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ECOLOGICAL ASSESSMENT PLAN FOR WASTE AREA GROUPING 5

T. L. Ashwood

Environmental Sciences Division

Publication No. 3777

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

ORNL/M--1871

DE92 010726

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Prepared by
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ESD Publication No. 3777

Manuscript completed: September 1991
Date Published: April 1992

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
(EX 20 10 30 1)

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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ACRONYMS

ACD	Analytical Chemistry Division
BMAP	Biological Monitoring and Abatement Program
ESD	Environmental Sciences Division
LLW	Low-level waste
OHF	Old Hydrofracture Facility
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	Polychlorinated biphenyl
RI	Remedial investigation
SWMU	Solid waste management unit
SWSA	Solid Waste Storage Area
TWRA	Tennessee Wildlife Resources Agency
USEPA	U.S. Environmental Protection Agency
WAG	Waste Area Grouping
WOC	White Oak Creek

EXECUTIVE SUMMARY

Waste Area Grouping (WAG) 5 at Oak Ridge National Laboratory contains 13 solid waste management units (SWMUs) covering a surface area of ~20 ha in Melton Valley south of the main plant area. The largest SWMUs are Solid Waste Storage Area (SWSA) 5 and SWSA 5 North. These two SWMUs also contain most of the radioactive contamination. WAG 5 contains two surface impoundments and two intermittent streams; runoff from WAG 5 enters White Oak Creek and Melton Branch. Principal contaminants include fission-product radionuclides and transuranic elements, but trace metals and some organics may also be present.

This document describes the ecological assessment that will be performed to determine the ecological effects of contamination from WAG 5. This document also supports the baseline risk assessment and subsequent alternatives evaluations for WAG 5.

The screening-level ecological risk assessment prepared for WAG 2 (White Oak Creek and White Oak Lake) is directly relevant to WAG 5 and will serve as the basis for the WAG 5 screening-level risk assessment as well as the planning basis for the ecological assessment. The conceptual framework developed for WAG 2 is being used to guide and integrate the biological sampling work in other WAGs that adjoin WAG 2 (e.g., WAG 5), and the WAG 2 ecological assessment will address, on a watershed scale, the population- and community-level concerns that would be inappropriate to address on the smaller spatial scale of other individual WAGs.

Three specific tasks are incorporated in the WAG 5 ecological assessment: (1) threatened and endangered species surveys, (2) ambient toxicity tests of seeps, stream reaches, and soil that are identified as being contaminant sources, and (3) sampling of wildlife (specifically wild turkeys) that could potentially transfer contaminants from WAG 5 to humans.

1. INTRODUCTION

Waste Area Grouping (WAG) 5 is one of the groups of solid waste management units (SWMUs) defined by Oak Ridge National Laboratory (ORNL) for purposes of remedial action planning (Energy Systems 1987). WAG 5 consists of 13 SWMUs, including Solid Waste Storage Area (SWSA) 5 (North and South), Old Hydrofracture Facility (OHF) and New Hydrofracture surface facilities, OHF pond, process waste sludge basin, and low-level waste (LLW) concentrate tanks (Fig. 1).

The environmental setting of WAG 5 is described in the Remedial Investigation (RI) Plan (Bechtel 1988) and is summarized briefly here. WAG 5 covers an area of ~20 ha (50 acres), > 75% of which is included in SWSA 5 (Bechtel 1988: Table 3-4). Most of the area is maintained in a grass cover, but deciduous forests fringe SWSA 5. The surface water resources within the WAG consist of two surface impoundments (OHF pond and process waste sludge basin) and two intermittent drainages (D-1 and D-2, Fig. 1); however, White Oak Creek (WOC), Melton Branch, Melton Branch Tributary, intermittent drainage D-3, and an unnamed stream also drain the area and lie within several meters of the WAG 5 boundaries (Fig. 1).

