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ENVIRONMENTAL RESTORATION FOOTPRINT REDUCTION PROCESS

EVALUATION OF GALLAHER BEND/BULL BLUFF PARCEL

DOE/OR/01-1479&D1

Energy Systems Environmental Restoration Program

Environmental Restoration Footprint Reduction Process

Evaluation of Gallaher Bend/Bull Bluff Parcel

Date Issued—July 1996

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.
managing the
Environmental Management Activities at the
Oak Ridge K-25 Site Paducah Gaseous Diffusion Plant
Oak Ridge Y-12 Plant Portsmouth Gaseous Diffusion Plant
Oak Ridge National Laboratory
under contract DE-AC05-84OR21400
for the
U.S. DEPARTMENT OF ENERGY

PREFACE

This *Environmental Restoration Footprint Reduction Process Evaluation of Gallaher Bend/Bull Parcel* (DOE/OR/01-1479&D1) was prepared as an information and management tool for the environmental management programs of the U.S. Department of Energy and Lockheed Martin Energy Systems, Inc. This report documents the results of an investigation intended to determine whether hazardous substance contamination is present on the parcel. This report and subsequent parcel investigations during FY96 are combined with an effort to perform work on Remedial Site Evaluations, with the common goal being No Further Investigation determinations for areas evaluated and found to be free of contamination. Both projects are being performed under Work Breakdown Structure 1.4.12.2.3.04.11 (Activity Data Sheet 8304, "ER Footprint Reduction and Site Evaluation Processes for the ORR").

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ABBREVIATIONS

AOC	area of concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
FFA	Federal Facility Agreement
GIS	geographic information system
LMER	Lockheed Martin Energy Research Corporation
LMES	Lockheed Martin Energy Systems, Inc.
NFI	No Further Investigation
NPL	National Priorities List
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
RI	Remedial Investigation
SWMU	solid waste management unit
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
WAG	waste area grouping

EXECUTIVE SUMMARY

The Oak Ridge Reservation (ORR) comprises 35,545 acres owned by the U.S. Department of Energy (DOE). Almost all of the ORR land is located within the city limits of Oak Ridge, Tennessee. The ORR contains four DOE installations: the Oak Ridge K-25 Site (formerly the Oak Ridge Gaseous Diffusion Plant) managed by Lockheed Martin Energy Systems, Inc. (LMES), the Oak Ridge Y-12 Plant managed by LMES, Oak Ridge National Laboratory managed by Lockheed Martin Energy Research Corporation, and the Oak Ridge Institute for Science and Education Scarboro Operations Site.

The DOE installations on the reservation generate solid, hazardous, and mixed waste (hazardous waste mixed with radionuclides). Also, the ORR has many historic or legacy waste areas that supported prior missions. Two federal laws, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), are the dominant regulatory drivers for environmental management activities on the ORR.

In December 1989, the ORR was placed on the National Priorities List (NPL) as a high priority hazardous waste site requiring remediation. In January 1992, DOE, the Environmental Protection Agency, and the Tennessee Department of Environment and Conservation (TDEC) negotiated the Federal Facility Agreement (FFA) for environmental restoration activities on the ORR. The FFA is intended to integrate the corrective action processes of RCRA and CERCLA.

DOE is responsible for cleaning up the ORR following the CERCLA process which assesses the impacts of ORR areas on human health and the environment. To fulfill this requirement, information about ORR areas and potential contamination must be collected and reviewed to determine whether CERCLA response activities are needed.

The Gallaher Bend/Bull Bluff parcel is being evaluated by the DOE Environmental Management program as part of an incremental process to identify what ORR lands have not been impacted by activities that would result in hazardous substance contamination, to issue all such lands a No Further Investigation (NFI) status, and to show that uncontaminated parcels or portions of parcels are no longer considered part of the NPL site. This process is generally referred to as the Environmental Restoration Footprint Reduction process. Contaminated areas identified on the parcel being evaluated will be added to Appendix C of the FFA as an area of concern (AOC) and be subject to the conditions of that agreement.

The CERCLA 120(h) process, which is utilized to identify the presence or likely presence of hazardous substances on property being transferred by federal agencies, is used to investigate ORR parcels for this project. The CERCLA 120 (h) process requires that the following information sources be used to identify the presence of hazardous substance contamination on government land: historical, aerial photography, and field investigation/verification. Remote sensing data were added to the minimum CERCLA 120 (h) requirements to augment the historical aerial photography and to ensure a comprehensive investigation using available sources.

The results of the investigation are as follows:

- No information gathered during the historical investigation indicated that any past or present activity on the parcel has resulted in hazardous substance contamination. Information on nearby

AOCs was submitted to a TDEC field investigation team for verification of their impact on the parcel.

- The aerial photography investigation indicates that this parcel was not used for industrial activities that would have resulted in hazardous substance contamination. The appearance of surface water ponds, however, may be indicative of underground water movement on the ORR.
- Vertical magnetic gradient and thermal-derived anomalies were identified by the remote sensing investigation. The vertical magnetic anomalies were mapped for verification by a TDEC field investigation team. Five locations of thermal-derived anomalies were identified. The thermal-derived anomalies were associated with post-1942 management of the parcel, trails, the existence of structures at Clark Center Park, or were correlated with historical photography land use/cover patterns and determined to be associated with prior agricultural activities.
- The field investigation/verification attributed all mapped anomalies to prior dwellings or changes in geology or soil type, and there were no observable negative environmental impacts to the parcel from any prior or present activities.

A thorough review of historical information, aerial photography, and remotely sensed data available for the parcel indicates that activities by the federal government and previous owners did not leave a contamination legacy. Field investigations and verification by TDEC confirm this finding. The possibility of groundwater contamination from affected areas of the ORR exists and there may be a need for groundwater use restrictions. Presently, there are no groundwater monitoring wells on the parcel and investigation results and current land use do not justify the initiation of intrusive sampling. The recommendation for this parcel is submittal to the tri-party members of the FFA for NFI designation.

1. INTRODUCTION

1.1 LOCATION OF PARCEL

The Gallaher Bend/Bull Bluff parcel comprises 1,200 acres on the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee (see Fig. 1). The boundary generally follows the winter pool shoreline of the Melton Hill Reservoir, the McCoy Branch embayment, and the Walker Branch embayment, consistent with the Tennessee Valley Authority (TVA) Oak Ridge Area S-16A quadrangle map. Other boundaries generally follow a set back of 150 ft from the center line of streams in the northern portion of the parcel and from the center line of Bethel Valley Road.

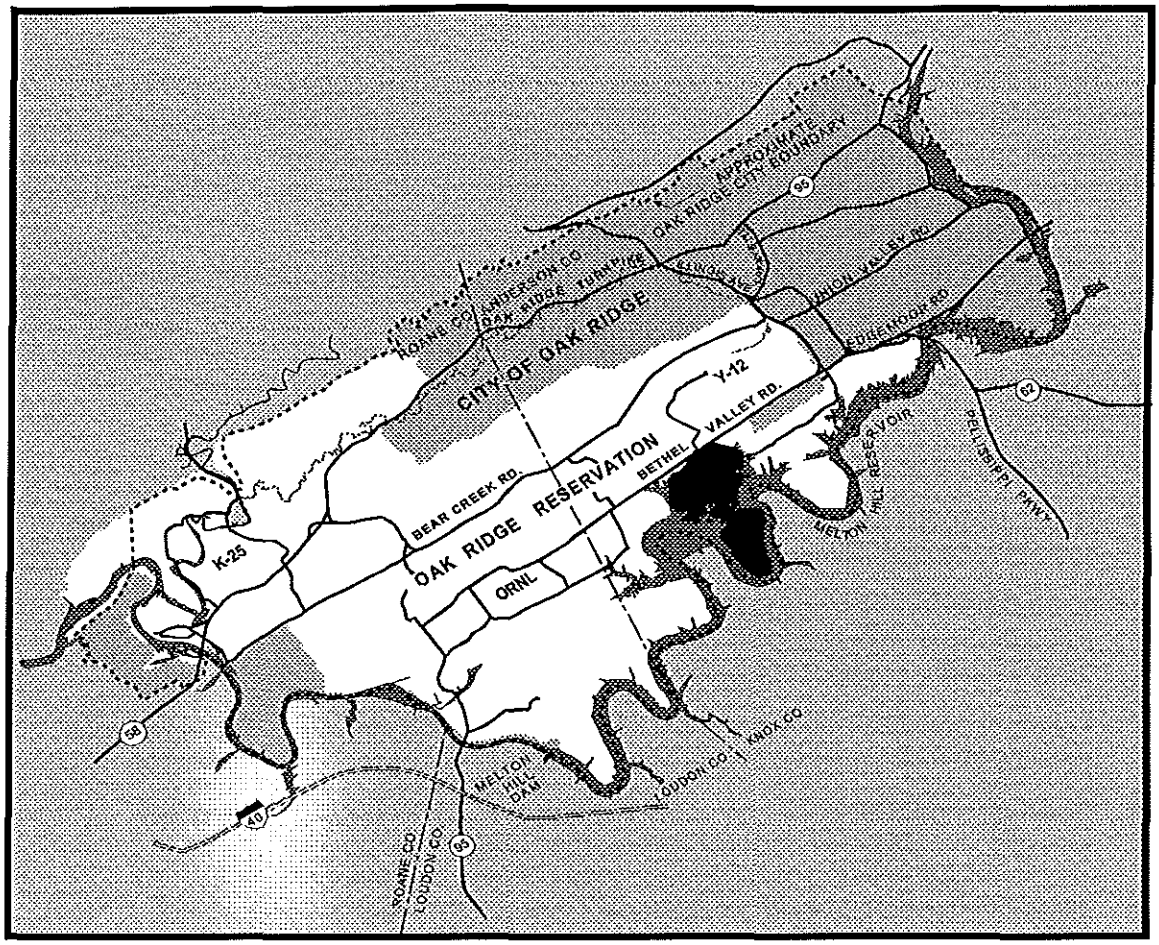

Fig. 1. Location of Gallaher Bend/Bull Bluff Parcel

1.2 PURPOSE

The Gallaher Bend/Bull Bluff parcel is being evaluated by the U.S. Department of Energy (DOE) Environmental Management program as part of an incremental process to identify ORR lands that have not been impacted by activities that would result in hazardous substance contamination and to issue all such lands a No Further Investigation (NFI) status. This process is generally referred to as the Environmental Restoration Footprint Reduction process. Contaminated areas identified on the parcel being evaluated will be added to Appendix C of the Federal Facility Agreement (FFA) as an area of concern (AOC) and be subject to the conditions of that agreement. Uncontaminated parcels or portions of parcels will not be considered part of the National Priorities List (NPL) site.

1.3 PROCESS OVERVIEW

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 120 (h) process, which is utilized to identify the presence or likely presence of hazardous substances on property being transferred by federal agencies, was used to evaluate this parcel. The CERCLA 120 (h) process information requirements are provided in Table 1 along with the applicable Footprint Reduction sources.

Table 1. Parcel evaluation information requirements [from CERCLA 120 (h)] and sources

CERCLA 120 (h) requirements	Sources
1. A detailed search of federal government records pertaining to the real property.	Historical
2. Recorded chain of title documents regarding the real property.	Historical
3. Aerial photographs that may reflect prior uses of the real property that are reasonably obtainable through state or local government agencies.	Aerial photography, Remote sensing
4. A visual inspection of the real property and any buildings, structures, equipment, pipe, pipeline, or other improvements on the real property, and a visual inspection of properties immediately adjacent to the real property.	Field investigation/ verification
5. A physical inspection of property adjacent to the real property to the extent permitted by owners or operators of such property.	Field investigation/ verification
6. Reasonably obtainable federal, state, and local government records of each adjacent facility where there has been a release of any hazardous substance or any petroleum product or its derivatives, including aviation fuel and motor oil, and which is likely to cause or contribute to a release or threatened release of any hazardous substance or any petroleum product or its derivatives, including aviation fuel and motor oil, on the real property.	Historical
7. Interviews with current or former employees involved in operations on the real property.	Historical

The first stage in the parcel evaluation process was to collect and process source data that would identify suspect locations (i.e., known sites with potential contamination and landscape anomalies that may suggest unknown contamination). The primary sources intended to identify potential contaminated sites were the literature search, interviews of persons familiar with activities on the parcel, and remotely

sensed gamma surveys. Sources to identify landscape anomalies included remotely sensed vertical magnetic gradient, thermal imagery, and aerial photography. Supportive indicators of possible contamination are ancillary data that do not directly indicate an anomaly but which, in conjunction with other data, support the anomaly identification (e.g., topography, geology, and the location of historical sites) (see Fig. 2).

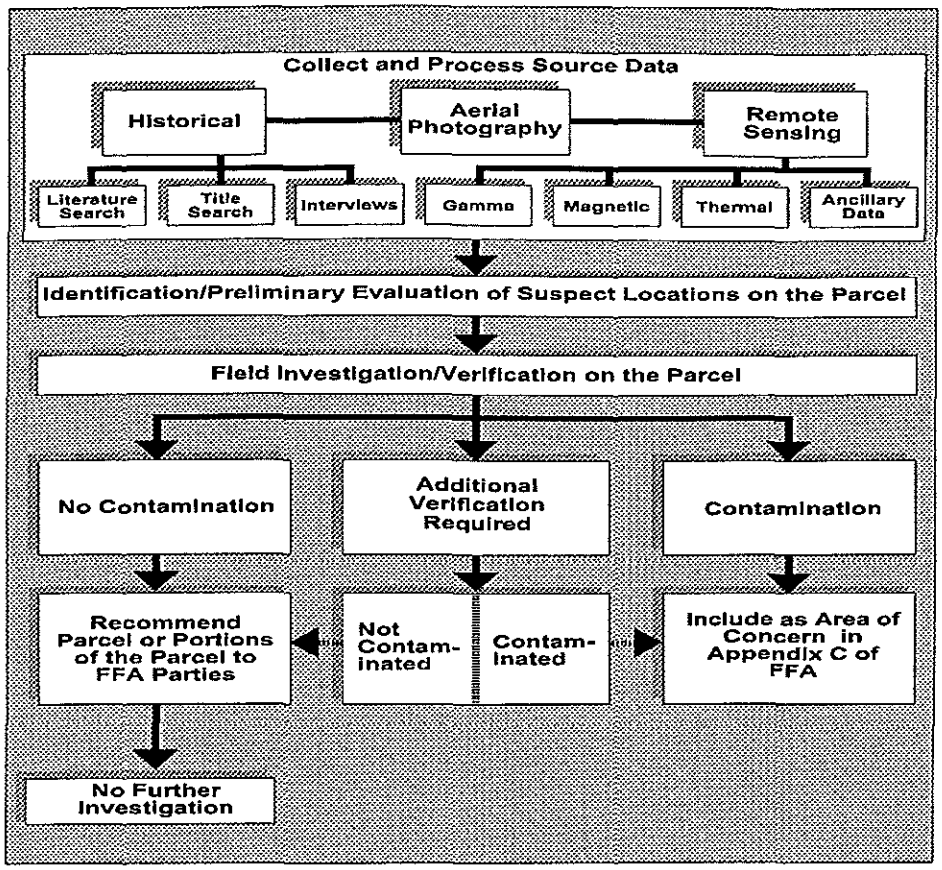

Fig. 2. Process Flowchart

The second stage in the process was to map and evaluate the potential contaminated sites and landscape anomalies. For sites with potential contamination, the following questions were addressed: What is the severity of contamination (in relation to background levels), and if contamination is adjacent to the parcel, what is the potential for the parcel to be impacted? For landscape anomalies, the following questions were addressed: What cultural or physical processes created each anomaly, when did they occur, and do the causal processes suggest contamination?

