysts. Table 12.2.7 lists the average of ten months; measurements were performed by the Oak Ridge Y-12 Plant laboratory on many of a total of about 40 parameters. The first column is the ERA accepted value. The next column is the average of the measured results for that batch, followed by the precision at the 95% confidence level.

12.2.8 Proficiency Environmental Testing (PET) Program at the Oak Ridge Y-12 Plant

The Oak Ridge Y-12 Plant laboratory participated in an external measurement control program using samples provided by the Analytical Products Group, Inc. (APG), a commercial supplier. The program is entitled

Table 12.2.5. ORNL participation in the EMSL-LV intercomparison program[a]

Nuclide/Schedule	ORNL results	EMSL known values	Ratio ORNL:EMSL	Within acceptable limits
Gross alpha/1st Qtr	9.0	11.0	0.82	Yes
Gross beta/1st Qtr	9.7	8.0	1.21	Yes
^{3}H/1st Qtr	4420	4480	0.99	Yes
Gross alpha/2nd Qtr	4.3	3.0	1.43	Yes
Gross beta/2nd Qtr	25.67	7.00	3.67	No
^{3}H/2nd Qtr	1600	1970	0.81	Yes
Gross alpha/3rd Qtr	8.0	15.0	0.53[b]	No[b]
Gross beta/3rd Qtr	17.0	8.0	2.1[b]	No[b]
^{131}I/year	7.0	9.0	0.78	Yes
Gross alpha/year (mixed nuclides)	14.0	17.0	0.82	Yes
^{226}Ra/year (mixed nuclides)	3.16	2.9	1.09	Yes
U(nat)/year (mixed nuclides)	5.0	5.0	1.00	Yes
Gross beta/year (mixed nuclides)	36.7	35.0	1.05	Yes
^{90}Sr/year (mixed nuclides)	8.0	7.0	1.14	Yes
^{60}Co/year (mixed nuclides)	7.0	10.0	0.70	Yes
^{134}Cs/year (mixed nuclides)	4.7	5.0	0.94	Yes
^{137}Cs/year (mixed nuclides)	4.0	5.0	0.80	Yes
^{3}H/3rd Qtr	2300	3125	0.74	Yes
Gross alpha/4th Qtr	4.7	6.0	0.78	Yes
Gross beta/4th Qtr	13.0	18.0	0.72	Yes

[a]All results are average of three determinations; units of all results and known values are pCi/L.

[b]Suspected mix-up in sample identification.

PET by the supplier. This program replaced the ERA program during 1986 in Energy Systems installations. Samples at two concentration levels are analyzed monthly and reported to APG. An evaluation report is received approximately three weeks later.

Levels of each parameter are different from month to month, so there are no continuing statistical data from a large batch of material. The report includes two evaluations as a measure of performance: percent recovery of the reference value, and deviation from the mean result of all reporting laboratories in the program.

Measurements that have questionable recoveries or are more than two standard deviations from the mean are investigated to determine if a problem exists. A written report of the investigation is submitted to laboratory management.

Listed in Table 12.2.8 are the average percent recoveries and the average number of standard deviations from the mean of all participants for the months of August through December 1986. These are two important factors in evaluation of performance by the EPA and have been extracted from a large quantity of data furnished in more detailed form. The Oak Ridge Y-12 Plant laboratory performance in 1986 was within the acceptable range on all parameters.

12.2.9 PET Program at ORGDP

The ORGDP laboratory participates in the external PET quality assurance program

Table 12.2.6. ORNL participation in the EML-QA Program in the first half of 1986

Sample material[a]	Nuclide	ORNL value	EML value	Ratio ORNL: EML	Within Acceptable level
Air filter	^{7}Be	1800	1980	0.86	Yes
	^{54}Mn	240	238	1.01	Yes
	^{60}Co	220	210	1.10	Yes
	^{90}Sr	4.1	4.52	0.91	Yes
	^{137}Cs	200	221	0.90	Yes
	^{239}Pu	2.4	2.39	1.00	Yes
	^{241}Am	2.5	2.60	0.96	Yes
	^{234}U	1.20	1.15	1.04	Yes
	^{238}U	1.10	1.15	0.96	Yes
Soil					
	^{40}K	29	20.4	1.42	Yes
	^{90}Sr	1.6	1.99	0.80	Yes
	^{137}Cs	0.84	0.81	1.04	Yes
	^{226}Ra	0.43	0.60	0.72	Yes
	^{239}Pu	0.013	0.010	1.30	Yes
Tissue					
	^{40}K	1.8	2.1	0.86	Yes
	^{90}Sr	1.4	2.04	0.69	Yes
	^{226}Ra	0.35	0.351	1.00	Yes
Vegetation					
	^{40}K	11	9.8	1.12	Yes
	^{90}Sr	3.3	3.33	0.99	Yes
	^{137}Cs	1.5	1.39	1.08	Yes
	^{239}Pu	0.019	0.017	1.12	Yes
	^{241}Am	0.015	0.010	1.50	Yes
	^{234}U	0.014	0.0122	1.15	Yes
	^{238}U	0.011	0.0117	0.94	Yes
Water	^{3}H	22	21.8	1.01	Yes
	^{54}Mn	2.4	2.3	1.04	Yes
	^{60}Co	2.3	2.3	1.00	Yes
	^{90}Sr	0.46	0.43	1.07	Yes
	^{137}Cs	2.5	2.43	1.03	Yes
	^{239}Pu	0.039	0.056	0.70	Yes
	^{241}Am	0.065	0.072	0.90	Yes
	^{234}U	0.032	0.032	1.00	Yes
	^{238}U	0.032	0.033	0.97	Yes

[a]Units for air are pCi/filter; for water, pCi/mL; for all others, pCi/g.