From 1959 to 1973, SWSA 5 was used for storage of solid LLW and some transuranic wastes. SWSA 5 North has been used since 1970 for storage of transuranic wastes. Liquid LLW was disposed of in both hydrofracture facilities and is stored in the LLW concentrate tanks. Thus, the primary contaminants present in WAG 5 are transuranic and LLW radionuclides (especially, ^{3}H, ^{60}Co, ^{90}Sr, ^{137}Cs, $^{233,235}U$, $^{238,239}Pu$, ^{241}Am, and ^{244}Cm). In addition, metals (e.g., Hg, Pb, and Se) and some organics [e.g., volatile solvents and polychlorinated biphenyls (PCBs)] are probably present, although data on these contaminants are extremely limited.

The remedial investigation in WAG 5 is described in the RI plan for ORNL WAG 5 (Bechtel 1988) and in Appendix A of this document. Together, these two documents describe the rationale and approach for sampling soil, groundwater, and surface water in WAG 5 to characterize the extent of contamination and to support the baseline risk assessments.

This ecological assessment plan presents the rationale and approach for biological sampling in WAG 5 based on U. S. Environmental Protection Agency (USEPA) guidance (Warren-Hicks et al. 1989), a review of existing information, and the risk assessment and conceptual model prepared for WAG 2.

1.1 REVIEW OF EXISTING INFORMATION

1.1.1 Conceptual Model

The conceptual model of WAG 5 presented in the RI plan supplement does not address the biotic components, but the conceptual model for movement of contaminants into and through the WAG 5 ecosystem is virtually identical to the model for WAG 2 described by Boston et al. (1992). Although a screening-level ecological risk assessment has not yet been performed for WAG 5, we expect that contaminants of concern and organisms at risk in WAG 5 will be similar to those described in the risk assessment for WAG 2 (Blaylock et al. 1991). WAG 2 and WAG 5 share common boundaries in both the