Field investigation was then performed to verify whether any activities adjacent to or on the parcel have had a negative environmental impact on the parcel and to explain the causes of many of the anomalies.

The third stage in the process was to synthesize the investigation information and to determine with a high degree of certainty how much of the parcel is either free of contamination, requires additional verification, or is contaminated. For the Gallaher Bend/Bull Bluff parcel, no contaminated areas were identified, and the entire parcel was submitted to the FFA parties for NFI designation.

2. HISTORICAL INVESTIGATION

2.1 LITERATURE SEARCH

2.1.1 Methods Used

The literature search was focused on reviewing documents from the following sources: the DOE Information Resource Center, the Central Research Library, the Environmental Restoration Document Management Center, and the Site and Facilities Planning Resource Center. Documents reviewed were related to past and present ORR land use, environmental restoration, and waste management (see Appendix B for a list of primary documents).

2.1.2 On-Site Findings

Information from the literature search was used to inventory the parcel's physical features and past and present land uses (see Table 2 and Fig. 3).

Table 2. Parcel inventory

Physical features
Buildings and Infrastructure: Clark Center Park restroom facility, shelter, and supporting utilities. Gallaher Bend Road, which connects to Bull Bluff Road at Clark Center Park, is the only road. A natural gas pipeline and a power line are located at the northern part of the parcel. **Cultural Sites:** 4 pre-World War II agriculture-related structures. **Topography:** Northern part consists of the ridge and both slopes of Haw Ridge. Southern part consists of moderately sloping land that extends to the tip of the bend. Bull Bluff is in eastern-central part. **Surface Hydrology:** Several streams flow into the Melton Hill Reservoir and several ponds are present on the parcel. **Vegetation:** A mixture of deciduous and coniferous forest covers 85% of the parcel, with grassland and hay fields comprising 15%. **Geology:** Chickamauga, Rome, Knox, and Conasauga formations.
Past and present land use
• Clark Center Park is a public recreational park managed by the Y-12 Plant. • The University of Tennessee grazed cattle in this area when it was used to support the activities of the Comparative Animal Research Laboratory from the late 1940s to the early 1980s. • The northwest portion of the site was used in the 1980s as an environmental research site to study the movement of nutrient materials from terrestrial to aquatic systems. • Hay farming is currently conducted by an off-site contractor. The hay is used as feed for livestock located off-site. The hay is monitored and the data are included in the annual Environmental Report for the ORR (Kornegay et al. 1994). Results of the hay monitoring reveal no contamination problems. • Timber harvesting is managed by DOE.

2.1.3 Adjacent Site Findings

Several documents described contamination at AOCs near the parcel (see Table 3 and Fig. 3). These findings were submitted to a Tennessee Department of Environment and Conservation (TDEC) field investigation team for verification of their impact on the parcel.

Table 3. Adjacent site contamination profile

Adjacent potential contaminated site	Contamination/CERCLA activities
Chestnut Ridge Operable Unit (OU) 2 (Filled Coal Ash Pond/McCoy Branch)	• The pond was constructed in 1955 to serve as a settling basin for coal ash from the Y-12 steam plant. By 1967 the pond had filled, spilling sediments directly into McCoy Branch. From 1967 to 1989, ash was carried by McCoy Branch to Rogers Quarry, ~0.5 mile downstream of the Coal Ash Pond. [a] • Ash pond impacts to surface water, stream sediments, and groundwater from metals, including uranium and major ions, are of concern. [a] • Since 1989 there has been a decrease in arsenic to levels that are well below the Environmental Protection Agency water quality criterion for protection of aquatic life. [b] • A Proposed Plan and Record of Decision have been prepared for the Filled Coal Ash Pond. The preferred alternative is stabilization of the dam and relocation of a wetlands which will be disrupted as a result of construction. Preparation of the Remedial Design Work Plan is underway. [a]
Rogers Quarry (Lower McCoy Branch)	• From 1967 to 1989, ash from the Filled Coal Ash Pond was carried by McCoy Branch to Rogers Quarry. The quarry also has been used for the disposal of a variety of plant process materials. Potential contaminants of concern are coal ash, metals, and radionuclides. [a] • A National Pollutant Discharge Elimination System (NPDES) outfall (S-19; previously designated 302) is located at the point of origin of lower McCoy Branch. Data collected show numerous exceedances of the NPDES permit, particularly pH levels. In addition, levels of arsenic, cadmium, copper, iron, lead, mercury, selenium, zinc, and temperature have exceeded Ambient Water Quality Criteria. [c] • According to the *Remedial Investigation/Feasibility Study for the Clinch River/Poplar Creek Operable Unit*, issued in September 1995, concentrations of arsenic in the surface water of lower McCoy Branch are comparable to concentrations in Melton Hill Reservoir. No clear toxicity is evident in surface water or sediment. [d]
Municipal Sewage Sludge Application Site	• This site was used from 1983 through 1986 for the disposal of digested sewage sludge from the sewage treatment plant in Oak Ridge. There was concern about high levels of radionuclides, metals, and nitrogen. [e] Surface water and sediment analysis revealed that nickel was the only metal that was found to be above background levels. [f] • In 1994, a NFI was approved for the site. [g]
Cesium-134 Tagged Tree	• Contamination at this site involved a single red cedar tree in a field inoculated on August 15, 1964, with 5.69mCi of cesium-134. The study was designed to determine the uptake and transfer of the radionuclide through metamorphosis of the bagworm moth. Approximately 100 square meters was involved. [h] • The tree has been cut since the experiment and the area will be evaluated for NFI status. [i]

Table 3 (continued)

Adjacent potential contaminated site	Contamination/CERCLA activities
Melton Hill Reservoir/Clinch River	The Clinch River has received hazardous substances released over a period of 50 years from the ORR. During the Remedial Investigation/Feasibility Study site characterization, contaminants in surface water were all found to be below Ambient Water Quality Criteria throughout the Clinch River; however, cesium-137 and mercury were elevated in Clinch River sediments downstream of source streams [which are downstream of the Gallaher Bend/Bull Bluff parcel]. The greatest risk to human health from contaminants in Clinch River is from the consumption of fish containing polychlorinated biphenyls and pesticides. The State of Tennessee has posted the Clinch River, advising persons to avoid or to limit the consumption of fish taken from these waters. In addition, several radionuclides in sediment would pose an unacceptable risk if dredged and placed on shore so as to allow unrestricted access. [d]

Sources: [a] Environmental Restoration Program 1996, [b] Kornegay et al. 1994, [c] CDM Federal Programs Corporation 1993, [d] Environmental Sciences Division and Jacobs Engineering Group, Inc.,1996, [e] Boegly and Iglar 1987, [f] Morrison and Cerling 1987, [g] DOE/OR/01-1251, No Further Investigation, Municipal Sewage Sludge Application Site, [h] Taylor 1986, [i] personal communication, R. Jolley, TDEC, June 6, 1996

2.2 TITLE SEARCH

2.2.1 Methods Used

A title search was conducted at the State of Tennessee, Anderson County Registrar of Deeds Office to record the chain of title documents for real property comprising the parcel (see Appendix B). Figure 3 shows the original land parcels that were transferred to the U. S. government.

2.2.2 Findings

None of the deeds reviewed described any past land uses that would indicate the possible generation or storage of any type of hazardous substance within the parcel.

2.3 INTERVIEWS

2.3.1 Methods Used

Personnel from Lockheed Martin Energy Systems, Inc. (LMES), Lockheed Martin Energy Research Corporation (LMER), DOE, TVA in Knoxville, Tennessee, and the U.S. Army Corps of Engineers District Office in Nashville, Tennessee, were contacted to determine if they had knowledge of, or records pertaining to, past or present ORR land usage that would indicate that storage or releases of hazardous substances have occurred on the parcel. Many LMES and LMER interviewees were experts in at least one of the following areas: environmental restoration, waste management, facilities and property management, environmental research, and forest management. The interviews were documented for reference and tracking, and the documentation is included in the administrative records file.

2.3.2 Findings

With the exception of the nearby disposal activities, no information gathered during the interviews indicated that any past or present activity adjacent to or on the parcel is a source of hazardous substance contamination.

Summary of Historical Investigation Findings. No information gathered during the historical investigation indicated that any past or present activity on the parcel has resulted in hazardous substance contamination. Information on nearby AOCs was submitted to a TDEC field investigation team for verification of their impact on the parcel.

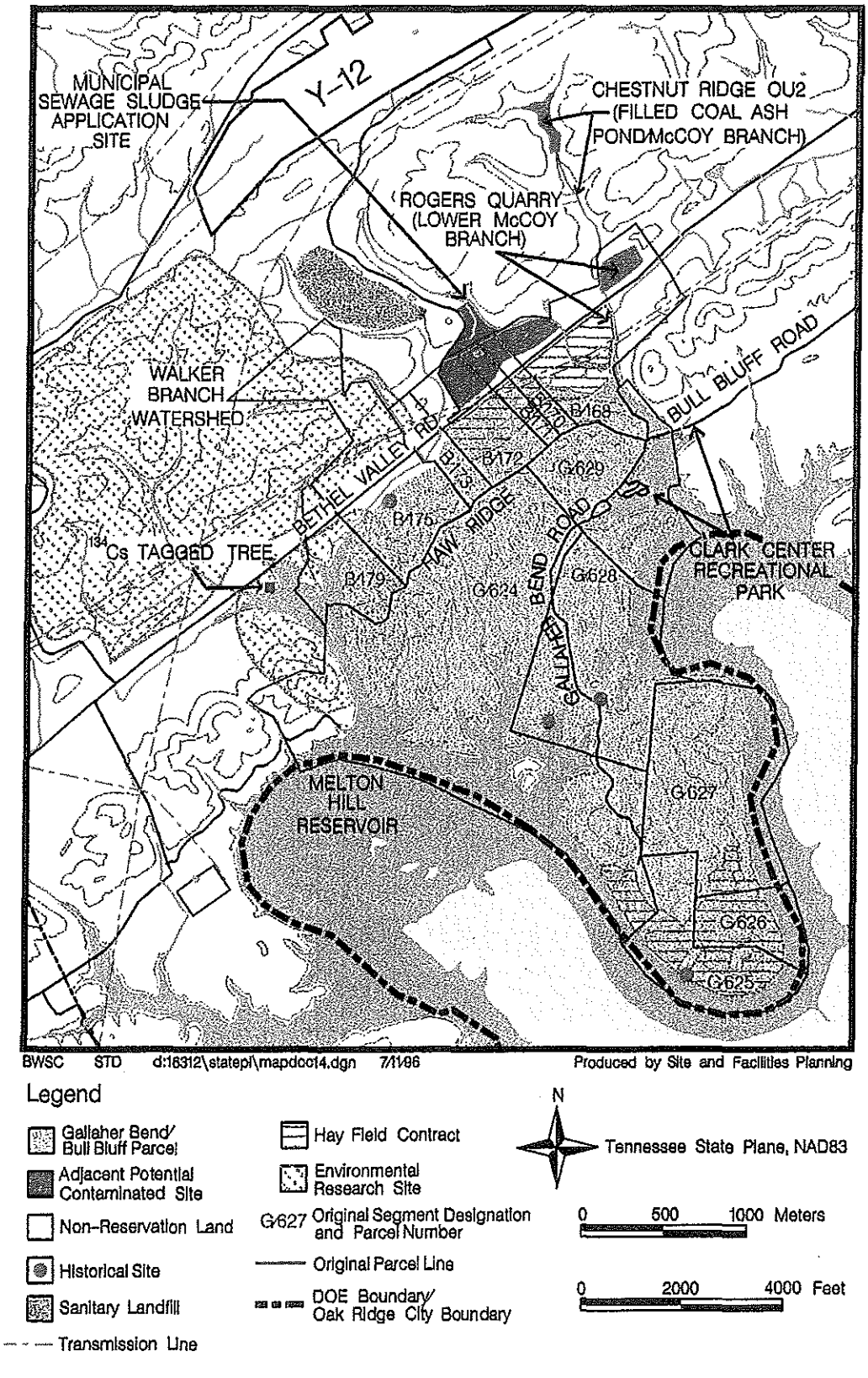

Fig 3. Historical Investigation Map

3. AERIAL PHOTOGRAPHY INVESTIGATION

3.1 METHODS USED

Historical aerial photography was analyzed by two different methods: a date-by-date analysis and a temporal analysis of landscape trends. The collection and analysis of historical aerial photography for detecting possible contamination-related activities were conducted in the following steps:

1. Good quality copies of aerial photographs provided by Oak Ridge National Laboratory (ORNL) were reviewed and selected based on completeness of coverage, quality, scale, and date. Complete aerial coverage of the parcel was available for 11 of the 25 separate black/white photographic collections, from 1939 to 1991 (see list of photographs in Appendix C).
2. A modified version of the United States Geological Survey (USGS) land use/cover classification system was developed to classify land use/cover (see Table 4 for a list of classifications and Appendix C for descriptions).

Table 4. Aerial photography land use/cover classifications

Category	Subcategory
Piles	
Excavations	
Construction Site	
Barren	
Residential	
Commercial and Services	
Industrial	Industrial Building
	Pipeline Route
	Wastewater Treatment
	Chemical Storage Facilities
Transportation	Trail
	Unpaved Road
	Paved Road
	Railroad Track
	Railroad Right-of-Way
Equipment Storage Area	
Utilities	
Agricultural	Buildings
	Cropland/Pastureland
	Orchards
Grass/Shrubland	
Upland Forest	
Wetland	Non-Forested Wetland
	Forested Wetland
Water	Streams and Rivers
	Reservoir
	Ponds/Lakes

Source: Modified from Anderson et al. 1976.