Table 12.2.7. Performance of Y-12 Plant laboratory on ERA certified solutions: 1986

Parameter[a]	ERA accepted value (mg/L)	Mean measured value (mg/L)
Aluminum by ICP	0.332	0.315 ± 0.062[b]
Ammonia nitrogen	4.5	4.40 ± 0.09
Barium by AA	0.294	0.289 ± 0.013
Biochemical oxygen demand	37	41 ± 6
Boron by ICP	0.492	0.500 ± 0.018
Cadmium by ICP	0.074	0.081 ± 0.018
Chloride	228	231 ± 5
Chromium by AA	0.416	0.408 ± 0.019
Cobalt by ICP	0.218	0.213 ± 0.008
Copper by ICP	0.383	0.372 ± 0.012
Cyanide	0.065	0.064 ± 0.006
Hexavalent chromium	0.102	0.107 ± 0.002
Kjeldahl nitrogen	2.7	2.8 ± 0.1
Manganese by AA	0.149	0.154 ± 0.005
Molybdenum by ICP	0.191	0.182 ± 0.009
Nitrate nitrogen	6.5	6.48 ± 0.08
Oil and grease	42	36 ± 1
PCB	0.0025	0.0023 ± 0.0004
Phenol	0.094	0.100 ± 0.006
Potassium by AA	93	86 ± 3
Residual chlorine	1.65	1.58 ± 0.05
Suspended solids	74	71 ± 3
Total solids	1050	955 ± 42
Uranium	0.090	0.090 ± 0.009

[a]ICP is inductively coupled plasma spectrometry. AA is atomic absorption spectometry.

[b]95% confidence limit for mean of ten monthly analyses.

conducted by APG. At the initiative of the ORGDP laboratory, QC managers from all the Energy Systems plants and Westinghouse Materials Company of Ohio (Fernald, Ohio) met with a representative of APG to set up a trial program. The results were reviewed at a later meeting, at which time all six plants agreed to become a "corporate group" of laboratories to receive monthly samples and monthly statistical reports from APG. Several pages of data are reported to each installation to show individual laboratory performance vs that of the other participants, and a full report is also issued to reflect the average performance of the six plants compared with all participants in the PET program.

Table 12.2.9 is a typical page from the report for October 1986 sent to the ORGDP laboratory. It shows that the measurements for each parameter are made at two concentration levels and that the statistical treatment of data is quite complete. ORGDP performance on these few parameters is typical of most parameters.

12.2.10 Tennessee Water Supply Control Program: ORGDP in 1986

Participation is required by the State of Tennessee in the water supply (WS) control

Table 12.2.8. Average performance of Y-12 Plant laboratory PET controls: 1986

Parameter[a]	Average percent recovery	Av No.[a] Std. dev.[b] from the mean of all participants[c]
Biochemical oxygen demand	104	0.62
Chemical oxygen demand	90	0.74
Total organic carbon	90	1.0
Ammonia nitrogen	92	0.52
Nitrate nitrogen	96	0.52
Orthophosphate as P	80	1.4
Kjeldahl nitrogen	100	0.63
Total phosphorus	127	0.93
Suspended solids	95	0.51
Dissolved solids	101	0.78
Oil and grease	103	0.64
Alkalinity	103	0.74
Calcium	119	2.0
Chloride	103	0.95
Conductivity	84	0.70
Magnesium	96	0.17
Potassium	114	0.73
Sodium	99	0.39
Sulfate	99	0.49
Total hardness as $CaCO_3$	108	1.1
pH	102	0.79
Arsenic	90	1.7
Barium	98	0.46
Cadmium	98	0.62
Chromium	100	0.57
Copper	99	0.54
Iron	99	0.68
Lead	103	0.44
Manganese	103	0.51
Mercury	96	0.44
Nickel	93	0.82
Selenium	101	0.97
Silver	99	0.61
Zinc	93	0.83
Phenol	90	0.48
Cyanide	107	0.86
Total residual chlorine	100	0.67

[a] Average of 5 months results by the Y-12 Plant.

[b] For EPA, the warning level is 1.87 std. dev., and the acceptance level is 2.58 std. dev. from the mean.

[c] The number of participant laboratories varied depending on the parameter and the month; the maximum in 1986 was 55 labs (suspended solids in October), the minimum was 4 (residual Cl in December).

Table 12.2.9. Proficiency Environmental Testing (PET) Program[a] for ORGDP (October 1986)—typical 1986 results[b]

Parameter	Concentration (mg/L)	
	Level 1	Level 2
Sodium		
Your result	81.50	52.90
Reference value	77.80	50.40
Mean of reporting laboratories	78.71	52.26
Actual standard deviation	8.74	3.24
Number reporting	18	18
Average % recovery	101.17	103.69
Your % recovery	104.76	104.96
Your result was	0.319	0.198
Deviations from the mean		
Sulfate		
Your result	53.00	26.00
Reference value	54.20	27.40
Mean of reporting laboratories	52.35	26.76
Actual standard deviation	7.03	3.83
Number reporting	19	19
Average % recovery	96.58	97.67
Your % recovery	97.79	94.89
Your result was	0.093	0.199
Deviations from the mean		
Total hardness as $CaCO_3$		
Your result	95.00	81.00
Reference value	96.90	83.40
Mean of reporting laboratories	95.90	79.68
Actual standard deviation	8.71	4.76
Number reporting	23	21
Average % recovery	98.97	95.53
Your % recovery	98.04	97.12
Your result was	0.103	0.278
Deviations from the mean		

[a] Analytical Products Group, Inc., P.O. Box 717, Marietta, OH 45750.