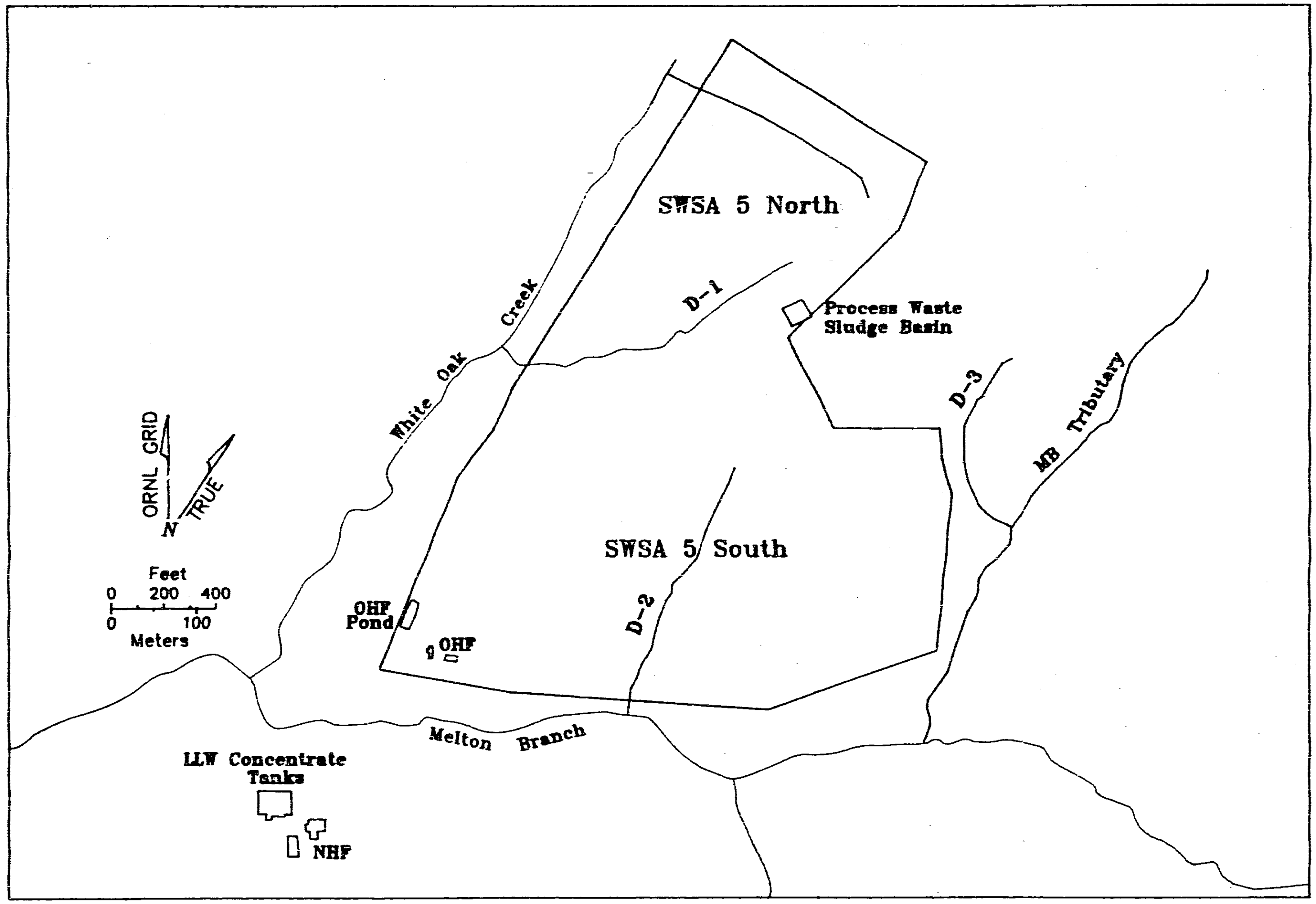

Fig. 1. ˀ AG 5 and environs including SWSA 5, White Oak Creek, Melton Branch (MB), MB tributary, old hydrofracture facility (OHF) and OHF pond, process waste sludge basin, drainages D-1, D-2, and D-3, new hydrofracture facility (NHF), and the LLW concentrate tanks.

Melton Branch and WOC watersheds, and the wastes buried in SWSA 5 are typical of wastes disposed of throughout the WOC watershed that comprises WAG 2.

Water is the primary vector for movement of contaminants within and out of WAG 5. Therefore, aquatic organisms in Melton Branch and WOC (Fig. 1) are important ecological receptors. In addition, plants and burrowing animals are capable of taking up contaminants from buried wastes, contaminated soil, and contaminated groundwater. Many contaminants are concentrated as they pass through the food web; thus, top-level predators—especially those that prey on aquatic organisms—may be especially at risk. Finally, certain wildlife (e.g., deer, wild turkeys, and many fish) are vectors for transporting contaminants to humans either on or off site.

1.1.2 Radioactive Contaminants

The screening-level ecological risk assessment for WAG 2 (Blaylock et al. 1991) did not evaluate the risk to biota from radioactive contaminants for two reasons: (1) previous investigations have revealed few biological effects from levels typical of WAG 2 and (2) remedial actions taken to address human health concerns associated with radionuclides are likely to address ecological concerns related to radionuclides. The same arguments can probably be made for WAG 5, but this issue will be addressed in the screening-level ecological risk assessment for WAG 5. Hence, radioactive contamination is of concern in biota primarily as it may affect human health. With that understanding, the following brief review of existing data is presented.

Results of the ORNL Biological Monitoring and Abatement Program (BMAP) have shown that ^{90}Sr and ^{137}Cs are accumulated in aquatic biota in WOC (Loar 1987, 1988, 1989, 1990, 1991). Fish contaminated with ^{137}Cs present a significant risk to human health (Blaylock et al. 1991). Turtles collected from White Oak Lake, downstream of WAG 5, contained elevated concentrations of ^{60}Co, ^{90}Sr, and ^{137}Cs (Loar 1988). Samples from waterfowl (i.e., Canada geese, American coot, mallard ducks) from around ORNL show that ^{137}Cs accumulates in breast tissue (Loar 1989, 1991).