3. The land use/cover features were mapped and digitized. A digital orthomosaic (created from aerial photography collected in 1993) was used as the frame of reference.
4. An aerial photograph manuscript was developed by overlaying and registering the selected photographs. Land use/cover patterns were interpreted for the photographs, and changes in land use/cover were noted for each successive photograph (see Fig. 4).
5. The mapped anomalies relating to changes in land use/cover were used during the field investigation and later synthesized with the other investigation data.

3.2 FINDINGS

Information from the analysis of aerial photographs shows that prior to federal acquisition of the ORR for the Manhattan Project (1939–1942), the parcel was used for mixed agricultural and forestry-related purposes (see Fig. 4 and Table 5). There were 18 different residential or agricultural buildings visible in 1942. Later photography shows that cropland and pastureland were largely abandoned after federal acquisition, and many areas were allowed to undergo natural succession. Most of the abandoned agricultural land gradually changed to grassland/shrubland, while the grassland/shrubland changed into upland forest (see Fig. 4 and Table 5). Current and recent uses consist of hay production and harvesting in the open areas and timber management of forested areas. Anomalies investigated are described below and shown in Fig. 5.

- Two tracts of land, comprising 23.5 acres on the east side of the parcel, did not undergo natural succession due to kudzu planting for erosion control purposes. A close inspection of the earlier photographs shows some erosion in the areas that are presently covered by kudzu.
- A long linear cut occurred between 1942 and 1952 in the northeastern portion of the parcel for the installation of a natural gas pipeline. During 1963, this portion of the parcel was also cleared for the installation of a high-tension power line.
- Two new ponds in the southwestern portion of the parcel appeared on a 1967 photograph. After comparison with historical records, interviews, and analysis of topographic and geologic conditions, it was determined that the smaller pond was created as part of underground water movement in conjunction with the creation of the adjacent TVA Melton Hill Reservoir. The larger pond was likely always present but was dry on earlier photographic dates.
- In the northeastern portion of the parcel, one new pond appeared in 1971 and three additional ponds in 1976.

Table 5. Land use/cover areal statistics

	Acreage by year[1]									
Class	1942	1952	1963	1967	1971	1976	1981	1984	1988	1991
Residential[2]	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ag. Bldgs.[2]	2.3	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Cropland/ Pastureland	175.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barren	31.7	3.6	0.0	2.0	2.0	2.0	2.0	8.9	8.9	10.3
Grassland/ Shrubland	322.7	453.3	183.1	160.0	158.9	158.1	158.1	158.1	156.1	156.1
Upland Forest	685.5	737.2	1031.4	1051.3	1052.5	1052.5	1052.5	1045.7	1047.9	1046.5
Water:Ponds	0.0	0.0	0.0	1.1	1.3	1.8	1.7	1.7	1.7	1.7

[1] Areal statistics are unavailable for 1939 because of poor quality photographs and for 1956 because of incomplete coverage.
[2] The areal statistics for residential and agricultural buildings was made by a conservative estimate of a buffer around noted buildings and does not reflect the footprint of the buildings themselves.

Summary of Aerial Photography Investigation Findings. The aerial photography investigation indicates that this parcel was not used for industrial activities that would have resulted in hazardous substance contamination. The appearance of surface water ponds, however, may be indicative of underground water movement on the ORR.

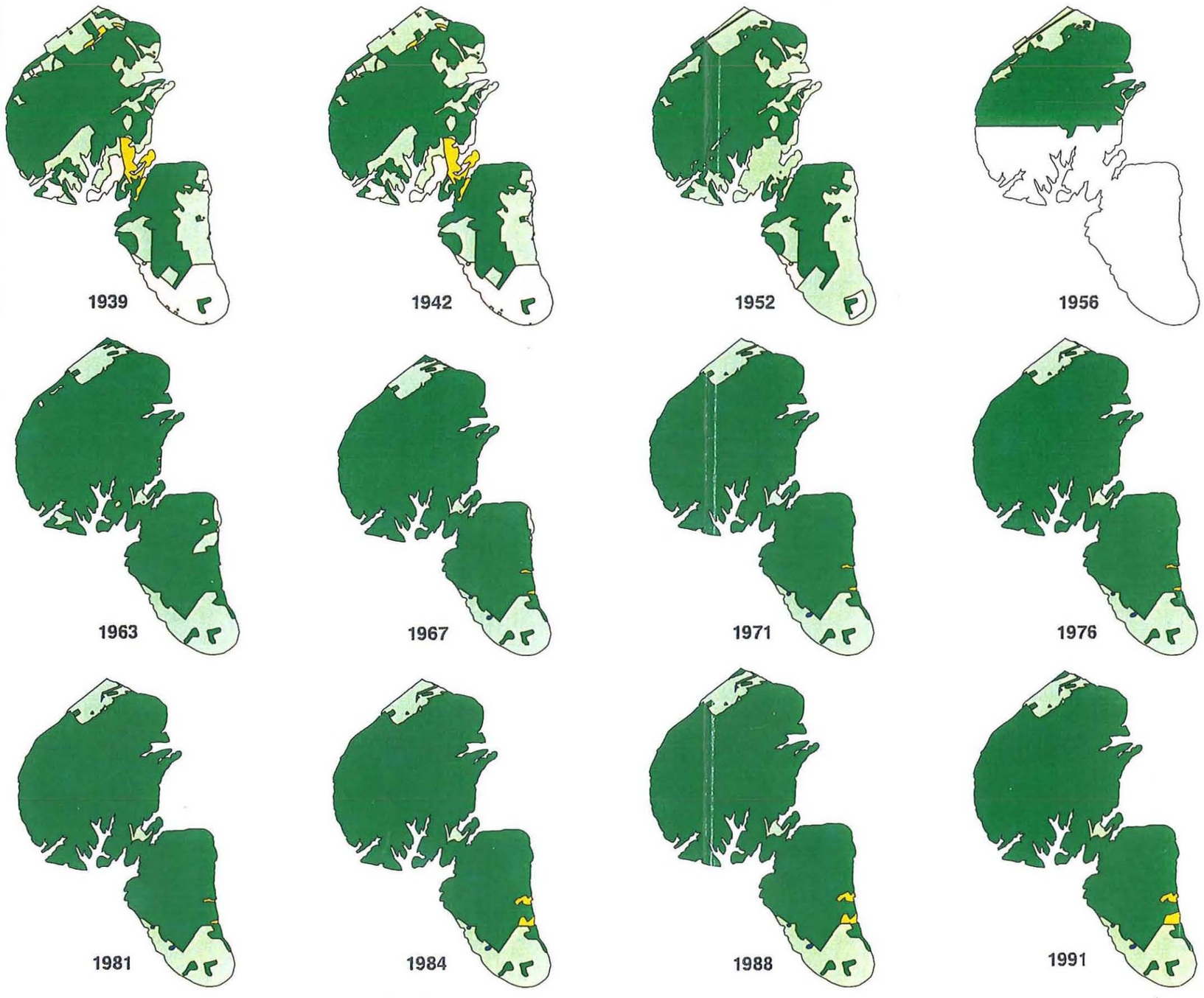

Fig. 4
Land Use/Cover
Gallaher Bend/Bull Bluff Parcel

LAND USE/COVER CLASS
- Agricultural Land; Buildings
- Agricultural Land; Cropland and Pasture
- Residential
- Barrenland
- Upland Forest
- Grassland/Shrubland
- Not Interpreted

Footprint Reduction Program
Environmental Restoration Division

0 1000 2000 Meters

0 3000 6000 Feet

Tennessee State Plane, NAD 83

N

Data Source: Footprint Historic Photo Interpretation
Radian International
Prepared by: Geographic Information Science and Technology, ORNL
Date prepared: July 10, 1996

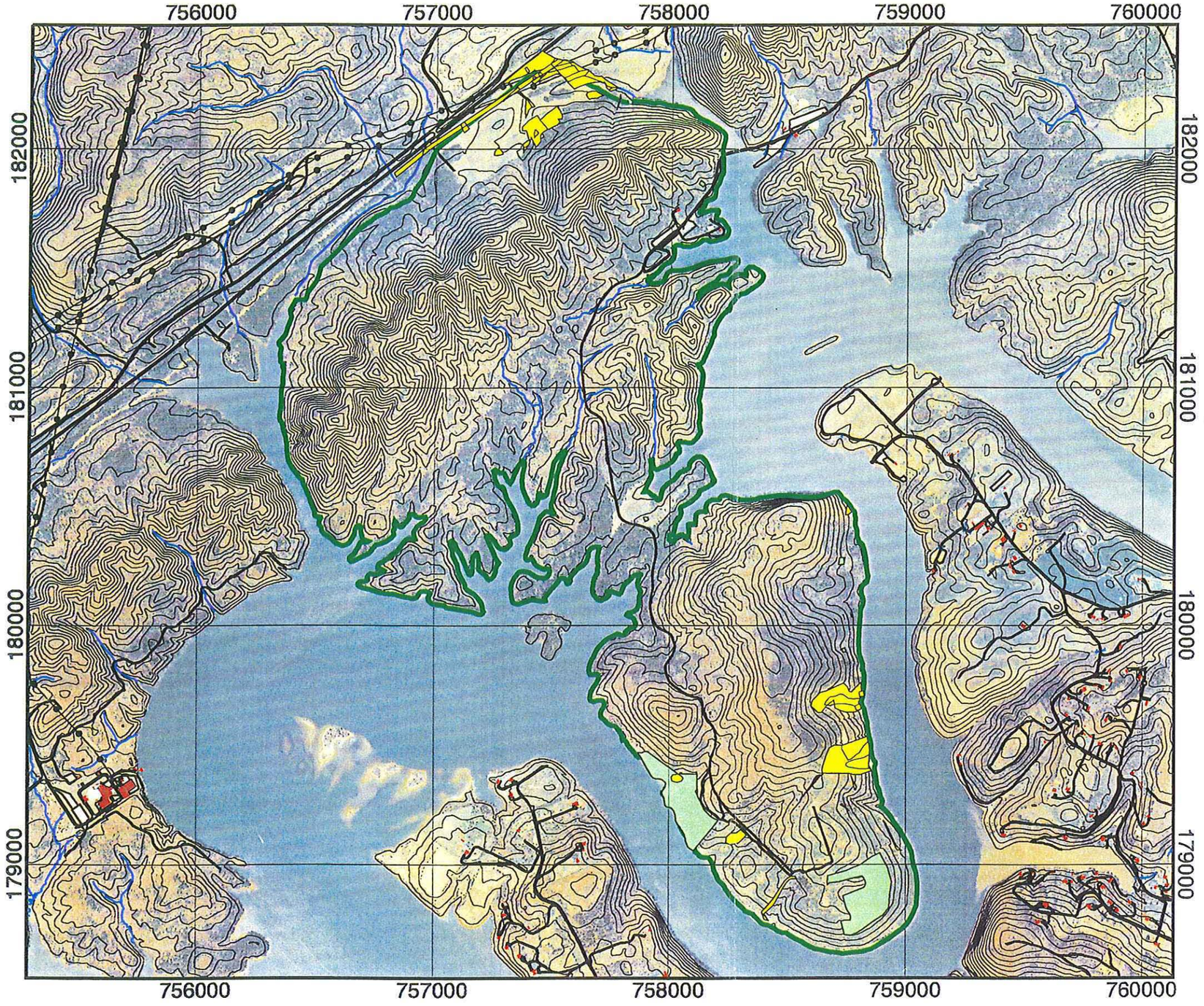

Fig. 5
Anomalies From Interpretation of Historical Aerial Photography: 1942-1991

Gallaher Bend/Bull Bluff Parcel

Anomaly
- **Unnatural Succesion**
- **Post-1942 Management**

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Footprint Historic Aerial Photo Interpretation, Radian Int.
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

4. REMOTE SENSING INVESTIGATION

4.1 METHODS USED

Remote sensing, the science of obtaining reliable information from sensors remote from the landscape, was used in addition to the minimum CERCLA 120(h) requirements of historical aerial photography interpretation because of the extensive characterizations of the ORR performed in the past using remotely sensed data. The following available remotely sensed data sources were used:

- color infrared photography,
- electromagnetic,
- gamma radiation detection,
- multispectral scanner imagery
- thermal infrared imagery, and
- vertical magnetic gradient.

Remotely sensed data were used to identify landscape anomalies that might suggest activities on the parcel that could result in contamination. An anomaly is an aberration on the landscape—a spatial pattern that is not expected in the geographic context, or a spatial pattern that is not expected in a temporal sequence of aerial photography.

For each remotely sensed data source, landscape anomalies were determined and defined as either linear features (e.g., gamma isolines) or polygonal features (e.g., land use/cover anomalies, thermal anomalies, etc.). The features were located as precisely as possible within the constraints of the digital orthophoto basemap, the nature of the original imagery, and the method for delineation of the features. These features were transferred and stored in a geographic information system (GIS).

Once stored in the GIS, the data sets were analyzed and compared. The purpose of the synthesis was to identify, explain, and resolve landscape anomalies. As multiple sources of data assist in the understanding of potential contaminated sites and landscape anomalies, the synthesis used the joint-occurrence of data to assist in analyzing these features. Spatial location, content, and certainty in these characteristics were simultaneously considered in reviewing the data sources and anomalies. Appendix D contains a more detailed description of the remote sensing methods.

4.2 FINDINGS

Color Infrared Photography. No anomalies were identified from the analysis of color infrared aerial photography of the parcel.

Electromagnetic. No anomalies associated with waste disposal practices were identified from the analysis of electromagnetic data of the parcel.

Gamma Radiation Detection. No elevated levels of gamma activity that would be associated with man-made sources were identified on the parcel.

Multispectral Scanner Imagery. No differences in vegetative vigor due to contaminant-induced vegetative stress were noted.