[b] About 40 parameters are measured at 2 levels each month.

programs for laboratory certification of drinking water. ORGDP results from a WS-018 study are shown in Table 12.2.10. Corrective actions have been taken for the analytes shown to be "not acceptable" for this study.

12.2.11 EPA/TN Discharge Monitoring Report (DMR) QA Study: ORGDP in 1986

All holders of major NPDES permits participate in the DMR control program. Samples are furnished by EPA; results are monitored by EPA and the state. Results obtained by ORGDP for the third quarter of 1986 are shown in Table 12.2.11. All results were within the acceptable range, except total suspended solids, for which the measured value was a little below the acceptance range.

12.2.12 EPA/TN DMR QA Study: ORNL in 1986

EPA conducts a national quality assurance program in support of the NPDES program. All holders of major NPDES permits are required to participate. EPA furnishes the QC samples and evaluates the results, and the State of Tennessee follows up on the results from the Oak Ridge

Table 12.2.10. ORGDP laboratory performance evaluation report: Water supply study number WS018 State of Tennessee (July 11, 1986) (μg/L)

Parameter	Sample No.	Reported value	True value[a]	Acceptance limits	Performance
Arsenic	1	16.2	15.0	11.4–18.4	Acceptable
	2	89.8	90.0	72.5–104	Acceptable
Barium	1	207	189	156–235	Acceptable
	2	325	315	260–353	Acceptable
Cadmium	1	40.9[b]	45.0	33.7–48.7	Acceptable
	2	5.20[b]	5.00	3.63–5.63	Acceptable
Chromium	1	31.4	27.5	23.1–32.1	Acceptable
	2	80.8	77.1	66.1–87.9	Acceptable
Lead	1	24.8	23.8	18.7–28.8	Acceptable
	2	84.3	85.0	69.2–98.2	Acceptable
Mercury	1	0.700	0.825	0.537–1.16	Acceptable
	2	3.40	3.58	2.55–4.49	Acceptable
Selenium	1	86.8	95.7	70.1–115.0	Acceptable
	2	15.3	15.4	11.8–19.5	Acceptable
Silver	1	15.3	16.0	12.8–19.5	Acceptable
	2	35.2	36.0	29.7–42.4	Acceptable
Nitrate (as N) (mg/L)	1	0.497	0.444	0.355–0.542	Acceptable
	2	9.05	9.37	8.22–10.4	Acceptable
Fluoride (mg/L)	1	0.7	0.531	0.474–0.577	Not acceptable
	2	1.4	1.38	1.25–1.48	Acceptable
Endrin	1	0.22	0.330	0.193–0.449	Acceptable
	2	1.68	2.80	1.72–3.55	Not acceptable
Lindane	1	0.11	0.170	0.0667–0.239	Acceptable
	2	3.12[b]	4.20	2.24–5.30	Acceptable
Methoxychlor	1	1.59	1.71	0.999–2.38	Acceptable
	2	14.79	19.7	12.2–26.3	Acceptable
Toxaphene	3	1.66	1.56	0.682–2.22	Acceptable
	4	3.51	6.53	3.34–8.87	Acceptable
2,4-D	1	45.9	81.2	26.8–115.0	Acceptable
	2	3.1	4.91	1.26–7.57	Acceptable
2,4,5-TP (Silvex)	1	14.2[b]	35.5	9.07–50.8	Acceptable
	2	2.5[b]	5.08	1.64–6.94	Acceptable
Chloroform	1	52.3	54.3	43.4–65.2	Acceptable
	2	11.4	12.1	9.68–14.5	Acceptable
Bromoform	1	35.1	27.0	21.6–32.4	Not acceptable
	2	91.1	74.2	59.4–89.0	Not acceptable
Bromodichloromethane	1	7.72	6.26	5.01–7.51	Not acceptable
	2	39.9	37.6	30.1–45.1	Acceptable
Dibromochloromethane	1	22.8	19.3	15.4–23.2	Acceptable
	2	52.1	42.9	34.3–51.5	Not acceptable
Total trihalomethane	1	117.9	106.8	85.4–128.0	Acceptable
	2	194.5	166.8	133.0–200.0	Acceptable

[a]Based on theoretical calculations or a reference value when necessary.
[b]Significant general method bias is anticipated for this result.

Table 12.2.11. EPA performance evaluation report DMR-QA study number 006 ORGDP 1986

Analytes	Reported value	True value[a]	Acceptance limits	Warning limits	Performance evaluation
		Trace metals (μg/L)			
Aluminum	2030	2129	1780–2430	1860–2350	Acceptable
Arsenic	320	342	244–419	266–397	Acceptable
Beryllium	260	291	246–326	256–316	Acceptable
Cadmium	296	307	269–348	279–338	Acceptable
Chromium	296	274	213–331	227–316	Acceptable
Copper	369	380	332–422	344–411	Acceptable
Mercury	50.5	50.0	34.4–65.9	38.3–61.9	Acceptable
Nickel	506	532	460–605	479–587	Acceptable
Selenium	51.8	54.9	32.6–66.9	36.9–62.6	Acceptable
Zinc	363	383	333–429	345–417	Acceptable
		Miscellaneous analytes			
pH (units)	6.67	6.70	6.54–6.83	6.58–6.80	Acceptable
Total suspended solids (mg/L)	26.2	35.6	26.6–37.5	28.0–36.1	Not acceptable
Oil and grease (mg/L)	15.3	16.0	7.40–22.1	9.24–20.3	Acceptable
		Nutrients (mg/L)			
Ammonia-nitrogen	4.2	4.60	3.68–5.49	3.90–5.28	Acceptable
Nitrate-nitrogen	2.39	2.50	2.05–2.95	2.16–2.84	Acceptable
		Demands (mg/L)			
COD	86.0	97.9	70.8–115	76.3–109	Acceptable
5-day BOD	45.0	63.8	40.4–87.3	46.2–81.5	Check for error

[a]Based on theoretical calculations or a reference value when necessary.

installations. Table 12.2.12 shows that ORNL generated acceptable results on all but one parameter, which is under examination. Note also that several parameters were measured and reported on a voluntary basis—that is, they were not permit parameters.