Each year, a number of deer are confiscated by the Tennessee Wildlife Resources Agency (TWRA) during managed hunts on the Oak Ridge Reservation (ORR) because of elevated ^{90}Sr levels in bones (J. W. Evans, TWRA, personal communication, to T. L. Ashwood, ORNL, 1991). Garten and Lomax (1987) concluded that a ^{90}Sr concentration of 5 pCi/g in vegetation was sufficient to cause a 45 kg deer to accumulate sufficient radioactivity to be confiscated. They measured ^{90}Sr concentrations ranging from 18.8×10^3 to 39.1×10^3 pCi/g in vegetation near two seeps on the perimeter of SWSA 5.

Talmage and Walton (1991) measured above-background levels of ^{90}Sr in small mammals in SWSA 4, which has a waste disposal history similar to that of SWSA 5. Delaney et al. (1979) measured ^{239}Pu in burrowing crayfish in an area of the WOC floodplain adjacent to WAG 5.

Amano et al. (1987) measured ^{3}H concentrations of 2×10^5 to 4×10^7 pCi/L in free water from pine tree cores in SWSA 5. By comparison, the normal background level of ^{3}H in rainwater rarely exceeds 6×10^3 pCi/L at the tumulus facilities in SWSA 6 (Wickliff et al. 1991a,b; Ashwood et al. 1991).

With the exception of the vegetation studies in SWSA 5, it should be clear that radioactive contaminants measured in biota have several possible sources, of which WAG 5 is only one. Thus, existing data suggest that WAG 5 contributes to radioactive contamination in aquatic and terrestrial biota, but the exact magnitude of the WAG 5 contribution is not obvious from existing data.

1.1.3 Nonradioactive Contaminants

Very few data are available on nonradioactive contamination in biota around ORNL. The screening level ecological risk assessment for WAG 2 suggested that mink and kingfisher populations in the WOC floodplain could be affected by PCB and mercury levels in fish. Similarly, PCB and mercury contamination of fish and waterfowl may pose a health risk to humans.

BMAP bioaccumulation studies have shown that PCBs and mercury occur in fish and clams in WOC, including reaches affected by WAG 5 (Loar 1987, 1988, 1989, 1990, 1991). Mercury concentrations as high as 0.5 μg/g (± 0.09) were measured in bluegill from a reach of WOC adjacent to SWSA 5. Mercury concentrations in bluegill generally declined downstream of this point. Levels of all other metals were at levels comparable to uncontaminated reference sites. PCB concentrations in bluegill were highest (1.08 ± 0.36 μg/g) in the section of WOC immediately below the ORNL main plant area and declined downstream of that point (Loar 1991). Chlordane was detected in clams throughout WOC and WOL, but the source is believed to be a tributary upstream of the main ORNL plant area (Loar 1991).

Terrestrial BMAP studies have measured PCB concentrations (≤ 0.5 μg/g) in two species of turtles in White Oak Lake (Loar 1991). Recent data on mallard ducks suggest that these migratory waterfowl may accumulate mercury and other trace metals (e.g., lead, selenium, and silver) during their stopovers on White Oak Lake (Loar 1991).

Preliminary results from studies conducted for the off-site contamination assessment program indicate the presence of mercury and PCBs in great blue heron eggs in a rookery on Poplar Creek near the northwest corner of the ORR (MacIntosh et al. 1992). However, although some herons from this rookery feed in WOC, other likely sources of PCBs and mercury exist on the ORR.

As with the radioactive contaminants, no studies have been conducted to quantify the role of WAG 5 in nonradioactive contamination of biota.