Thermal Infrared Imagery. The thermal-derived anomalies for the parcel included five locations of interest. The first location is in the northeastern portion of the site, south of Bethel Valley Road. The thermal-derived anomalies in the area can be associated with post-1942 management (roads, fence lines, power lines, power line cut areas, mowed fields, and ponds). The second location lies near the northwest edge of the study area and consists of a trail. The third location includes thermal-derived anomalies associated with Clark Center Park. The fourth location is in the center of the parcel and is associated with a grassy area near the Melton Hill Reservoir shoreline. This area has remained in the "Grassland/Shrubland" category of the historical photography analysis since 1952. The fifth location includes large areas of an apparently disturbed landscape concentrated in the southern portion of the parcel. Subsequent correlation of these large anomalies with the land use/cover patterns on the historical aerial photography suggested these anomalies are all associated with prior agricultural cropland and pastureland. Currently, hay farming is conducted in portions of this location; the remainder of these anomalies are scrub/shrub and unmowed fields. Other thermal anomalies are associated with Gallaher Bend Road and are not of concern.

Vertical Magnetic Gradient. All magnetic anomalies indicated by remotely sensed data were mapped for verification by a TDEC field investigation team.

See Fig. 6 for a summary of anomalies. Supportive and ancillary maps are included in Appendix D.

Summary of Remote Sensing Investigation Findings. Vertical magnetic gradient and thermal-derived anomalies were identified by the remote sensing investigation. The vertical magnetic anomalies were mapped for verification by a TDEC field investigation team. Five locations of thermal-derived anomalies were identified. The thermal-derived anomalies were associated with post-1942 management of the parcel, trails, the existence of structures at Clark Center Park, or were correlated with historical photography land use/cover patterns and determined to be associated with prior agricultural activities.

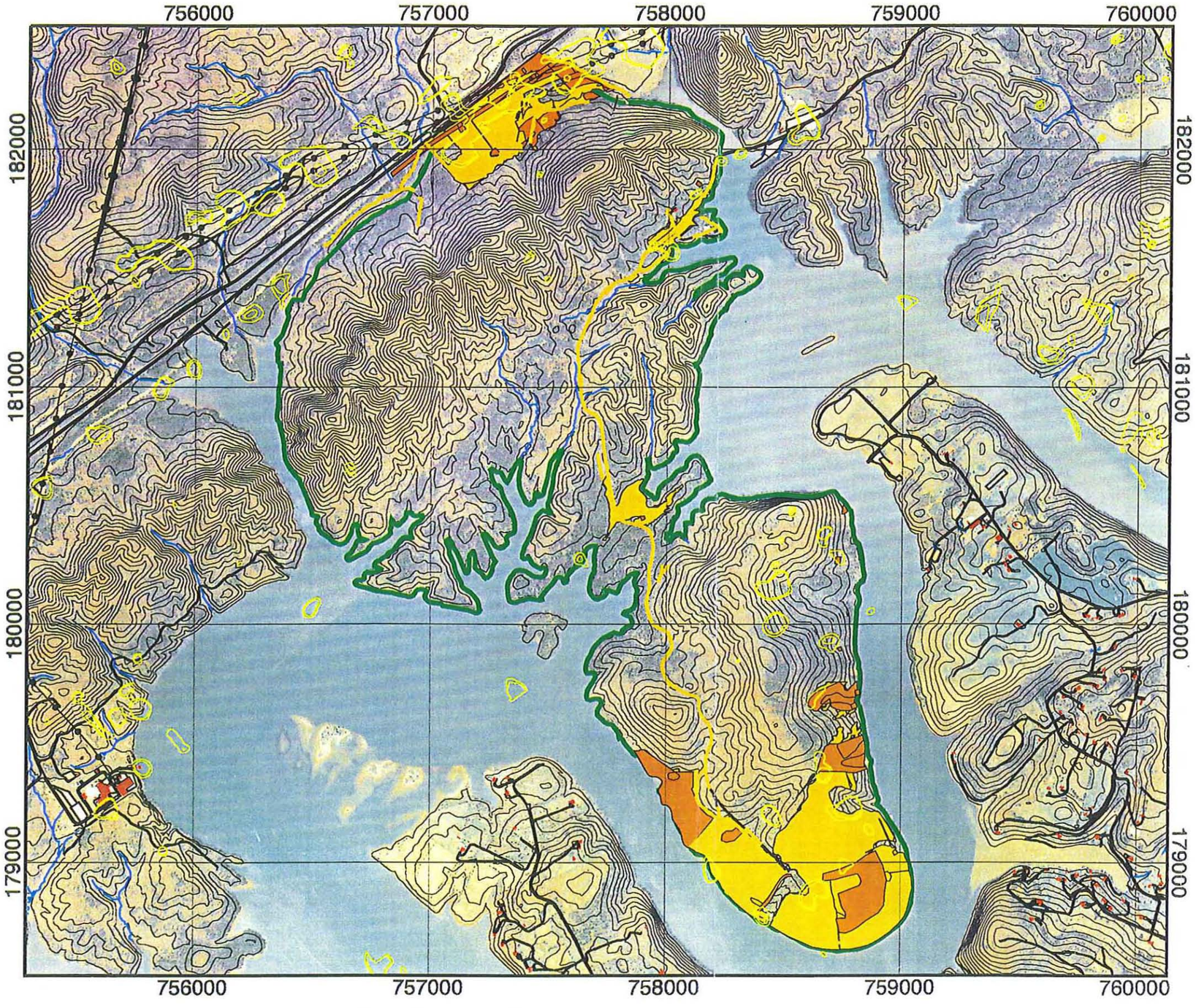

Fig. 6
All Anomalies
Gallaher Bend/Bull Bluff Parcel

- 10-Ton Magnetic Anomaly
- Thermal Anomaly
- Land Use/Cover Anomaly

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Remote Sensing Program, EIM Program Radian International
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

5. FIELD INVESTIGATION/VERIFICATION

5.1 METHODS USED

An analysis of information compiled for the parcel and from TDEC records was performed to locate any information on past federal activities associated with the parcel.

A field investigation plan was then developed to ensure maximum coverage of the parcel. Preliminary site visits were performed to analyze the difficulties that would occur in the investigation. Interviews were conducted with present real property managers to determine what, if any, federal activities are presently being performed on the parcel. Issues that would require corrective action by DOE or contractors were identified.

The parcel was inspected for radioactive contamination by taking ambient gamma readings along roadways, fields, trails, and structures. Wooded ridges were inspected to ensure that potential areas of concern were investigated. Anomalies, observations, and data were recorded in field notebooks and later presented in a final report which is included in Appendix E. The location of the field survey sites are shown in Fig. 7.

5.2 FINDINGS

- The mapped anomalies indicated on Fig. 6 were visited and gamma radiation was measured using a Ludlum sodium iodide scaler ratemeter. All of the readings were within background tolerances.
- Most of the magnetic anomalies were on slopes or ridges while others were at the heads of drainages. One anomaly is located in a sinkhole. The presence of these anomalies can be attributed to geologic or geomorphic causes. Two magnetic anomalies were associated with abandoned dwellings from the era prior to federal activity at Oak Ridge.
- An extensive field investigation of the topographical surface was conducted and there were no observable negative environmental impacts to the parcel from any prior or present activities.

Summary of Field Investigation/Verification Findings. All of the mapped anomalies were attributed to prior dwellings or changes in geology or soil type, and there were no observable negative environmental impacts to the parcel from any prior or present activities

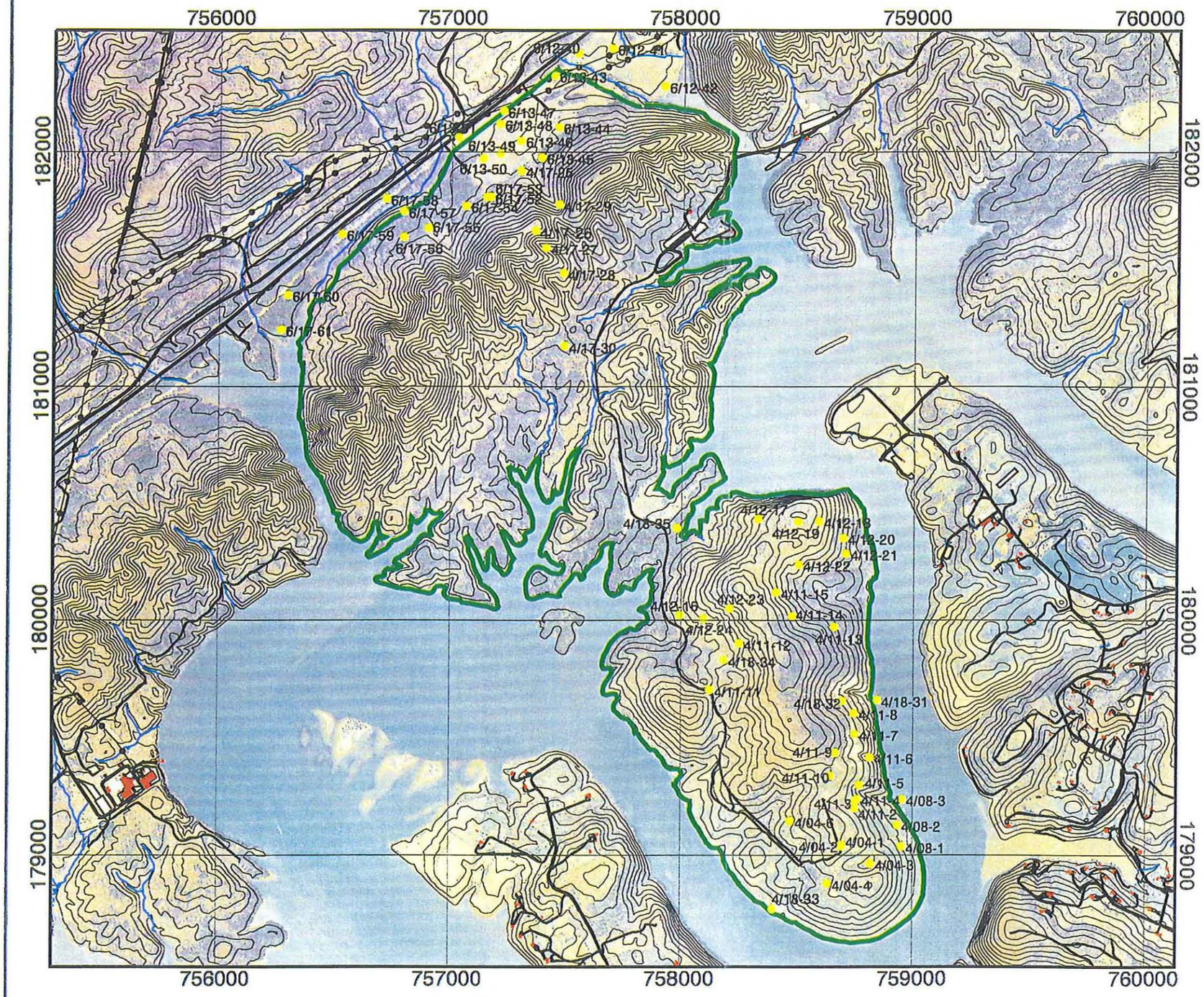

Fig. 7
Surveyed Sites

Gallaher Bend/Bull Bluff Parcel

4/18-33 **Surveyed Site**
Month/Day-GPS Station Number
(See Table E.1)

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters
0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Site Source:	Tennessee Department of Environment and Conservation
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

6. INVESTIGATION RESULTS

6.1 SUMMARY OF FINDINGS

- No information gathered during the historical investigation indicated that any past or present activity on the parcel has resulted in hazardous substance contamination. Information on nearby AOCs was submitted to a TDEC field investigation team for verification of their impact on the parcel.
- The aerial photography investigation indicates that this parcel was not used for industrial activities that would have resulted in hazardous substance contamination. The appearance of surface water ponds, however, may be indicative of underground water movement on the ORR.
- Vertical magnetic gradient and thermal-derived anomalies were identified by the remote sensing investigation. The vertical magnetic anomalies were mapped for verification by a TDEC field investigation team. Five locations of thermal-derived anomalies were identified. The thermal-derived anomalies were associated with post-1942 management of the parcel, trails, the existence of structures at Clark Center Park, or were correlated with historical photography land use/cover patterns and determined to be associated with prior agricultural activities.
- The field investigation/verification attributed all mapped anomalies to prior dwellings or changes in geology or soil type, and there were no observable negative environmental impacts to the parcel from any prior or present activities.

6.2 CONCLUSION

A thorough review of historical information, aerial photography, and remotely sensed data available for the parcel indicates that activities by the federal government and previous owners did not leave a contamination legacy. Field investigations and verification by TDEC confirm this finding. The possibility of groundwater contamination from affected areas of the ORR exists and there may be a need for groundwater use restrictions. Presently, there are no groundwater monitoring wells on the parcel and investigation results and current land use do not justify the initiation of intrusive sampling. The recommendation for this parcel is submittal to the tri-party members of the FFA for NFI designation.

6.3 LIMITATIONS OF STUDY

- This study, completed in FY96, reviewed information available as of that date and does not address future activities within or adjacent to the parcel that could result in contamination.
- This study did not involve an in-depth review of groundwater data for the parcel. If the parcel is ever considered for release to the public, the potential for groundwater contamination should be considered prior to release.

7. REFERENCES

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CDM Federal Programs Corporation. 1993. *Remedial Investigation Work Plan for Chestnut Ridge Operable Unit 4 (Rogers Quarry/Lower McCoy Branch) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR-1152&D1, Y/ER-70&D1, Oak Ridge, Tennessee.

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Appendix A

GLOSSARY

Anomaly	An aberration in the landscape either in time, geography, or magnetics. A temporal anomaly is, for instance, a land cover type that does not follow a normal pattern of vegetation succession (e.g., an upland forest appears to change to grassland in 5 years). A geographic anomaly is one that involves an unusual geographic context, such as a quarry, a large opening in a forest, or a mound, all of which may suggest waste disposal activities. A magnetic anomaly is a change in the earth's magnetic field which may be caused by metallic objects or geological conditions.
Area of Concern (AOC)	Areas, including buildings, that are currently identified for investigation and/or remediation by the U.S. Department of Energy Oak Ridge Operations Office Environmental Restoration Program. Areas of concern are listed in Appendix C of the Federal Facilities Agreement (FFA). Under the FFA, the term "area of concern", or abbreviation AOC, can include both solid waste management units under the Resource Conservation and Recovery Act and/or areas of contamination under the Comprehensive Environmental Compensation, and Liability Act (CERCLA).
National Pollutant Discharge Elimination System (NPDES)	Section 402 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act) that establishes a permit for discharges to water and provides standards by which such permits may be granted.
No Further Investigation (NFI)	A CERCLA decision document (form) that follows a remedial site evaluation when, as a result of the evaluation, it is determined that either no actual release has occurred, or a release has occurred but does not pose a significant threat requiring action.
Potential Contaminated Site	A site within or adjacent to the parcel that is known to be or suspected to be contaminated, such as a waste area grouping, a solid waste management unit, an area of concern, or a contaminated research site.
Proposed Plan	A public-participation requirement of CERCLA in which the Environmental Protection Agency summarizes for the public the preferred cleanup strategy, rationale for the preference, alternatives presented in the detailed analysis of the remedial investigation and feasibility study, and wavers to cleanup standards of CERCLA 121 (d) (4) that may be proposed. The plan may be prepared either as a fact sheet or a separate document. In either case, it must actively solicit public review and comment on all alternatives under consideration.
Record of Decision (ROD)	The CERCLA document used to select the method of remedial action to be implemented at a site after the Feasibility Study/Proposed Plan process has been completed.