12.2.13 EPA Contract Lab Program (CLP) Qualification at ORGDP in 1986

In 1986, the ORGDP Analytical Lab was approved by the EPA as a Contact Lab Program (CLP) laboratory. EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, (EMSL-LV) is responsible for QA/QC functions of this program. The laboratory completed performance evaluation samples submitted by EMSL-LV and was audited by EMSL-LV in 1986. The laboratory presently participates in the EPA CLP quarterly blind evaluation program for EPA regional and contract labs. The ORGDP lab scored 99% and 98%, respectively, on initial organic and inorganic quarterly blinds submitted in November 1986.

Table 12.2.12. EPA performance evaluation report DMR-QA study number 006 ORNL 1986

Analytes	V[a] P	Reported value	True value[b]	Acceptance limits	Warning limits	Performance evaluation
			Trace metals (μg/L)[c]			
Aluminum		2000	2129	1780–2430	1860–2350	Acceptable
Arsenic		270	342	244–419	266–397	Acceptable
Beryllium	X	290	291	246–326	256–316	Acceptable
Cadmium		320	307	269–348	279–338	Acceptable
Chromium		280	274	213–331	227–316	Acceptable
Cobalt	X	980	953	783–1090	822–1050	Acceptable
Copper		360	380	332–422	344–411	Acceptable
Iron		1400	1311	1120–1480	1170–1440	Acceptable
Lead		130	118.8	89.0–146	96.1–139	Acceptable
Manganese		560	510	448–564	463–550	Check for error
Mercury		29.0	50.0	34.4–65.9	38.3–61.9	Not acceptable
Nickel		550	532	460–605	479–587	Acceptable
Selenium		62	54.9	32.6–66.9	36.9–62.6	Acceptable
Vanadium	X	1700	1660	1370–1930	1440–1860	Acceptable
Zinc		400	383	333–429	345–417	Acceptable
			Miscellaneous parameters			
pH (units)		6.64	6.70	6.54–6.83	6.58–6.80	Acceptable
Total suspended solids (mg/L)		32	35.6	26.6–37.5	28.0–36.1	Acceptable
Oil and grease (mg/L)		17.1	16.0	7.40–22.1	9.24–20.3	Acceptable
Total cyanide (mg/L)		1.07	1.05	0.609–1.36	0.706–1.27	Acceptable
Total phenolics (mg/L)		0.260	0.277	0.115–0.438	0.155–0.398	Acceptable
Total residual chlorine (mg/L)		1.30	1.14	0.721–1.49	0.820–1.40	Acceptable
			Nutrients (mg/L)			
Ammonia-nitrogen		4.56	4.60	3.68–5.49	3.90–5.28	Acceptable
Nitrate-nitrogen		2.50	2.50	2.05–2.95	2.16–2.84	Acceptable
Kjeldahl nitrogen	X	15.6	15.2	11.6–18.4	12.4–17.6	Acceptable
Total phosphorus		1.20	1.10	0.848–1.39	0.913–1.32	Acceptable
Orthophosphate	X	1.30	1.31	1.09–1.51	1.14–1.46	Acceptable
			Demands (mg/L)			
COD	X	96	97.9	70.8–115	76.3–109	Acceptable
TOC		37.9	38.6	28.9–47.7	31.4–45.3	Acceptable
5-day BOD		74	63.8	40.4–87.3	46.2–81.5	Acceptable

[a]An "X" in this column indicates a voluntary analyte not listed in the facilities permit.
[b]Based on theoretical calculations or a reference value when necessary.
[c]Units are as specified by EPA for this program.

12.3 ANALYSIS PROCEDURES

Listings of the analysis procedures and references back to EPA methods are given in Tables 12.3.1–12.3.5.

12.4 GENERAL PROCEDURES

The Energy Systems Committee on Environmental Analysis was established in 1977 to provide a uniform basis for measuring