1.2 OBJECTIVES

The objectives of an ecological assessment are (1) to quantify the ecological effects occurring at a hazardous waste site and (2) to provide input to the decision-making processes associated with the RI and subsequent remedial actions (Warren-Hicks et al. 1989). For WAG 5, the objectives of this ecological assessment are: (1) to determine whether and to what extent ecological damage is occurring as a result of contaminants present in the various SWMUs and (2) to support the baseline ecological risk assessment and subsequent evaluation of remedial alternatives.

2. APPROACH

The first step in conducting an ecological assessment is to identify assessment and measurement endpoints (Warren-Hicks et al. 1989). Assessment endpoints should be socially and biologically relevant, operationally definable and measurable, susceptible to the hazards at the site, and logically related to the remedial investigation (Suter 1989). Measurement endpoints must correspond to or predict an assessment endpoint and must be readily measurable. They should also be appropriate to the scale of the site and the exposure pathway (Suter 1989).

Assessment endpoints typically relate to populations or higher levels of biological organization. The exception to this occurs with rare or endangered species, where each individual is assumed to be potentially important to the survival of the species. An assessment endpoint may also be related to human health effects. Within this framework, the ecological assessment of WAG 5 has three potential assessment endpoints: (1) status of threatened or endangered species, (2) significant impacts on populations of species found on the ORR, (3) contamination of wildlife consumed by humans, and (4) loss of floodplain or wetland ecosystem values.

To an extent, the first, third, and fourth endpoints can be addressed in WAG 5. However, the second endpoint is meaningless for macroorganisms on a 20-ha segment of the 15,000-ha ORR, unless there are populations that exist only in WAG 5 (a highly unlikely scenario given the disturbed nature of the site). Nevertheless, the WAG 5 ecological assessment can provide data that will support a larger-scale assessment of contaminant effects on biological populations. The WAG 2 ecological assessment will integrate ecological effects of contaminants from the source WAGs (e.g., WAG 5) on populations within the WOC watershed. Data are needed from WAG 5 to assess the toxicity of localized contaminant sources.

Measurement endpoints associated with the three assessment endpoints include the following: (1) the presence or absence of endangered species in WAG 5, (2) ambient toxicity of water or soil in contaminant source areas within WAG 5, (3) contaminant levels in wildlife potentially consumed by off-site humans or intruders, and (4) the presence and extent of floodplain and wetland ecosystems in WAG 5. Tasks have been identified as described in succeeding sections to address each of these endpoints.

2.1 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

Data from the ecological assessment should support the risk assessment. In the case of WAG 5, no screening-level ecological risk assessment has been conducted to provide guidance on specific contaminants of concern, species at risk, or critical data gaps.

The screening-level risk assessment for WAG 2 (Blaylock et al. 1991) is directly relevant to WAG 5. WAG 2 and WAG 5 share common boundaries in both the Melton Branch and WOC watersheds, and the wastes buried in SWSA 5 and SWSA 5 North are typical of wastes disposed of throughout the WOC watershed that comprises WAG 2. Therefore, the screening-level ecological risk assessment for WAG 5 will be based in large part on the WAG 2 assessment. Any additional data requirements resulting from this assessment will be incorporated into a revision of this plan.

2.2 SURVEYS OF THREATENED AND ENDANGERED SPECIES, FLOODPLAINS, AND WETLANDS

Although several federally listed threatened or endangered species occur in the region (Kroodsma 1987), none are known to occur in WAG 5. Several state-listed species occur on the ORR and may occur in WAG 5. WAG 5 will be surveyed to determine whether state-listed species are present or are likely to be present. The surveys will be conducted by biologists familiar with the species that may be expected to live in habitats similar to WAG 5 and will be conducted during times of the year when the species are most likely to be identifiable. The surveys will only provide evidence of presence or absence; no quantitative information on population status will be obtained.

In addition to the threatened and endangered species surveys, the locations of any floodplains and wetlands in WAG 5 will also be identified. These locations will be identified on a map of the area.