Remedial Design	An engineering phase that follows the Record of Decision when technical drawings and specifications are developed for subsequent remedial action at a site on the National Priorities List.
Remedial Investigation (RI)	The CERCLA process of determining the extent of hazardous substance contamination, and, as appropriate, conducting treatability investigations. The RI provides the site-specific information for the feasibility study.
solid waste management unit (SWMU)	Any unit at a facility from which hazardous might migrate, irrespective of whether the unit was intended to for the management of solid and/or hazardous waste. Includes, but is not limited to, container storage areas, tanks, surface impoundments, waste piles, land treatment units, landfills, incinerators, injection wells, recycling operations, miscellaneous units, and releases from such units.
waste area grouping (WAG)	A grouping of facilities and/or release sites with area-wide soil and/or groundwater contamination that is not readily traceable to individual facilities or sites. Generally, a WAG would be limited to a contiguous and hydrologically defined area.

Appendix B

HISTORICAL INVESTIGATION SUPPLEMENTAL INFORMATION

PRIMARY DOCUMENTS RESEARCHED DURING LITERATURE REVIEW

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Forest Management Plan, ERDA Oak Ridge Reservation: 1976-1980, D.M. Bradburn, ORNL.

Geotechnical and Hydrologic Evaluation of Y-12 Plant Coal Ash Pond Dam, Y/SUB/86-47970/1, Geotek Engineering Company, 1986.

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Oak Ridge Reservation Land-Use Plan, DOE/ORO-748 (Rev. 1), prepared by Oak Ridge Operations, March 1980.

Oak Ridge Reservation Land-Use Plan, ORO-748, prepared by Oak Ridge Operations, August 1975.

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Remedial Investigation Report for Chestnut Ridge OU 2 (Filled Coal Ash Pond/McCoy Branch) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, ES/ER-23&D1, Y/ER/Sub-90/97777/2, CH2M HILL, 1991.

Remedial Investigation Work Plan for Chestnut Ridge Operable Unit 4 (Rogers Quarry/Lower McCoy Branch) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, CDM Federal Programs Corporation, 1993.

Resource Management Plan for the Oak Ridge Reservation, Vol. 6, Appendix F: Forest Management, D.M. Bradburn and E.H. Rosenbalm ORNL, 1984.

Resource Management Plan for the Oak Ridge Reservation, Vol. 15: Waste Management, ORNL-6026/V15, prepared by Brian A. Kelly, ORNL, 1984.

Resource Management Plan for the Oak Ridge Reservation, Vol. 23: Oak Ridge National Environmental Research Park, Research Sites, and State Natural Areas, ORNL/ESH-1/V23, Parr and Pounds, ORNL.

Resource Management Plan for the Oak Ridge Reservation, Vol. 25: Resource Management Organization Data Base and Bibliography, ORNL/ESH-1/V25, K.A. Jones, Information Resources Organization, ORNL, 1987.

Resource Management Plan for the Oak Ridge Reservation, Vol. 26: Resource Management Organization Data Base and Bibliography, ORNL/ESH-1/V26, J.A. Lahmon, Information Services Division, ORNL, 1988.

Sludge Application and Monitoring Program on the Oak Ridge Reservation, 1986–1993, ORNL/TM-11601, Gunderson, C. A. et al, Environmental Sciences Division, ORNL, September 1995.

Survey of Metals, Radionuclide and Organic Contamination at 20 Waste Area Groups (WAGs), ORNL Facilities, Oak Ridge, Tennessee, S. J. Morrison and T. E. Cerling, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, July 1987.

Table B.1. Recorded chain of title documents

Segment/ Tract	Grantor	Grantee	Deed Reference				Date of Instrument	Date of Recording	Acreage
			Civil District	Book	Volume	Page			
B/168	Anna & R. E. Thompson	John J. & Mossie Wright	9	Y	3	341	08-29-34	08-29-34	191.09
	Billie & J. B Thompson	John J. & Mossie Wright	9	I	4	198	12-29-41	12-29-41	
B/170	Anna, E. H., F. J., & R. E. Thompson	Arthur Peters et ux	9	D	4	291	05/10/37	05/10/37	20.70
B/171	Sally M. Moneymaker	Minnie E. Holloway et vir	9	Q	3	27	08/22/24	11/01/24	23.20
B/172	See Note 1	J. H. Holloway et al	--	--	--	--	--	--	80.80
G/173	C. E. Brennan	Herman Jenkins	9	I	4	571	08/31/40	10/13/42	34.90
B/175	T. L. & Leola Seeber	J. B. Holloway et ux	9	K	4	161	12/18/42	12/19/42	188.30
B/179	Malisse Metcalf	W. R. Price	9	W	3	300	01/10/34	01/10/34	72.70
G/624	W. Cecil Anderson	C. W. & J. H. Davis	9	S	3	367	02/26/29	04/24/29	629.00
	R. M. McConnell	C. W. & J. H. Davis	9	S	3	367	02/26/29	04/27/29	
G/625	M. M. & Beatrice Gallaher	Andy Miller et ux (Emma)	9	C	4	512	03/11/38	03/13/39	141.70
G/626	J. R., M. M., and Myrtle Gallaher	Jennis Hobert Owenby et ux	9	I	4	254	01/27/43	02/17/42	52.70
G/627	Charles Ogle	Ted Rayfield et ux	9	C	4	584	08/09/39	09/19/39	210.70
	D. C. & Cora Maples	Ted Rayfield et ux	9	C	4	584	08/09/39	09/19/39	
G/628	N. B. Mount	J. R. Kidwell et ux	9	A	4	47	01/07/35	01/07/35	160.00
G/629	Dan Qualls	Roy G. Farar et al	9	S	3	474	08/25/30	08/26/30	148.20
	Dan Qualls	Roy G. Farar et al	9	U	3	557	10/13/30	10/13/30	
	Dan Qualls	Roy G. Farar et al	9	V	3	26	10/13/30	01/10/31	
	C. B. Jones	Roy G. Farar et al	9	V	3	68	02/11/31	02/26/31	
	Sarah E. & W. M. Burton	Roy G. Farar et al	9	S	3	520	01/09/31	01/10/34	
G/631	Ruth McCoy	Henry McCoy	9	Y	3	221	01/27/34	06/23/34	21.80

Note 1: A recorded transfer of land to J. H. Holloway et al. was not found at the Anderson County Register of Deeds Office

Appendix C

AERIAL PHOTOGRAPHY INVESTIGATION SUPPLEMENTAL INFORMATION

DEFINITIONS USED FOR AERIAL PHOTOGRAPHY INVESTIGATION

Piles. This category is defined as elevated deposits of material having no apparent use in a manufacturing process, such as deposits that cannot be placed in the Aggregate category.

Excavation. An excavation is defined as a depression and its surrounding area, apparently made by human activity, for any purpose other than that which would be created during an active construction operation. This category excludes any excavation included in the construction site category. Piles or elevated areas within excavation are not separately delineated.

Construction Site. This category is used to describe the affected area found within and surrounding construction projects. Such an area must have exhibited evidence that the construction is occurring at the time the aerial photograph was acquired. Such evidence includes, but is not limited to, the presence of construction equipment and vehicles, construction materials and piles, parking areas, and undeveloped surface areas of a temporary nature.

Barren. Undeveloped land that is predominantly void of vegetation and is not considered an excavation or a pile.

Residential. Residential structures and associated land including, but not limited to, single family and duplex houses, apartment buildings, and mobile homes. Apartments may be distinguished from office or other commercial structures by the presence of landscaped grounds, large parking areas, recreational facilities (children's playgrounds, swimming pools, etc.), and multiple building entrances with sidewalks. Evidence for residential use includes individual driveways, small landscaped areas, and possibly recreational facilities.

Commercial and Services. Areas of developed land used predominately for sale of products and services including, but not limited to, offices, retail, schools, hospitals, churches, barracks, attendant outbuildings, and water towers. In areas that appear predominately residential, commercial buildings (i.e., converted from residential to commercial use) will be identified by parking facilities, signs, materials, and equipment.

Industrial. Includes areas of developed land used for manufacturing or industrial purposes. This category may be further subdivided as follows:

Industrial Building. Includes warehouses, maintenance facilities, weapons storage areas, airplane hangers, etc.

Pipeline Route. Includes all pipeline and duct routes, including some air management systems. Only the outermost extent of the pipeline route is delineated, not individual pipelines within a single route. When visible on the photographs, this category "overlays" all other categories, including, buildings, roads, railroads, parking lots, etc. The only exception is a pipeline that passes under a road or enters a tunnel. The route is terminated when the pipeline disappears.

Wastewater Treatment. Facilities generally associated with water or wastewater treatment or collection. All of these subcategories include the immediate surroundings (i.e., paved areas, a retaining wall, edges of a pad, and fences).

Chemical Storage Facilities. This category is further subdivided as follows:

Aggregate. Includes maintained piles of materials apparently used in manufacturing. Evidence includes a groomed appearance to the pile, proximity to industrial areas, and material delivery systems or loading devices (e.g., railroad tracks).

Drum Storage Area. Defined as an area where drums (e.g., 55-gal Department of Transportation chemical storage drums), carboys, or other similar containers are stored together. This includes the extent of the apparent storage area, not just the area covered by drums at the time of the photograph, and includes the walkways or driveways between rows of drums.

Mobile Vessel Storage Area. A facility for the temporary storage or parking of mobile chemical vessels (tank trucks, railroad cars, load luggers, etc.). This category can "overlay" the railroad or paved road categories. The apparent extent of the storage area is delineated, rather than only the area covered at the time of the photograph.

Tank Farm. Above- or below-ground single and multiple fixed tanks, in either vertical (circular as seen from above) or horizontal (oblong/linear) orientation. These tanks may represent either storage vessels or process vessels that are believed to contain any liquid other than drinking water. The edge of the surrounding berm, or tank pad, on which multiple tanks are located is defined as the limit of this category. Individual tanks are not delineated unless there is no berm or pad. Water towers are classified as commercial and are not included in this category.

Transportation. The category is further subdivided as follows:

Trail. This category includes those areas that cannot be classified in the unpaved road category. They are narrow, inconsistent vehicular and/or pedestrian ways that usually have grassy or barren soil bases and apparently do not lead to any particular location or feature. Generally unimproved.

Unpaved Road. Unpaved vehicle or pedestrian route comprised of dirt, cinders, or gravel is considered an unpaved road. This category includes areas that are not part of a proper road system, but are apparently traveled. This category is also used to identify general unpaved surfaces not associated with traffic.

Paved Road. All paved areas used for transportation, such as airplane runways and ground vehicle roadways, including public and private streets, highways, commercial driveways, etc. This category can include paved areas that are not part of the regularly traveled right-of-way but are paved and apparently traveled upon.

Railroad Tracks. Railroad tracks are delineated at the outer edge of the outermost track. When tracks become separated by more than the width of two tracks, they are classified under another category as appropriate.

Railroad Right-of-Way. An area of grass or railroad ballast outside the area of actual railroad tracks is defined as a railroad right-of-way. This category also includes railroad rights-of-way that have been abandoned and no longer contain trackage (but that still contain ties of ballast and have not yet been converted to another use).

Equipment Storage Area. This category includes areas apparently used to store mobile or nonmobile equipment as defined below. The area that appeared to be included in the activity (e.g., the walkways or driveways between rows of mobile or nonmobile equipment) is delineated, rather than the ground area covered by equipment at the time the aerial photograph was acquired. Equipment storage areas are used to store nonmobile equipment or containers such as boxes, pallets, cargo containers, etc., used for the shipment of raw materials or finished products, and also for storage of commercial or industrial vehicles (trucks, forklifts, airplanes, etc.).

Utilities. This category includes all visible electrical transmission power lines, gas lines, etc., and their associated rights-of-way.

Agricultural. This category is further subdivided as follows:

Building. Any structure used primarily for agricultural purposes, including equipment storage buildings, collection barns, etc.

Cropland and Pasture. Includes all land used for cultivation and grazing, including fallow crop fields. Keys to interpretation include:

Crops. Regularly shaped fields with smooth to medium texture depending on scale and season. Just before planting, bare ground may be observed. Rows of crops are likely visible. On higher resolution photos, individual plants may be seen. Other evidence includes the presence of fences, farm machinery, collection barns, and collection bins.

Pasture. At lower resolution, pastures are generally indistinguishable from cropland. In such photos, pastures exhibit a smooth texture with uneven tone (caused by varied grass heights). When pastures are compared to undeveloped brush, they appear smoother and well managed. At higher resolution, individual grazing animals may be observed. Other evidence includes the presences of fences and the existence of visible animal trails around gates and near feeding areas and barns.

Orchards. Represents the cultivated growth of trees and vineyards. These can be distinguished from non-cultivated trees by a regular pattern of tree rows. Harvesting equipment may also be present. Vineyards are characterized by linear trellises separated by 3 to 4 ft, and are usually planted parallel to the contours of the land.

Grass/Shrubland. Land where the majority of the vegetation is naturally occurring grasses or shrubs.

Upland Forest. Land where the majority of the vegetation is naturally occurring trees.

Wetlands. Areas that lie at or below the water table for some part of the year. This category is further subdivided as follows:

Non-forested Wetland. Wetland comprised of grass cover and nonvegetated mud flats exclusive of tree cover. This is delineated between the edge of water cover and the inner edge of the dry grass cover.

Forested Wetland. Wetland that contains water-tolerant tree species. The outermost edge is delineated at the edge of tree cover as defined by the tree's crowns. The innermost edge is delineated at the edge of the water cover.

Water. This category is further subdivided as follows:

Streams and Rivers. Natural flowing waterways delineated at the edge of the water.

Reservoir. Pond or lake that was constructed by any type of dam.