Table 12.3.1. Energy Systems environmental analysis procedures for water

Parameter	Energy Systems method	EPA method	Detection limit[a] (mg/L)
Gross alpha activity	EC-101		1.0 pCi/L
Gross beta activity	EC-101		4.0 pCi/L
Americium-241 and Curium-244	EC-102		3.0 pCi/L ea.
Arsenic and selenium, gaseous hydride-AA			
As	EC-104	206.3	0.002
Se	EC-104	270.3	0.002
Asbestos	EC-105		2×10^6 fibers/L
Biochemical oxygen demand (5-d)	EC-106	405.1	5.0
Bromide, spectrophotometric	EC-107	ASTM D 1216-77	0.1
Chemical oxygen demand (low level), titration method	EC-109	410.2	5
Chloride, titration ($HgNO_3$)	EC-112	325.3	2
Anions, ion chromatograph[b]			
Chloride	EC-113	300.0	2
Nitrate (N)	EC-113	300.0	0.5
Sulfate	EC-113	300.0	10
Chlorine (total residual), amperometric	EC-115	330.1	0.05
Chromium (VI), spectrophotometric	EC-118	USGS[c]	0.01
Coliform bacteria (fecal)	EC-119	909C Std Mth[d]	1 col/100 mL
Coliform bacteria (total)	EC-120	909A Std Mth	1 col/100 mL
Color	EC-122	110.2	1 color unit
Conductance (specific)	EC-124	120.1	0.5 μmhos/cm
Cyanide (total)	EC-127	335.2	0.02
Dissolved oxygen, membrane electrode method	EC-130	360.1	0.1
Fluoride	EC-133	340.2	0.1
Gamma-ray emitters	EC-134		2.5 pCi/L
Herbicides (chlorinated phenoxy acid), GC method			
2, 4-D	EC-137	509B Std Mth	0.1 μg/L
Silvex	EC-137	509B Std Mth	0.1 μg/L
Mercury (total)	EC-139	245.1	0.0002
Iodine-131	EC-138		4.0 pCi/L
Methylene-blue-active substances	EC-145	425.1	0.05
Neptunium-237	EC-146		1.0 pCi/L (ORNL) 4×10^{-2} pCi/L
Nitrogen, ammonia, spectrophotometric	EC-147	350.2	0.2
Nitrogen, ammonia, SIE	EC-148	350.3	0.2
Nitrogen, Kjeldahl (total), spectrophotometric	EC-150	351.4	0.2
Nitrogen, Kjeldahl (total), volumetric	EC-151	351.3	0.2
Nitrogen, Kjeldahl (total) SIE	EC-152	351.3	0.2
Nitrogen, nitrate-nitrite, Cd-Redn.	EC-153	353.3	0.2
Nitrogen, nitrate, brucine method	EC-154	352.1	0.2
N-nitrosomorpholine, spectrophotometric	EC-155		1.0
Oil and grease, gravimetric	EC-156	413.1	5
Oil and grease, infrared	EC-157	413.2	2.0
Total organic carbon, combustion or oxidation	EC-158	415.1	1
Phenols	EC-159	420.1	50 μg/L (w/o conc.) 5 μg/L (with conc.)
pH, electrometric	EC-160	150.1	Nearest 0.1 pH unit

Table 12.3.1 (continued)

Parameter	Energy Systems method	EPA method	Detection limit[a] (mg/L)
Phosphorus (all forms), spectrophotometric	EC-161	365.2	0.1
Polychlorinated biphenyls (PCB)	EC-162	608	0.5 μg/L ea.
Pentachlorophenol, HPLC	EC-164		50 μg/L
Pesticides (organochlorine), GC method	EC-165		
Lindane		608[e]	0.01 μg/L
Endrin		608	0.05 μg/L
Toxaphene		608	1.0 μg/L
Methoxychlor		509A Std Mth	0.2 μg/L
Plutonium isotopes	EC-168		1.0 pCi/L (ORNL) 4×10^{-2} pCi/L
Solids (dissolved)	EC-176	160.1	10
Solids (settleable)	EC-177	160.5	0.2 mL/L/h
Solids (total)	EC-179	160.3	10
Solids (undissolved)	EC-180	160.2	4
Solids (volatile)	EC-182	160.4	5
Strontium-90	EC-184		4.0 pCi/L
Sulfate, turbidimetric method	EC-185	375.4	10
Technetium-99	EC-186		300 pCi/L
Thorium isotopes	EC-187		0.4 pCi/L (ORNL) 4×10^{-2} pCi/L
Thorium, spectrophotometric	EC-187A		2×10^{-3} mg/L
Turbidity	EC-188	180.1	0.05 NTU
Tritium	EC-189		5000 pCi/L
Uranium (total), fluorometric	EC-191		1×10^{-3} mg/L
Uranium isotopes	EC-192		1 pCi/L (ORNL) 4×10^{-2} pCi/L
Uranium isotopic abundances	EC-196		0.001 wt %
Trihalomethanes, extraction-GC method			
$CHCl_3$	EC-198	601[e]	1 μg/L
$CHBrCl_2$	EC-198	601	0.5 μg/L
$CHBr_2Cl$	EC-198	601	1 μg/L
$CHBr_3$	EC-198	601	5 μg/L
Organic extractables (base/neutral/acid)	EC-170	625	mostly 2-20 mg/L each[f]
Organic purgeables (volatile)	EC-172	624	mostly 20-30 mg/L each[g]

[a]The detection limit for specific samples may vary depending on interferences in the sample matrix. For many EPA-approved procedures, Method Detection Limits (MDLs) are not provided. EPA does not require that its MDLs be applied on its methods; however, any data reported at levels below its MDLs must be supported by sound statistical documentation. The detection limits applied by the Energy Systems laboratories meet the needs of the programs they support; lower levels may be reported on some parameters, on special request and at increased cost.

[b]Approved for drinking water only (reagent water).

[c]"Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 78-679, or "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments," N. W. Skougstad et al., U.S. Geological Survey, *Techniques of Water-Resources Investigation,* Book 5, Chapter A1, 1979.

[d]All references to Standard Methods for the 15th Edition, 1980.

[e]*Federal Register* 49 (209), 43,261, October 26, 1984.

[f]For 81 compounds.

[g]For 31 compounds.

Table 12.3.2. Energy Systems atomic absorption and ICP environmental analysis procedures[a,b] for water and wastewaters

Element	MMES EC-140 EPA 200 Series Flame AA DL[c] (mg/L)	MMES EC-140 EPA 200 Series Graphite furnace AA DL (mg/L)	MMES EC-141 EPA 200.7 ICP DL (mg/L)[d]
Ag	0.01	0.0002	
Al	0.05	0.003	0.045
As	0.002[e]	0.005[c]	0.053
Ba	0.2	0.002	0.002
Ca	0.1		0.01
Cd	0.002	0.0001 (special)	0.004
Cr	0.01	0.001	0.007
Cu	0.004	0.001	0.006
Fe	0.06	0.001	0.007
K	0.1		
Li	0.01		
Mg	0.1		0.03
Mn	0.01	0.0002	0.002
Mo	0.1	0.001	0.008
Na	0.1		0.029
Ni	0.01	0.001	0.015
Pb	0.01	0.001	0.042
Se	0.002[e]	0.002	0.075
Zn	0.02	0.00005	0.002

[a]Detection limits are given as a guide. Actual limits may vary as the sample matrix varies.