2.3 AMBIENT TOXICITY TESTS

The purpose of ambient toxicity tests is to assess the toxicity of water or soil in a given area. Ambient tests have the advantage of providing a direct measure of an area's toxicity, and they provide an integrated response to the suite of potential toxicants present. This integrated response is difficult or impossible to predict from simple measurements of chemical concentrations and single-chemical toxicity tests.

2.3.1 Aquatic Toxicity Tests

WAG 5 is drained by WOC and its tributary, Melton Branch. The ORNL BMAP routinely monitors these streams and provides information on contaminant levels in fish and clams (Loar et al. 1991). In addition, the remedial investigation plan for WAG 2 (Energy Systems 1991) provides for sediment sampling in both streams. Both the WAG 2 and WAG 5 RI plans provide for quarterly sampling of seeps along Melton Branch and WOC, and the Active Sites Environmental Monitoring program samples seeps adjacent to SWSA 5 North quarterly (Ashwood et al. 1992).

These various studies will identify the major inputs of contaminants to Melton Branch and WOC. To assess whether individual inputs represent a threat to the aquatic biota, toxicity tests will be conducted on samples from the two impoundments, seeps identified in previous studies as being contaminated, and tributaries within WAG 5 that have previously contained contamination (D-1) or that have not previously been sampled (D-2). Specific sample sites are identified in Fig. 2, and the rationale for selection is included in Table 1.

Table 1. Location and rationale for toxicity testing sample sites

Location No.	Site description[a]	Rationale[a]
1	Bank seep (WOC 213[b]) on WOC	Seep contains contaminants from SWSA 5 North (Ashwood et al. 1991).
2	Seep on Tributary D-1	Seep contains contaminants from SWSA 5 South (Ashwood et al. 1991).
3	Mouth of Tributary D-1	Stream contains contaminants from SWSA 5 South(Ashwood et al. 1991).
4	Seep on border of SWSA 5 South	Seep (S-2) identified by Duguid (1975).
5	OHF Pond	Sediments and water are contaminated (Stansfield and Francis 1986).
6	Seep on border of SWSA 5 South	Seep (S-5) identified by Duguid (1975). Contaminated with ^{90}Sr (Garten et al. 1987).
7	Mouth of Tributary D-2	Contaminant levels and toxicity unknown.
8	Seep on border of SWSA 5 South	Seep (S-11) identified by Duguid (1975). Contaminated with ^{90}Sr (Garten et al. 1987).
9	Seep on MB tributary	Seep contains 200-400 µCi/L of ^{3}H probably from SWSA 5 South (Wickliff, D. S., ORNL, personal communication, 1991).
10	Process waste sludge basin	Contaminant levels and toxicity unknown.

[a] MB= Melton Branch; OHF = Old Hydrofracture Facility; ORNL = Oak Ridge National Laboratory; SWSA = Solid Waste Storage Area; WOC = White Oak Creek.

[b] WOC 213 is seep designation in Fig. A.2 of Ashwood et al. (1991). The designation means that the seep is ~213 m downstream of the unnamed tributary entering WOC immediately north of SWSA 5 North.

Toxicity tests are conducted at several locations in WOC and Melton Branch and their tributaries as part of the BMAP. We will coordinate the WAG 5 toxicity testing task to coincide with BMAP sampling to take advantage of sampling manpower and to provide maximum utility of the results (i.e., comparisons of toxicity at several locations along each stream). Samples will be collected three times at each WAG 5 site (beginning in December 1991) in order to encompass annual variation caused by seasonal and rainfall conditions.