Ponds/Lakes. Naturally occurring body of water not associated with water treatments considered a pond or lake. This category is delineated at the edge of the water.

Table C.1. Historical black/white photography analyzed for Gallaher Bend/Bull Bluff parcel

Year[a]	Nominal scale	Source/agency
1939	1:36,000	TVA
1942	Not available	National Archives
1952	1:43,200	TVA
1956	1:18,000	TVA
1963	1:24,000	TVA
1967	1:24,000	TVA
1971	1:24,000	TVA
1974	1:31,680	TVA
1975	Not available	GS-VDUT
1976	Not available	GS-VDUT
1976	1:7,200	USGS
1978	1:12,000	TVA
1979	1:12,000	TVA
1980	1:12,000	TVA
1981	1:9,600	TVA
1981	1:12,000	TVA
1981	1:24,000	TVA
1982	1:12,000	TVA
1983	1:12000	TVA
1984	1:12,000	TVA
1984	1:24,000	TVA
1984	1:36,000	TVA
1988	1:12,000	TVA
1988	1:24,000	TVA
1991	1:40,000	TVA

[a] There was complete coverage of the parcel for only 11 dates. Those dates were interpreted for the parcel in addition to 1956 which had incomplete coverage.

Appendix D

REMOTE SENSING INVESTIGATION SUPPLEMENTAL INFORMATION

DATA AND IMAGERY USED IN REMOTE SENSING INVESTIGATION

Color Infrared Photography

The reflected infrared wavelength bands recorded in color infrared photography are very sensitive to changes in moisture and water in vegetation and on the surface of the earth. Spatial variations in the health and vigor of vegetation may be an indicator of surface compaction and/or associated stress from contamination. Vegetation stress may also be due to natural disturbances, such as disease, insects, wind or water related damage. Thus, the analysis of color infrared photography has been extensively used to detect surface activities, such as archaeologic sites or natural disturbances.

Selected color infrared photographic prints were visually inspected. Larger streams crossing the study areas were examined for signs of unusual turbidity or sediment load that could be the result of construction activity or other heavy human disturbances upstream. The images were also examined for signs of obvious vegetative stress.

Two overflights of low altitude color infrared aerial photography were collected in April of 1992 over the ORR.

Airborne Gamma

Airborne gamma surveys are useful for mapping radiation over large areas. Such surveys have been historically used to detect terrestrial gamma emissions from both natural radiation (deJong, et al., 1994; Jackson, 1992; Wollenberg, et al., 1993) and man-made radiation. Detection of man-made radiation (contamination in this study) requires modeling of the spatial variation in natural radiation and the subsequent removal of this component in the airborne measurements. The transformation of airborne radiation sensor data to near-ground (e.g., 1 meter above ground level) is also important. Radiation levels above terrestrial background were considered as anomalous features and were investigated through field studies.

Although airborne gamma radiation surveys are an excellent method of screening large areas for surface contamination such as contaminated creek sediments or seeps, the absence of elevated readings does not preclude the existence of buried radioactive waste. Soil is an excellent shielding material and a few feet of soil cover would nearly always prevent detection of buried radionuclides by both airborne gamma spectroscopy and surface walk-over surveys.

Two airborne surveys have recently been conducted over the ORR. EG&G conducted an airborne survey of approximately 80 percent of the ORR in 1992 as part of the DOE Aerial Measurements System. Aerodat acquired gamma data of the entire ORR between December 1992 and April 1994 as part of the ER Remote Sensing Program airborne geophysical survey. Since the Aerodat data do not contain all of the corrections employed by the EG&G surveys, further processing of the data was performed to map man-made radiation.

Vertical Magnetic Gradient Data

Vertical magnetic data was used as the primary data source studied for locating magnetic anomalies. A common threshold was established for all study areas using detailed (20-foot cell) gridded data. A field reconnaissance was employed by Environmental Sciences Division staff to identify reasons for selected anomalies and to set data thresholds and detection limits. The data were then processed to

produce geographic coverages of 5-ton and 10-ton potential anomalies. Each of these maps indicates the presence of a magnetic gradient that would result from metallic mass of 5 tons and 10 tons, respectively.

Objects that can produce "anomalous" magnetic readings include both natural sources, such as changes in geology or soil type, and man-made objects which contain steel or iron. The magnetometer will detect man-made objects both on the surface (cars, buildings, power poles) and underground (pipelines, 55-gal drums, underground storage tanks). One of the characteristics that distinguishes magnetic measurements from other remote sensing techniques such as infrared photography, multispectral scanning, and gamma spectroscopy is this ability to detect buried objects, even under 100 ft or more of soil and rock.

To assist TDEC in field investigations of anomalous regions and to present the magnetic results in a form that is easily understood by non-geophysicists, each magnetic anomaly was assumed to be the result of a compact source located near the surface. By modeling the magnetic data in this fashion the original vertical magnetic gradient contours were converted from field strength in nanoTeslas per meter to an equivalent source strength in tons of steel. The results show that an equivalent source strength of 5 tons of steel is a reasonable threshold contour. A cache of 50 or more 55-gal drums, for example, should produce a recognizable magnetic anomaly.

Airborne geophysical data (magnetic and electromagnetic data) of the entire ORR were acquired between December 1992 and April 1994.

Thermal Imagery

Differential measures of surface temperature are recorded in thermal imagery and may be clues to subsurface materials, such as buried objects. Similar to near-infrared reflected wavelengths of energy, thermal wavelengths are highly sensitive to moisture conditions. In the case of disturbed soils (e.g., indicating buried trenches) the moisture gradient across disturbed and undisturbed sites may be large. The thermal gradient between such locations is normally significant in predawn hours due to the emissivity of water versus soil. Thus, the analysis of predawn thermal imagery may aid in identifying potential contamination sources that would otherwise be missed on infrequent historical aerial photography.

Thermal imagery was visually reviewed to identify potential surface pathways of contaminants from higher elevations in the watersheds: surface streams, major springs or seeps that could migrate waste contamination from groundwater into surface streams, and wetland areas. The thermal imagery, both predawn and daytime thermal IR, was also examined for signs of past human disturbance such as structures and roads.

Thermal imagery surveys of the ORR have been conducted during the following time periods: April 1992 [4000 ft above ground level (AGL)], March 1994 (2000 ft AGL) , and June 1996 (2000 ft AGL).

Multispectral Imagery

Digital airborne multispectral scanner (MSS) imagery consists of 11 unique bands of reflected and emitted energy captured coincidentally by the scanner and may be analyzed jointly to identify a variety of surface features. Similar to the thermal imagery, several of these bands are collected in non-visible wavelengths of energy.

The lowest altitude imagery available was examined unless the imagery did not fully cover the study area. In the latter case, higher-altitude multispectral imagery was employed to complete coverage of the study area. All overlapping flight paths necessary to cover the study area were examined.

Appropriate band combinations and band reflectance ratios were employed to compute indices of vegetative vigor such as the Normalized Difference Vegetation Index (NDVI). These computed digital indices were displayed and visually inspected for areas of unusual vegetative stress that could be associated with hazardous wastes or subsurface burials. The NDVI can be used as an indicator of the relative vigor of vegetative cover, with higher values indicating greater biomass. The NDVI was used to screen for areas exhibiting unusual vegetative stress. The 24-bit imagery was displayed on one screen with a linked screen displaying, for comparison, MSS bands that simulate natural color photography.

Multispectral scanner surveys of the ORR were conducted during the following time periods: April 1992 [4000 ft above ground level (AGL)], March 1994 (2000 ft AGL) , and June 1996 (2000 ft AGL).

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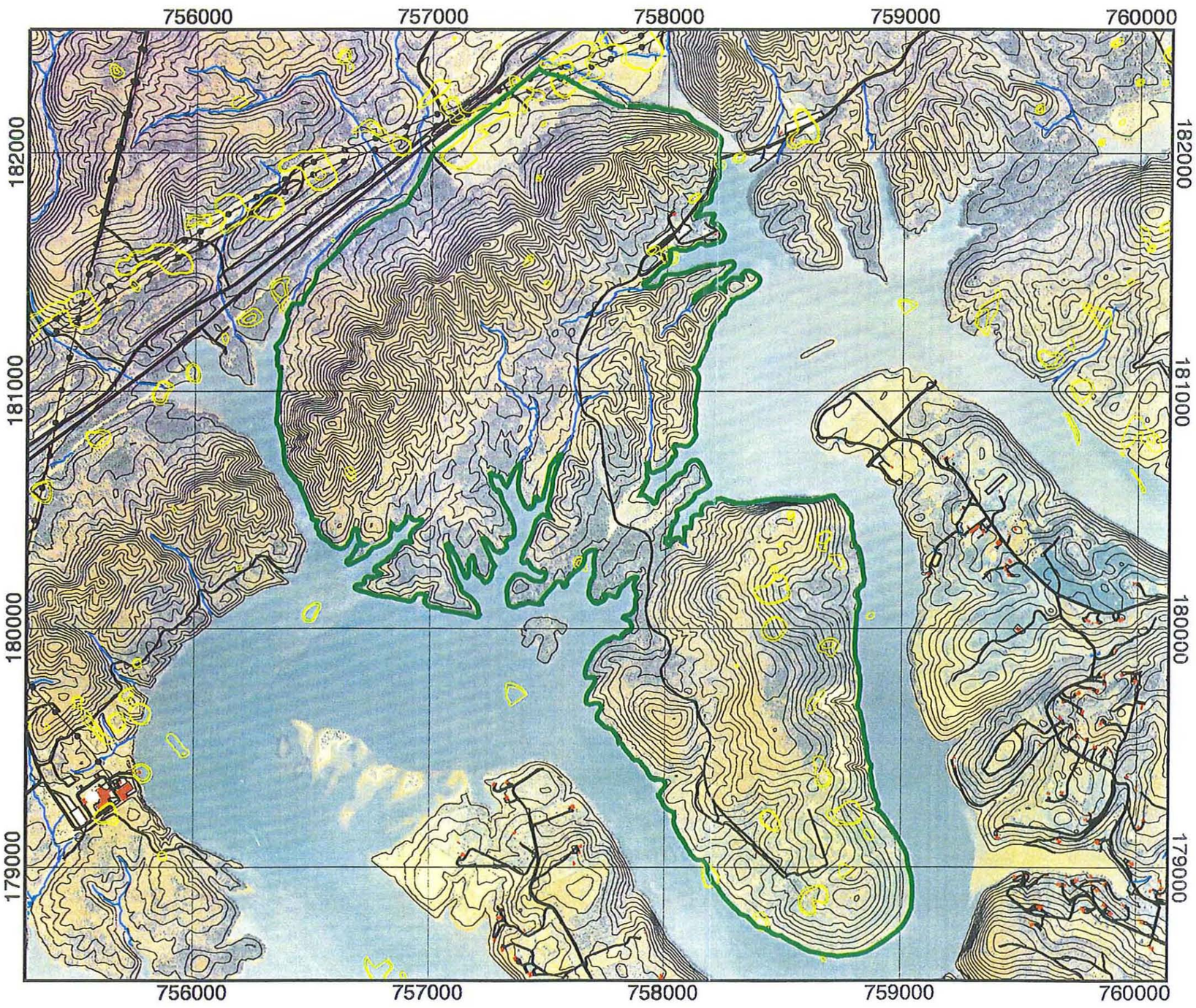

Fig. D. 1
Anomalies Exceeding Ten-Ton Vertical Magnetic Gradient Threshold

Gallaher Bend/Bull Bluff Parcel

10-Ton Magnetic Threshold
Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Remote Sensing Program, EIM
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

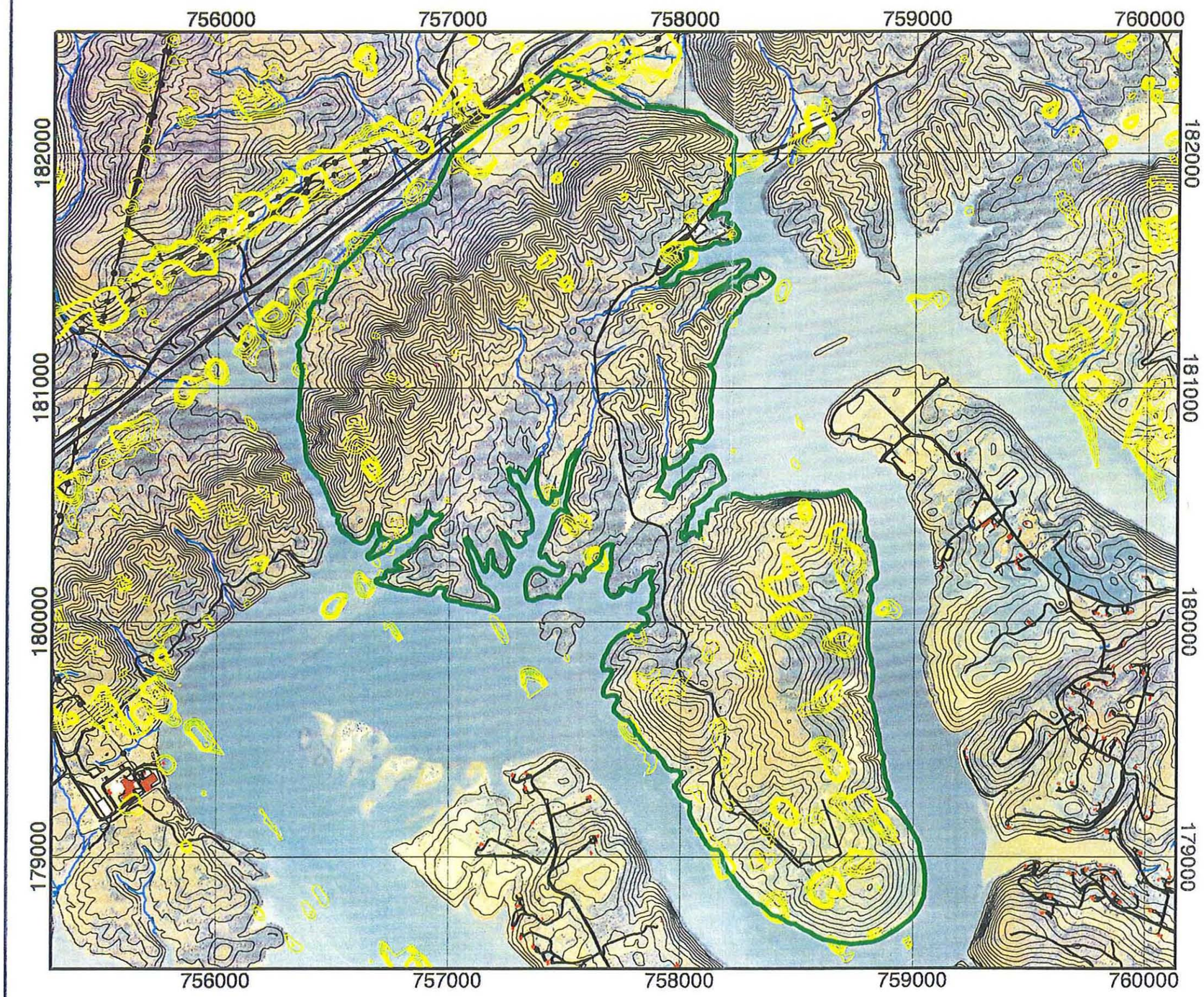

Fig. D. 2
Anomalies Exceeding Five Ton Vertical Magnetic Gradient Threshold

Gallaher Bend/Bull Bluff Parcel

- 5-Ton Magnetic Threshold

Base Data:

- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Remote Sensing Program, EIM
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

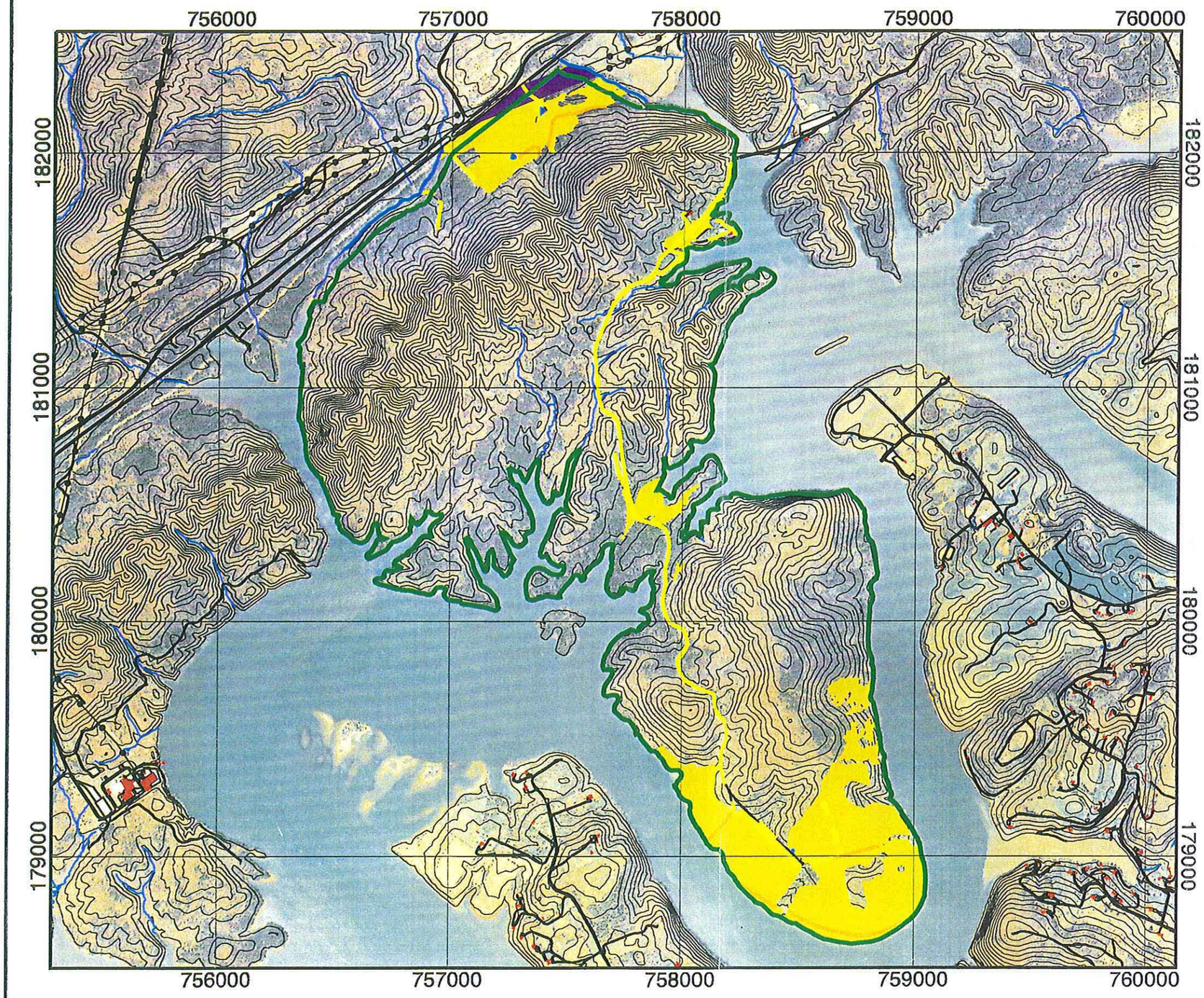

Fig. D. 3
Predawn and Daytime Thermal Infrared Screening

Gallaher Bend/Bull Bluff Parcel

Thermal Anomalies:
- Stream/Pond
- Structures/Buildings
- Road/Trail
- Communications/Utilities
- Unspecified Human Disturbance
- Fence Line

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Remote Sensing Program, EIM
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

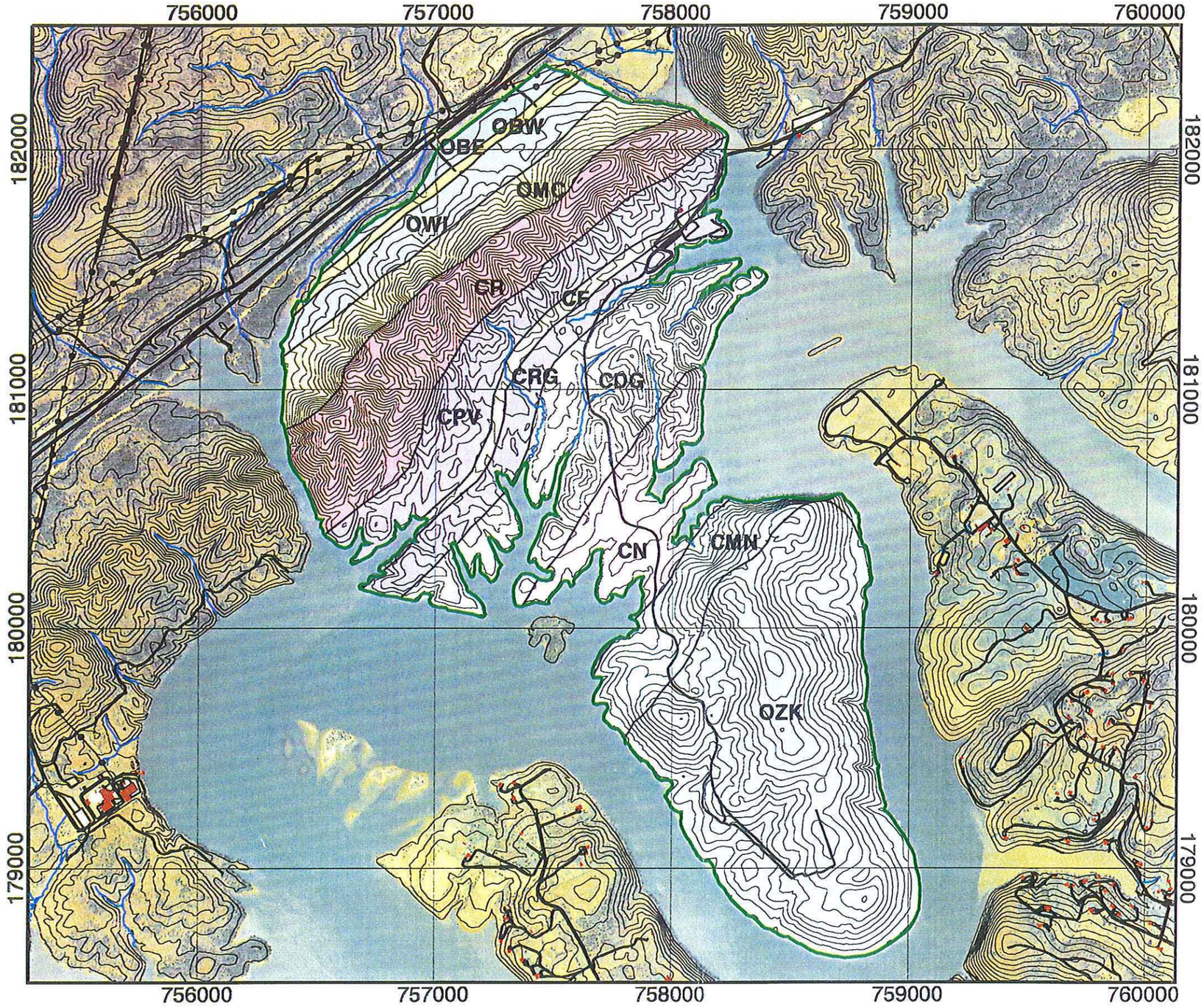

Fig. D. 4
Geology

Gallaher Bend/Bull Bluff Parce

Geology:

OBE	OZK	CF
OBW	CRG	CMN
OMC	CR	CN
OWI	CDG	CPV

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Geology Source:	Preliminary geology from Oak Ridge Reservation Hydrologic and Geologic Study (ORRHAGS)
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

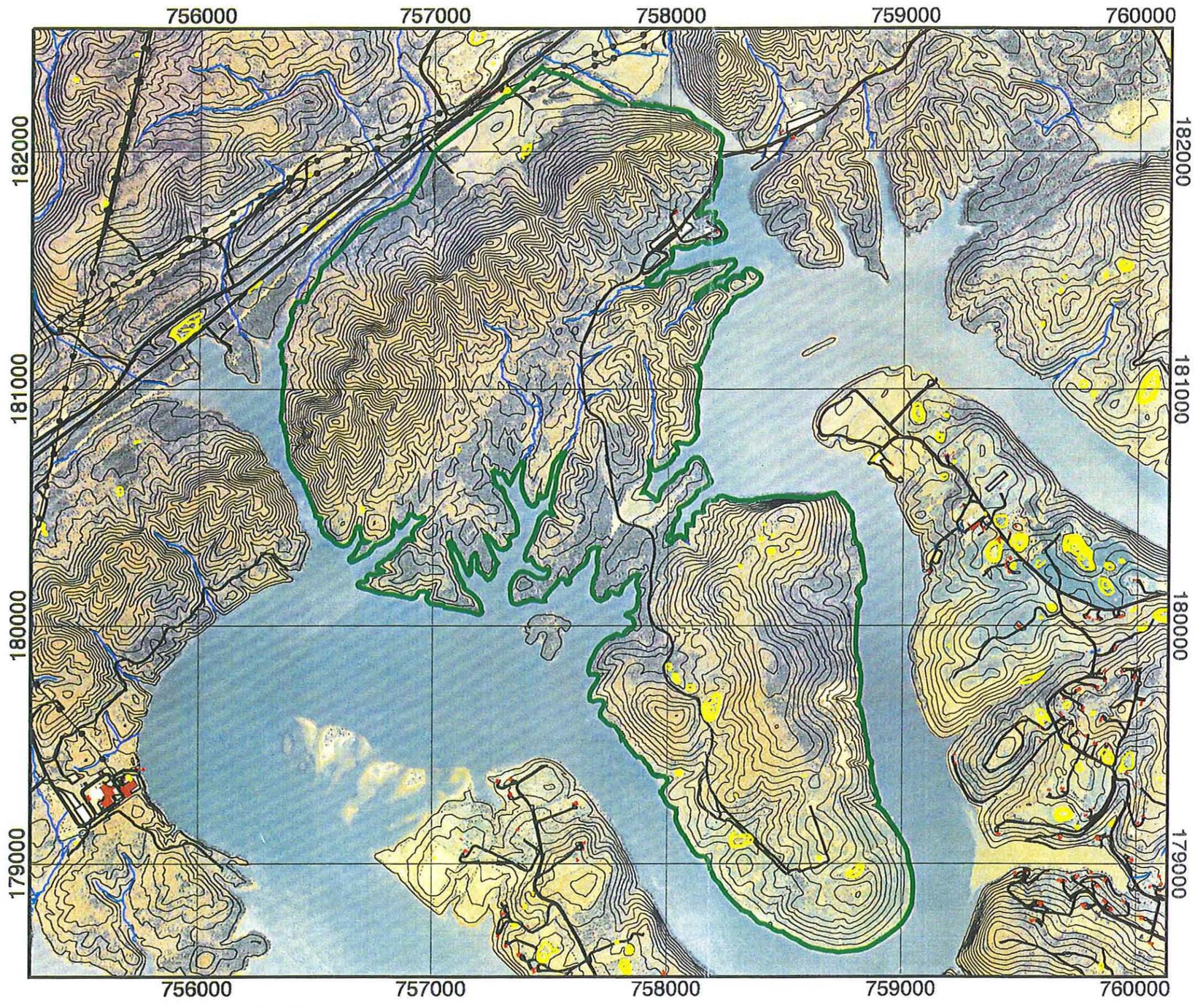

Fig. D. 5
Depression Contours

Gallaher Bend/Bull Bluff Parcel

- Depression Contour

Base Data:
- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Parcel Boundary
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division

0 500 1000 Meters

0 1000 2000 3000 Feet

Tennessee State Plane, NAD83

N

Anomaly Source:	Basemap and Imagery Project, EIM Program
Base Source:	1993 Orthophoto Imagery and Planimetric Vectors, Basemap and Imagery Project, EIM Program
Prepared by:	Geographic Information Science and Technology, ORNL
Date prepared:	July 10, 1996

Appendix E

SITE INVESTIGATION REPORT FOR GALLLAHER BEND/BULL BLUFF PARCEL

Footprint Reduction Program on the Oak Ridge Reservation

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
RADIOLOGICAL MONITORING AND OVERSIGHT PROGRAM

Robert Storms
Robert Jolley
Don Gilmore
Environmental Restoration Support Section

E.1 INTRODUCTION AND SCOPE

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) recently surveyed the area identified as the Gallaher Road/Bull Bluff parcel of the Footprint Reduction Project for negative environmental impacts associated with federal activities at the Oak Ridge Reservation (ORR).

A proposal to identify portions of the ORR that have been environmentally unaffected by federal activities was submitted to TDEC in March 1996. The purpose was to determine which land parcels could be conditionally released from CERCLA requirements and to reduce the size and configuration of the area of the ORR designated as part of the National Priorities List site. Approximately 5,175 acres were targeted for investigation during FY 96.