[b]The detection level for specific samples may vary depending on interferences in the sample matrix. EPA does not require that its Method Detection Limits (MDLs) be applied on its approved methods; however, any data reported below its MDLs must be supported by sound documentation. The detection limits applied by Energy Systems laboratories meet the needs of the programs they support.

[c]DL = detection limit (not identical with EPA). These DLs are instrumental limits, which vary from one instrument or laboratory to another. Reporting limits may be three to five times the instrumental limits.

[d]Instrumental EPA limits; DLs under evaluation for this new method at Energy Systems.

[e]Cold vapor technique.

environmental pollutants and to ensure that measurement sensitivity, quality, and methodology remain in accord with the federal and state requirements for environmental monitoring. The resulting Environmental and Effluent Analysis Manual, which is updated regularly (Union Carbide, 1977), emphasizes laboratory procedures for measuring parameters that appear on the NPDES permits or air discharge permits of any of the Oak Ridge DOE installations. The manual details 111 analytical procedures for water, air, sediment and soil, biota, and miscellaneous media such as oil under test for reuse. Procedures for both radiological and nonradiological parameters are included. EPA-approved analytical methods are used whenever possible.

This committee also coordinates special quality control programs of interest to all installations, such as the measurement of fluorides in air or PCBs in oil. It has also been instrumental in the generation and evaluation of proposed analytical control standards, such as PCBs in transformer oil and ^{99}Tc in grass and soil. The committee has also accepted responsibility for overseeing the reliability of certain external quality control standards, including those generated and certified by a commercial source.

Table 12.3.3. Energy Systems environmental analysis procedures for air

Parameter	Energy Systems method	NIOSH or EPA method	Detection limit
Gamma-ray spec., air filters	EC-240		Procedure in prep.
I-131, gamma-ray spec., air filter	EC-242		2.5 pCi/filter
Pu, air filters, radiochemistry	EC-250	EPA-680/4-75-001	0.04 pCi/filter
Sr-90, air filters, radiochemistry	EC-258		2 pCi/filter
Tc-99, air filters, radiochemistry	EC-260		300 pCi/filter
Th alpha isotopes, radiochemistry	EC-264		0.04 pCi/filter
U isotopes, air filters, radiochemistry	EC-287	EPA-680/4-75-001	0.04 pCi/filter
Gross alpha, beta, air filters, radiochemistry	EC-210	APHA 601, 602[a]	Alpha 0.005 pCi/m^3 Beta 0.025 pCi/m^3
U, air filters, fluorometric	EC-285		0.05 μg/sample
U, stack gases, spec./fluoro.	EC-289		1.7 μg/m^3
Organic solvents, air, GC method	IHA-250	NIOSH 127[b]	18 cpds; 0.01 to 1.0 mg/sample
PCBs, air, GC	IHA-270	NIOSH 244	10 μg/m^3
Toluene disocyanate, air	IHA-280	NIOSH 141	7 μg/m^3
Tributyl phos., air, GC method	IHA-285	NIOSH S208	2.7 mg/m^3
Vinyl chloride, air, GC method	IHA-294	NIOSH 178	8 μg/m^3
Dustfall, gravimetric	EC-277		Procedure in prep.
Metals in air particulates, emission spec.	EC-244		For 48 metals, mostly 1–10 μg each/sample
Dichlorotetrafluoroethane, GC method	IHA-230	NIOSH S108	3500 mg/m^3
Dioctyl phthalate, air, GC method	IHA-235	NIOSH S40	2 mg/m^3
Formaldehyde, air	IHA-237	NIOSH 125	0.1 mg/m^3
Isopropanol, air	IHA-240	NIOSH S64	180 mg/m^3
Quinoline, air	IHA-273		Procedure in prep.
Fluoride, air, SIE	EC-236		5 μg/sample
Fluoride, stacks, SIE	EC-237		30 μg/m^3
Oil mist, air, infrared	IHA-247		0.5 mg/m^3
Pentachlorophenol, air, HPLC	IHA-260	NIOSH S297	0.27 mg/m^3

[a] *APHA Methods*, American Public Health Assoc., 1977.
[b] *NIOSH Manual of Analytical Methods*, Second Ed., U.S. Dept. of Health, Education, and Welfare, 1977.

Quality assurance in environmental monitoring is a well-accepted responsibility at all of the Oak Ridge installations. The program at ORNL is specifically developed to keep pace with the broad surveillance responsibilities for both radiological and nonradiological monitoring in the Oak Ridge area. This program includes:

- operating procedures for each activity;
- inspection lists of operating and maintenance activities;
- check-off frequency lists for all QA steps, such as schedules for equipment inspection and test control;
- documentation of compliance with QA procedures;
- participation in intralaboratory and interlaboratory sample-exchange programs;
- evaluation of the adequacy of sample preparation work and data analysis; and
- identification of the role, responsibilities, and authority of each staff member as related to quality assurance.