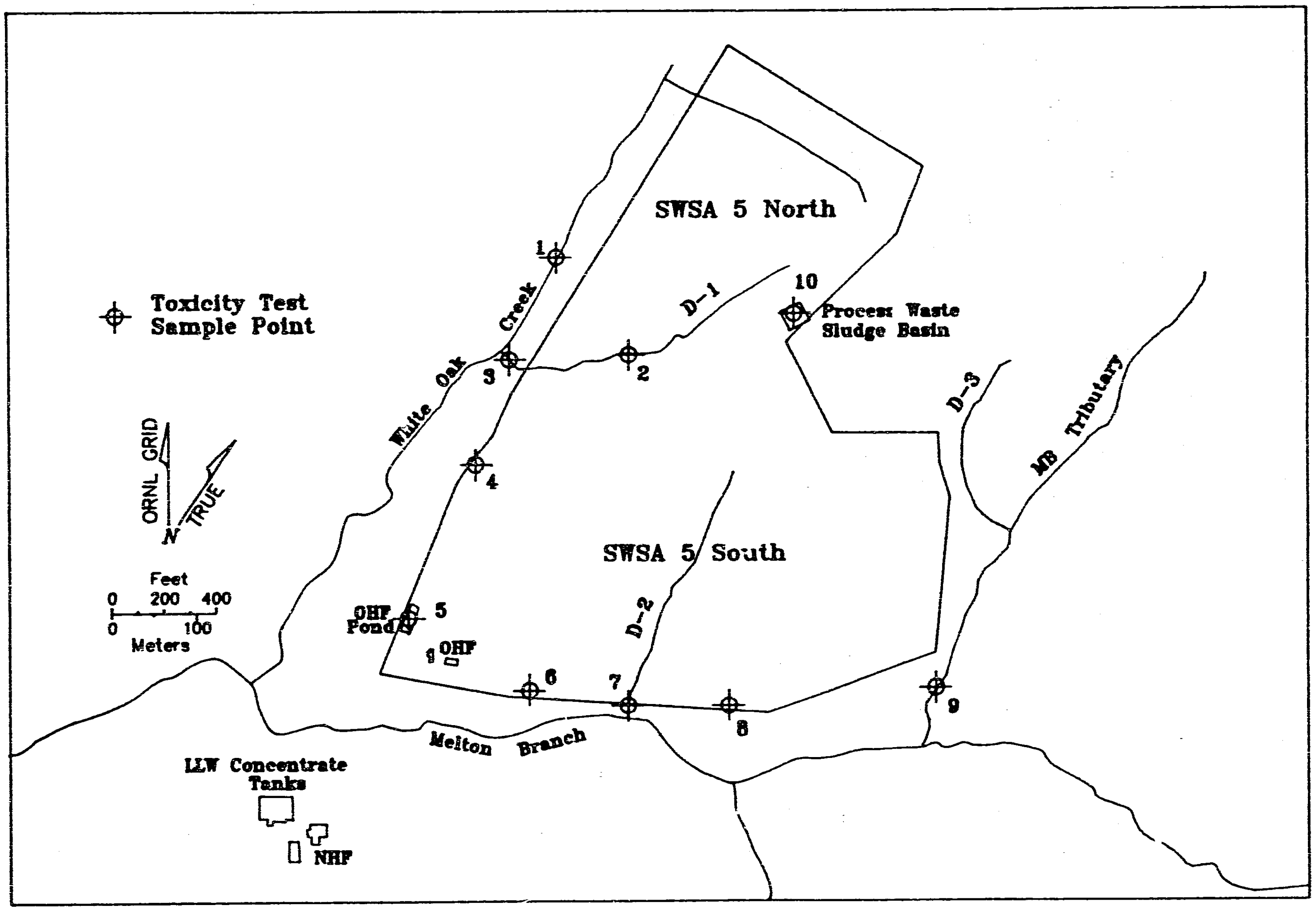

Fig. 2. WAG 5 and environs including toxicity test sample sites.

Toxicity tests that use *Ceriodaphnia dubia* in accordance with USEPA Procedure 1002.0 will be conducted in the Environmental Sciences Division (ESD). This procedure involves the use of 10 replicates for each sample and a control group. No chemical measurements other than field parameters measured during sample collection (i.e., temperature, pH, specific conductance, and dissolved oxygen) will be made as part of this task, because other tasks will obtain data on water quality.