The Gallaher Bend/Bull Bluff parcel was selected as the first candidate site. Historical investigations, aerial photography analysis, and remote sensing analyses were studied for evidence of federal activities that could have potentially resulted in adverse impacts to the environment. Magnetic, radiological, and anthropogenic anomalies were plotted on maps to assist the field investigation team. TDEC conducted the field investigation with logistical support provided by LMES, LMER and DOE.

TDEC performed a walkover radiological and observational survey of the parcel and adjoining land. The investigation focused on possible anthropogenic sources of contamination that may render the parcel unfit for release. Contamination may be in the form of solid waste, radiological waste, or hazardous waste, or surface water contamination. Groundwater contamination will be addressed in detail if the property is released to the public.

TDEC investigated the anomalies identified by the Footprint Reduction project team and other features observed in the field. Cultural changes, nonsequential vegetation changes, radiological, and geophysical anomalies were investigated. Karst features, abandoned and existing roads and other areas were inspected when found in the field.

E.2 MATERIALS AND METHODS

Procedures employed during this project are consistent with those contained in the *TDEC/DOE-O Work Plan for the Walkover Survey Program.*

The survey team consisted of Robert Storms, Robert Jolley, and Don Gilmore. The team used a Ludlum Model 2221 Scaler Ratemeter with a 2x2 inch NaI detector. One-minute counts were performed at each survey point within one foot of the ground.

Findings are reported in counts per minute (cpm). It should be noted that if radiological contamination is detected, TDEC has a micro-rem meter which provides data in tissue dose equivalent units (rem). TDEC also uses a portable gamma spectrometer to determine the isotopes involved.

Background levels are geologically and geographically dependent. Therefore an arbitrary threshold value of twice areal background was established. Readings above that number will be noted as anomalous and background readings and measurements for the specific area will be taken.

TDEC reviewed the material provided by LMES and LMER, as well as all pertinent information from TDEC files. The size of the site precluded the use of grid survey techniques and after deliberation it was decided to concentrate on magnetic anomalies and area surveying.

- Routes were selected that would ensure maximum coverage of the area. Roads and trails were investigated to determine if materials were dumped on the site.
- Magnetic anomalies were examined to ensure that there were no observable structures present.
- Remote areas were investigated on foot to determine if they were disturbed by federal activities.
- The shoreline was accessible by boat and was investigated thoroughly.

TDEC teams used a combination of land and Global Positioning Systems (GPS) navigation and radiological instruments to evaluate particular points within the parcel.

Coordination for site access was arranged with LMER, and personnel from LMER were notified when TDEC personnel were on-site.

GPS, photographic, mapping, and aerial photography support were provided by the Graphic Information Science and Technology Group as part of the Geospatial Support Program of Environmental Restoration.

All interim status reports were presented at meetings with the Footprint Reduction project manager with LMES.

E.3 RESULTS AND DISCUSSION

Data is provided in units of counts per minute (see Table E. 1). The scaler ratemeter is calibrated so that for Cs-137, 1000 cpm $\approx$ 1 μR/hr. Because the actual radionuclides detected are unknown, this information can only serve as a point of reference, not as a conversion factor.

TDEC teams visited and measured gamma radiation using a Ludlum sodium iodide scaler ratemeter at the mapped anomalies. The readings ranged from a low of 6911 counts per minute (cpm) to a high of 16,982 cpm. All of the readings measured were well within background tolerances. The high reading was measured at an outcrop of Nolichucky Shale which has a naturally high gamma count. Attachment 1 contains the readings and their locations as measured by the GPS. During the field inspection no evidence of possible disposal of hazardous materials was found.

Most of the magnetic anomalies were on slopes or ridge crests while others were at the heads of drainages. Two anomalies (see Fig. D.1 in Appendix D), numbered 4 and 21, were associated with abandoned dwellings. One anomaly, number 19, is located in a sinkhole. The presence of the anomalies, with the exception of numbers 4 and 21, can be attributed to geologic or geomorphic causes. All the data associated with the investigation are presented as Tables E.1 and E.2.

A cultural site was found by Mr. J. M. Finger, the ORNL Environmental Oversight representative. This site is just north of Structure 628C along the east side of the access road. A domestic water well was noted by TDEC at the Structure 628C site. The well has a six-inch casing and is open to the surface. Water was detected in the well but was not sampled. Table E. 2 provides a list of the cultural sites.

TDEC conducted an extensive field investigation of the ground surface of the parcel. There were no observed environmental impacts to the site. There were several man-made structures that were in various stages of decay. The man-made structures on the parcel were identified as historical remains from the era prior to federal activity at Oak Ridge. The possibility that groundwater contaminants will migrate from affected areas of the ORR into the parcel exists and constitutes the need for groundwater use restrictions.

Positive controls will be required to einsure that inadvertent or unintentional environmental impacts are prevented. Prior to any future activities, the nature of these controls should be resolved between LMES, DOE, and TDEC before the site's release or reuse to ensure that confidence in this report remains high.

Most of the data is fairly straightforward. No conspicuous contamination was detected. When comparing measurements to a background. TDEC identifies an area as potentially contaminated when readings are above twice background levels. None of the locations surveyed here fit that criteria. From the data derived during this project, TDEC is comfortable that there is no public health concern due to federal activities on the parcel.

Table E.1. Field survey data

Date Surveyed	GPS Station	Readings cpm[1]	Location[2] Latitude	Longitude	Corrected Location[3] Latitude	Longitude	Comments
4-Apr-96	0001	8993	35 56.03	84 14.47	35 56 2.5533	84 14 28.0748	Top of Ridge
	Duplicate	8880					
	Duplicate	9040					
	Duplicate	9143					
	Average	9014					
	0002	8500	*	*	35 56 2.7246	84 14 28.122	Top of Ridge
	Duplicate	8300					
	Duplicate	8100					
	Average	8300					
	0003	8156	35 56.015	84 14.4205	35 56 0.0379	84 14 23.0233	Anomaly 19 Sinkhole
	Duplicate	8143					
	Duplicate	8115					
	Average	8138					
	0004	8548	35 55.9563	84 14.51	35 55 57.387	84 14 30.5401	Anomaly 20
	Duplicate	9551					
	Duplicate	9371					
	Duplicate	9443					
	Average	9228					
	0005	Skipped	*	*	35 56 7.1109	84 14 36.9829	No Entry
	0006	8667	35 56.134	84 14.629	35 56 6.173	84 14 36.8753	Anomaly 16 Slope in Drain
	Duplicate	8701					
	Duplicate	8825					
	Average	8731					
8-Apr-96	0001	8695	35 56.039	84 14.2938	Handheld Magellan Point		Hay Field
	0002	9336	35 56.089	84 14.3051	Handheld Magellan Point		Hay Field
	0003	11601	35 56.148	84 14.2903	Handheld Magellan Point		Hay Field

Table E.1 (continued)

Date Surveyed	GPS Station	Readings cpm[1]	Location[2] Latitude	Location[2] Longitude	Corrected Location[3] Latitude	Corrected Location[3] Longitude	Comments
11-Apr-96	0001	9557	*	*	*	*	B' Flag GPS Malfunction
	0002	9333	35 56.14	84 14.41	35 56 7.8214	84 14 25.6592	Blue Flag
	0003	10547	35 56.13	84 14.43	35 56 8.4675	84 14 25.8322	Red Flag 515
	0004	14447	35 56.15	84 14.41	35 56 9.054	84 14 25.2742	Anomaly 18 Groundhog Hole
	0005	9163	35 56.20	84 14.42	35 56 11.046	84 14 24.8302	Anomaly 17 Ravine
	0006	9023	35 56.25	84 14.37	35 56 14.827	84 14 22.9583	Barrens South-1
	0007	10950	35 56.30	84 14.43	35 56 18.144	84 14 25.5077	Barrens South-2
	0008	9833	35 56.35	84 14.43	35 56 21.055	84 14 25.5644	Barrens North-1
	0009	10517	35 56.26	84 14.48	35 56 15.567	84 14 28.8828	Anomaly 15 Ravines
	0010	8088	35 56.21	84 14.48	35 56 12.39	84 14 29.7714	Field
	0011	9554	35 56.39	84 14.44	35 56 24.6517	84 14 50.5180	Roadside Gully
	0012	9458	35 56.48	84 14.77	35 56 31.0991	84 14 45.2538	Anomaly 13 Flat Area
	0013	7802	35 56.55	84 14.46	35 56 33.1630	84 14 28.8424	Anomaly 12 Flat Area
	0014	10586	35 56.59	84 14.58	35 56 34.7464	84 14 36.0749	Anomaly 11 Hillside-Slope
	0015	8532	35 56.65	84 14.64	35 56 38.1454	84 14 38.7492	Anomaly 10 Slope
12-Apr-96	0016	16982	35 56.62	84 14.96	35 56 35.1860	84 14 55.4816	Nolichucky Shale Outcrop
	0017	10828	35 56.82	84 14.70	35 56 48.4700	84 14 41.6733	Maynardville Formation Outcrop
	0018	11027	35 56.80	84 14.52	*	*	Anomaly 5
	0019	8332	35 56.80	84 14.58	*	*	Anomaly 6
	0020	8745	35 56.76	84 14.45	*	*	Anomaly 7 40 Degree Slope
	0021	10245	35 56.72	84 14.44	35 56 43.406	84 14 26.5911	Large Ravine with Old Barbed Wire
	0022	9160	35 56.70	84 14.58	*	*	Draw
	0023	6911	35 56.60	84 14.78	*	*	Rock Outcrops and Fence
	0024		35 56.56	84 14.83	35 56 34.613	84 14 51.4377	Large Swallet 30' x 30' x 25'
17-Apr-96	0025	11239	35 57.63	84 15.37	**	**	Field North Side of Haw Ridge
	0026	13485	35 57.49	84 15.33	**	**	Crest of Haw Ridge
	0027	10244	35 57.45	84 15.30	**	**	Anomaly 1 Ridge Finger
	0028	11426	35 57.39	84 15.25	**	**	Anomaly 2 Top of Ridge Finger
	0029	13935	35 57.55	84 15.26	**	**	Divide/Air Gap
	0030	9915	35 57.22	84 15.25	**	**	Anomaly on North of Haw Ridge
	Map# 31	11630	No GPS				Reused Steel Pipe for Drainage

Table E.1 (continued)

Date Surveyed	GPS Station	Readings cpm[1]	Location[2] Latitude	Longitude	Corrected Location[3] Latitude	Longitude	Comments
18-Apr-96	0031	9503	35 56.38	84 14.36	**	**	Below Anomaly 14 at Lake
	0032	10500	35 56.38	84 14.46	**	**	Anomaly 14 Slope, Head of Ravine
	0033	7109	35 55.90	84 14.67	**	**	Anomaly 21 Slope, Flags 513,516
	0034	7034	35 56.48	84 14.80	**	**	Anomaly 22 Bank of Lake
	0035	11099	35 56.79	84 14.93	**	**	Anomaly 3 Finger of Ridge
12-Jun-96	0036	7424	35 58.07	84 14.96	**	**	Grassy Field Bethel Valley Rd and McCoy Branch
		7572					
		7628					
	0037	8188	35 57.98	84 14.91	**	**	Grassy Field McCoy Br and Power Lines
		8374					
		8335					
	0038	5761	35 57.97	84 15.03	**	**	Shed Deer Check Station
		5634					
		5863					
	0039	11652	35 57.98	84 15.12	**	**	Hay Field West of Silo
		11576					
		11416					
	0040	11675	35 57.90	84 15.20	**	**	West of Silo Bethel Valley Rd
		11756					
		11747					
	0041	10505	35 57.91	84 15.10	**	**	Hay Field Center of Field at Power Lines
		10515					
		10487					
	0042	9370	35 57.82	84 14.95	**	**	Hay Field at River
		9326					
		9361					
13-Jun-96	0043	7149	35 57.85	84 15.27	**	**	Hay Field
		7524					
		8431					

Table E.1 (continued)

Date Surveyed	GPS Station	Readings cpm[1]	Location[2] Latitude	Longitude	Corrected Location[3] Latitude	Longitude	Comments
	0044	8461 8397 8230	35 57.73	84 15.26	**	**	Hay Field
	0045	10870 11102 10970	35 57.66	84 15.31	**	**	Hay Field
	0046	6342 6558 6360	35 57.70	84 15.37	**	**	Hay Field
	0047	9814 9850 9918	35 57.77	84 15.42	**	**	Hay Field
	0048	10256 10246 10110	35 57.74	84 15.43	**	**	Hay Field
	0049	11249 11042 11257	35 57.67	84 15.43	**	**	Hay Field
	0050	11850 11752 11936	35 57.66	84 15.48	**	**	Hay Field
	0051	10907 10982 10778	35 57.71	84 15.55	**	**	Hay Field
18-Jun-96	0052	10696 10623 10901	35 57.57	84 15.46	**	**	Hay Field
	0053	11791 11836 11707	35 57.57	84 15.47	**	**	Forest
	0054	12084 12041 12005	35 57.55	84 15.53	**	**	Forest
	0055	9926 9927 9792	35 57.50	84 15.64	**	**	Rock Outcrop

Table E.1 (continued)

Date Surveyed	GPS Station	Readings cpm[1]	Location[2] Latitude	Location[2] Longitude	Corrected Location[3] Latitude	Corrected Location[3] Longitude	Comments
	0056	10108 10222 10167	35 57.48	84 15.71	**	**	Forest
	0057	8391 8168 8303	35 57.54	84 15.71	**	**	Forest
	0058	8739 8607 8442	35 57.57	84 15.76	**	**	Ecological Field Study Area
	0059	8596 8825 8600	35 57.49	84 15.89	**	**	Forest
	0060	11099 11105 11200	35 57.35	84 16.05	**	**	Natural Gas Right-of-Way
	0061	8773 8693 8718	35 57.27	84 16.07	**	**	Unofficial Campsite

NOTES

[1] Readings are one minute total counts on a Ludlum 2x2 NaI scaler ratemeter and are reported in counts per minute (cpm).

[2] Locations are unprocessed GPS readings from ASHTECH GPS.

[3] Processed GPS readings.

* No reading, operator error

** No reading, base station not in operation

Table E.2 Man-made features found during field investigation not previously noted

Structure 628C - Domesticwater well found near foundation (well open)
Structure 625A - Galvanized pipe with cap found near fence ("13-R" embossed on cap)
Several partial barbeed wire fence lines
Two galvanized feed buckets on fence lines