Several of the American National Standards Institute (ANSI) standards (ANSI, 1969, 1974a, 1974b) available for environmental sampling and

Table 12.3.4. Energy Systems environmental analysis procedures for soil and sediment

Parameter	Energy Systems method	EPA method	Detection limit (mg/kg)
Fluoride	EC-305		Procedure in preparation
Gamma ray spectrum analysis	EC-307		Procedure in preparation
Mercury (total), flameless atomic absorption	EC-310	245.5	0.2
Metals, atomic absorption	EC-320	200 Series	See Table 12.3.2
Metals, inductively coupled plasma-optical emission spectrometric (ICP-OES)	EC-325	200.7	See Table 12.3.2
Neptunium-237, radiochemical	EC-330		20 pCi/kg
Neptunium, direct gamma spectrum	EC-331		Procedure in preparation
Plutonium, radiochemical	EC-336		20 pCi/kg
Polychlorinated biphenyls (PCB), gas chromatographic	EC-340		0.1
Strontium-90, radiochemical	EC-350	704 Std Mth[a]	200 pCi/kg
Technetium-99, radiochemical	EC-355		2×10^4 pCi/kg
Thorium, spectrophotometric	EC-360		3
Thorium (alpha-emitting) isotopes, radiochemical	EC-365		4 pCi/kg
Uranium (total), fluorometric	EC-370		0.5
Uranium (total and isotopic), isotope dilution mass spectrometric	EC-374		10 ng total U
Uranium isotopes, radiochemical	EC-378		4 pCi/kg

[a]References to Standard Methods are from the 14th Edition, 1975.

Table 12.3.5. Energy Systems environmental analysis procedures for biota

Parameter	Energy Systems method	EPA method	Detection limit (mg/kg)
Fluoride in vegetation	EC-410		3
I-131 and Sr-90 in raw milk	EC-418		I-131, 1 pCi/L Sr-90, 1 pCi/L
Metals in fish, atomic absorption	EC-425	600-4-81/055[a]	See Table 12.3.2
Metals in vegetation, atomic absorption	EC-430		See Table 12.3.2
Pu isotopes in fish	EC-436		20 pCi/kg (ORNL) 4 pCi/kg
Pu isotopes in vegetation	EC-438		40 pCi/kg (ORNL) 4 pCi/kg
PCBs in fish and animal tissue	EC-440	600/4-81-055[a]	0.1
Sr-90 in fish	EC-460		1000 pCi/kg (ORNL) 200 pCi/kg
Sr-90 in vegetation	EC-462		1000 pCi/kg (ORNL) 200 pCi/kg
Th isotopes in vegetation	EC-464		40 pCi/kg (ORNL) 4 pCi/kg
U (total) in vegetation	EC-470		0.5
U (total and isotopic) in vegetation	EC-472		10 ng/sample
U isotopes in vegetation	EC-484		40 pCi/kg (ORNL) 4 pCi/kg
Gamma-ray spectrometry of deer muscle	EC-413		Procedure in preparation
Gamma-ray spectrometry of fish	EC-415		Procedure in preparation
Gamma-ray spectrometry of vegetation	EC-417		Procedure in preparation
Technetium-99 in fish	EC-463		Procedure in preparation
Technetium-99 in vegetation	EC-463 A		Procedure in preparation
Uranium isotopes in animal tissue	EC-480		Procedure in preparation
Procedures for atomic absorption			
Metals in fish, furnace AA	EC-425	600/4-81-055[a]	
Cd			0.01
Cr			0.05
Cu			0.10
Ni			0.50
Pb			0.05
Metals in vegetation, flame AA	EC-430		
Cd			0.5
Cr			3.0
Cu			2.0
Ni			3.5
Zn			0.5

[a]"Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue," EPA, Rev. October 1980.

data analysis are being implemented in the stack and air sampling programs at the three Oak Ridge installations. The American Chemical Society Committee on Environmental Improvement guidelines (Am. Chem. Soc., 1980) on data acquisition are being considered for implemention at the three installations.

Figure 12.4.1 is a schematic diagram showing a flow chart of this QA program. A sample flow and feedback loop on environmental surveillance is shown in Fig. 12.4.2. Several studies have been completed on the development of QA in environmental sampling. More detailed discussions of this QA program are presented elsewhere (Oakes et al., 1977a, 1977b, 1978, 1980; Oakes, 1983; Shank et al., 1980).