2.3.2 Soil Toxicity Tests

In areas of WAG 5, we anticipate that soil may be contaminated. These areas may be identified initially through the walkover radiological survey and subsequently through direct soil sampling to be conducted as part of the RI activities. Contaminants may be taken up by plants or by burrowing animals. These organisms may then be at risk, or pass the contamination to other organisms in the food chain.

Soil toxicity tests using earthworms and cabbage seedlings in accordance with demonstrated procedures (Green et al. 1988; Roberts and Dorough 1985; Wentsel and Guelta 1987, 1988) will be conducted in ESD. For planning purposes, we have assumed that three sites will be identified for testing.

2.4 WILDLIFE CONTAMINATION SURVEY

The BMAP already collects fish and clam data on bioaccumulation of contaminants in reaches of streams affected by WAG 5. Garten and Lomax (1987) have provided a method for estimating the concentration of ^{90}Sr in deer feeding on vegetation in WAG 5. Data obtained by TWRA suggest that other radionuclides are not significant contaminants in deer killed on the ORR (J. W. Evans, TWRA, personal communication, to T. L. Ashwood, ORNL, 1991). A survey of waterfowl that may be affected by WAG 5 contaminants (as well as by contaminants from other areas) is being conducted as part of the BMAP. The only other significant wildlife species that occurs on WAG 5 and is consumed by humans is wild turkey.

Wild turkeys were reintroduced to the ORR by TWRA in 1986. The ORR now serves as a source for stocking other wildlife management areas with these birds (J. W. Evans, TWRA, personal communication, to T. L. Ashwood, ORNL, 1991). Because wild turkeys have a large home range, there is substantial potential for turkeys to become contaminated in WAG 5 (and elsewhere) and to carry that contamination to other areas where they are subject to hunting or capture and transfer.

2.4.1 Sample Collection

Wild turkeys will be attracted to a site with bait and live-trapped with a cannon net during January and February 1992. Trapping will coincide with TWRA turkey management activities and will be conducted by TWRA and ESD personnel. Captured turkeys will be whole-body gamma-counted, and their legs will be screened for beta radiation. This screening procedure will identify birds that have elevated concentrations of gamma emitting isotopes, such as ^{60}Co and ^{137}Cs, and beta emitting isotopes, such as ^{90}Sr. Any such contaminated birds will be sacrificed and subjected to more rigorous analysis as described in Sect. 2.4.2. Additional randomly selected birds will be sacrificed to bring the total number of birds analyzed to 20. Any birds that die during the collection process will be included as part of the 20-bird sample because trap mortality is assumed to be a random process.

2.4.2 Analyses

A sample of the breast tissue of each bird will be analyzed for specific gamma emitting isotopes by direct counting. In addition, breast tissue from each bird will be analyzed for mercury and other trace metals and for PCBs. A bone sample from each bird will be analyzed for ^{90}Sr.

No standardized USEPA procedures have been established for radiological or nonradiological analysis of wildlife tissues. Turkey samples will be analyzed in ORNL's Analytical Chemistry Division (ACD) using procedures developed for BMAP samples of fish tissue. These procedures will be documented in a separate statement of work to ACD prior to beginning of analytical work.

3. SCHEDULE

To support the baseline risk assessment, all data must be available by the end of December 1992. The threatened and endangered species surveys will be conducted beginning in early 1992 and will be completed in June 1992. Ambient toxicity testing of water samples will begin in December 1991, and additional samples will be taken in February and August 1992. Soil samples will be taken as soon as sites are identified. Wild turkeys will be collected in early 1992.

The screening level ecological risk assessment will be conducted in December 1991 and January 1992, and results will be issued in draft form in February 1992. All results will be presented in an ecological assessment report issued in draft form in November 1992.

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