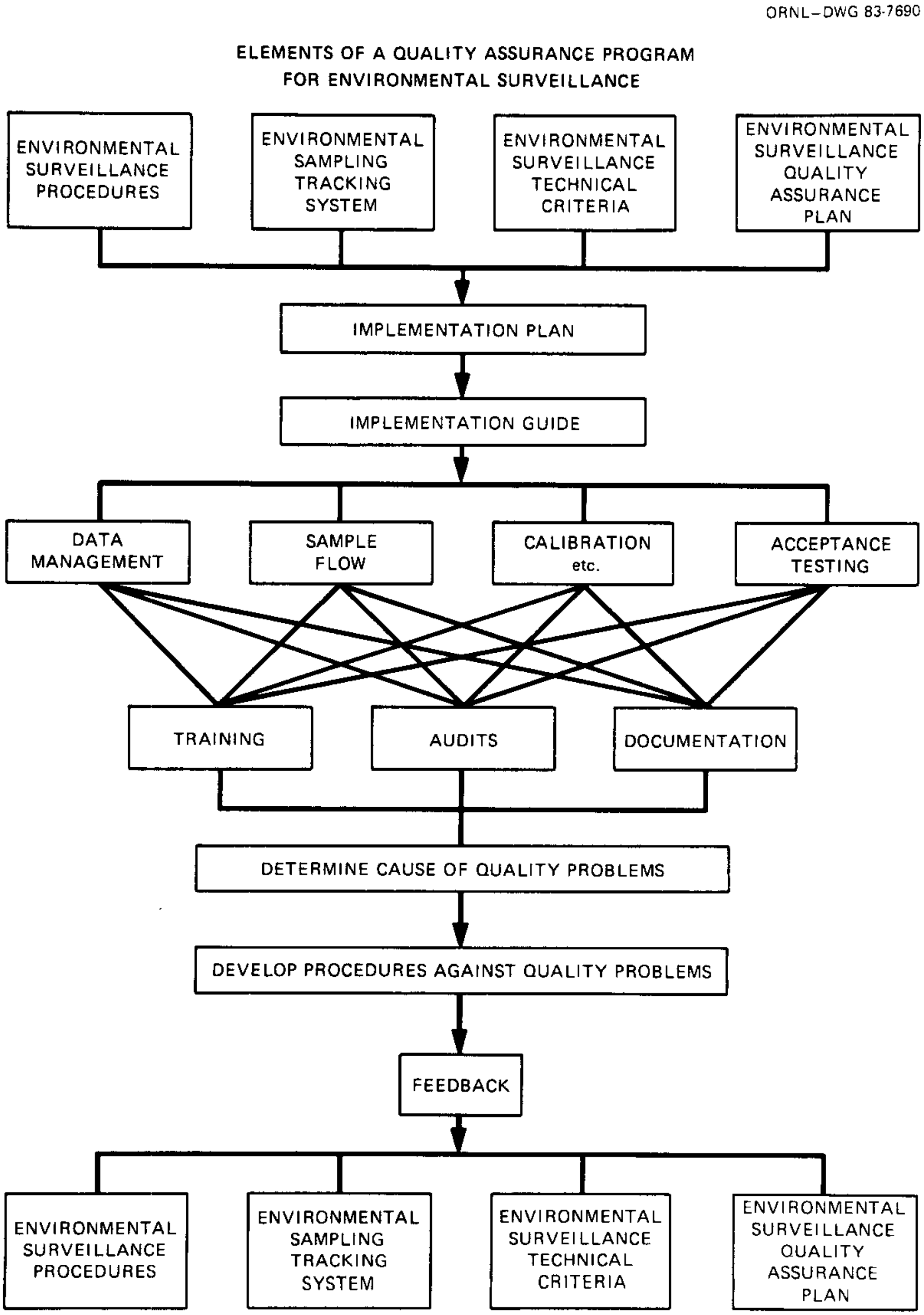

Fig. 12.4.1. Schematic diagram showing flow chart of QA program.

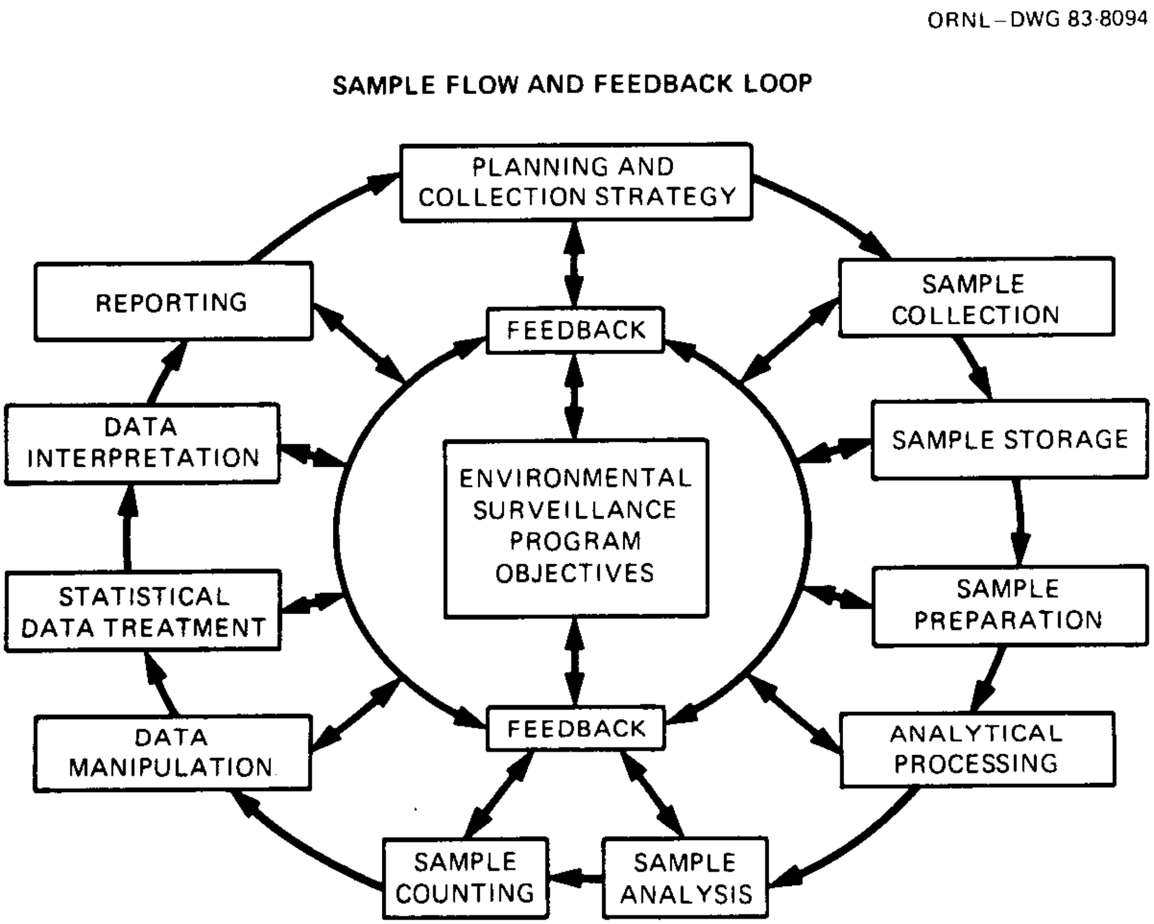

Fig. 12.4.2. Environmental surveillance sample flow and feedback loop.

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