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OAK RIDGE NATIONAL LABORATORY

LOCKHEED MARTIN

ORNL/TM-13432

ENVIRONMENTAL SCIENCES DIVISION

Biological Monitoring and Abatement Program Plan for Oak Ridge National Laboratory

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Environmental Sciences Division
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ACRONYMS

BMAP	Biological Monitoring and Abatement Program
DOE	U.S. Department of Energy
FCK	First Creek kilometer
FFK	Fifth Creek kilometer
FY	fiscal year
HFIR	High Flux Isotope Reactor
LMER	Lockheed Martin Energy Research, Corp.
MEK	Melton Branch kilometer
MSRE	Molten Salt Reactor Experiment
NPDES	National Pollutant Discharge Elimination System
OECD	Office of Environmental Compliance and Documentation
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OR-SMO	Oak Ridge Sample Management Office
PCB	polychlorinated biphenyl
QA	quality assurance
QAP	quality assurance procedure
QC	quality control
TDEC	Tennessee Department of Environment and Conservation
WCK	White Oak Creek kilometer
WOC	White Oak Creek
WOL	White Oak Lake

1. INTRODUCTION

(L. A. Kszos)

As a condition of the National Pollutant Discharge Elimination System (NPDES) permit issued to Oak Ridge National Laboratory (ORNL) on April 1, 1986, a Biological Monitoring and Abatement Program (BMAP) was developed for White Oak Creek (WOC); selected tributaries of WOC, including Fifth Creek, First Creek, Melton Branch, and Northwest Tributary; and the Clinch River (Loar et al. 1991). Prior to the implementation of the ORNL BMAP, previous studies on the aquatic ecology of the WOC watershed focused on the radioecological effects of ORNL discharges and were not designed to characterize the aquatic biota. The 1950–53 and 1979–80 surveys conducted by Krumholz (1954a, 1954b, 1954c) and Loar et al. (1981), respectively, provided detailed descriptions of the aquatic communities of WOC and White Oak Lake (WOL).

The ORNL BMAP was first developed in 1986 (Loar et al. 1991) in order to determine if the effluent limits established for various ORNL facilities protect and maintain the classified uses of the receiving streams, especially the growth and propagation of fish and aquatic life, as designated by the Tennessee Department of Environment and Conservation (TDEC). The ORNL BMAP results from 1986 to 1995 are documented in technical reports reports (Ashwood 1993, 1994; Hinzman 1995; Loar 1992a, 1992b, 1992c, 1994a, 1994b) and quarterly reports. Historical data collected as part of the ORNL BMAP consists of instream toxicity monitoring, bioaccumulation monitoring of nonradiological contaminants in aquatic biota, biological indicator studies, instream ecological monitoring, assessment of contaminants in the terrestrial environment, and radioecology of WOC and WOL.

The renewed NPDES permit issued in December 1996 (effective in February 1997) requires a BMAP for WOC, Clinch River, Northwest Tributary, Melton Branch, Fifth Creek, and First Creek. The components of the Biological Monitoring and Abatement Program Plan for Oak Ridge National Laboratory will meet the requirement in the permit that a revised plan for biological monitoring be submitted to the State of Tennessee's Division of Water Pollution Control no later than 180 days from the effective date of the permit. The specific requirements are found in Part III(I) of the NPDES permit (Appendix). Section 2 of this plan provides the scope and objectives of the ORNL BMAP; Sect. 3 contains a site description; Sect. 4 identifies the rationale, sampling locations, schedules, and methods for the monitoring tasks; and Sect. 5 discusses qualty assurance and quality control.

2. SCOPE AND OBJECTIVES

(L. A. Kszos)

The overall purpose of this plan is to evaluate the receiving streams' biological communities for the duration of the permit and meet the objectives for the ORNL BMAP as outlined in the NPDES permit (Appendix).

2.1 SCOPE

The ORNL BMAP will focus on those streams in the WOC watershed that (1) receive NPDES discharges and (2) have been identified as ecologically impacted. In response to the newly issued NPDES permit, the tasks that are included in this BMAP plan include monitoring biological communities (fish and benthic invertebrates), monitoring mercury contamination in fish and water, monitoring polychlorinated biphenyl (PCB) contamination in fish, and evaluating temperature loading from ORNL outfalls. The ORNL BMAP will evaluate the effects of sediment and oil and grease, as well as the chlorine control strategy (as outlined in the NPDES permit) through the use of biological community data. Monitoring will be conducted at sites in WOC, First Creek, Fifth Creek, Melton Branch, and WOL.

2.2 OBJECTIVES

The ORNL BMAP is to address the following objectives as quoted from NPDES permit.

- Temperature loadings are within state water criteria for protection of fish and aquatic life for warm summer conditions. This should be verified and reported annually.
- Whether mercury at the site is not being contributed to the stream that will impact fish and aquatic life or violate the recreational criteria. Instream water analyses for mercury shall be part of the Biological Monitoring and Abatement Program.
- Sediment and oil and grease from storm discharges are not creating stream impacts.
- The status of PCB contamination in fish in the White Oak Creek watershed.
- Assessment of chlorine control strategy in protecting the stream in the main plant area.

In addition, the ORNL BMAP will evaluate whether effluent limits established at ORNL protect and maintain the classified uses that have been established by the TDEC for WOC and its major tributaries.

3. SITE DESCRIPTION

(L. A. Kszos)

The WOC watershed (Fig. 3.1) is located near the southern boundary of the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) and has a drainage area of 16.9 km^2 at its mouth at Clinch River kilometer 33.5. Parallel northeast-tending ridges constitute the northern and southern borders of the watershed; a third ridge (Haw Ridge) bisects the basin and separates Bethel Valley to the north and Melton Valley to the south. Because of dam construction, three distinct aquatic environments can be identified within the WOC watershed: (1) WOL, (2) WOC embayment below WOL, and (3) WOC and tributaries above WOL. WOL was created in 1941, when a small highway fill dam was constructed approximately 1.0 km above the confluence of WOC and Clinch River (Fig. 3.1). The region of the watershed above WOL is emphasized in this plan.

The headwaters of WOC originate on the southeast slope of Chestnut Ridge. The largest tributary of WOC is Melton Branch, which originates at the eastern end of Melton Valley and joins WOC at WCK 2.5 (Fig 3.1), approximately 500 m above WOL. The watershed area of upper WOC at White Oak Creek kilometer (WCK) 6.8 is 2.07 km^2 and is similar in size to that of upper Melton Branch (1.35 km^2). Stream flow in WOC is augmented by discharges from ORNL facilities that are centrally located in the upper WOC watershed (Fig. 3.1). Although most of the ORNL complex is situated in Bethel Valley, some facilities are located in Melton Valley. WOC and several of its tributaries — First Creek, Fifth Creek, and Northwest Tributary — are located within or adjacent to the main plant area and receive effluents from various ORNL operations.

Three major treated effluent discharges enter WOC: the Sewage Treatment Plant, the Coal Yard Runoff Treatment Facility, and the Nonradiological Wastewater Treatment Facility. In addition to these major treated wastewaters, 147 outfalls discharge stormwater and/or cooling tower blowdown, cooling water, groundwater, and steam condensate to WOC and its tributaries.

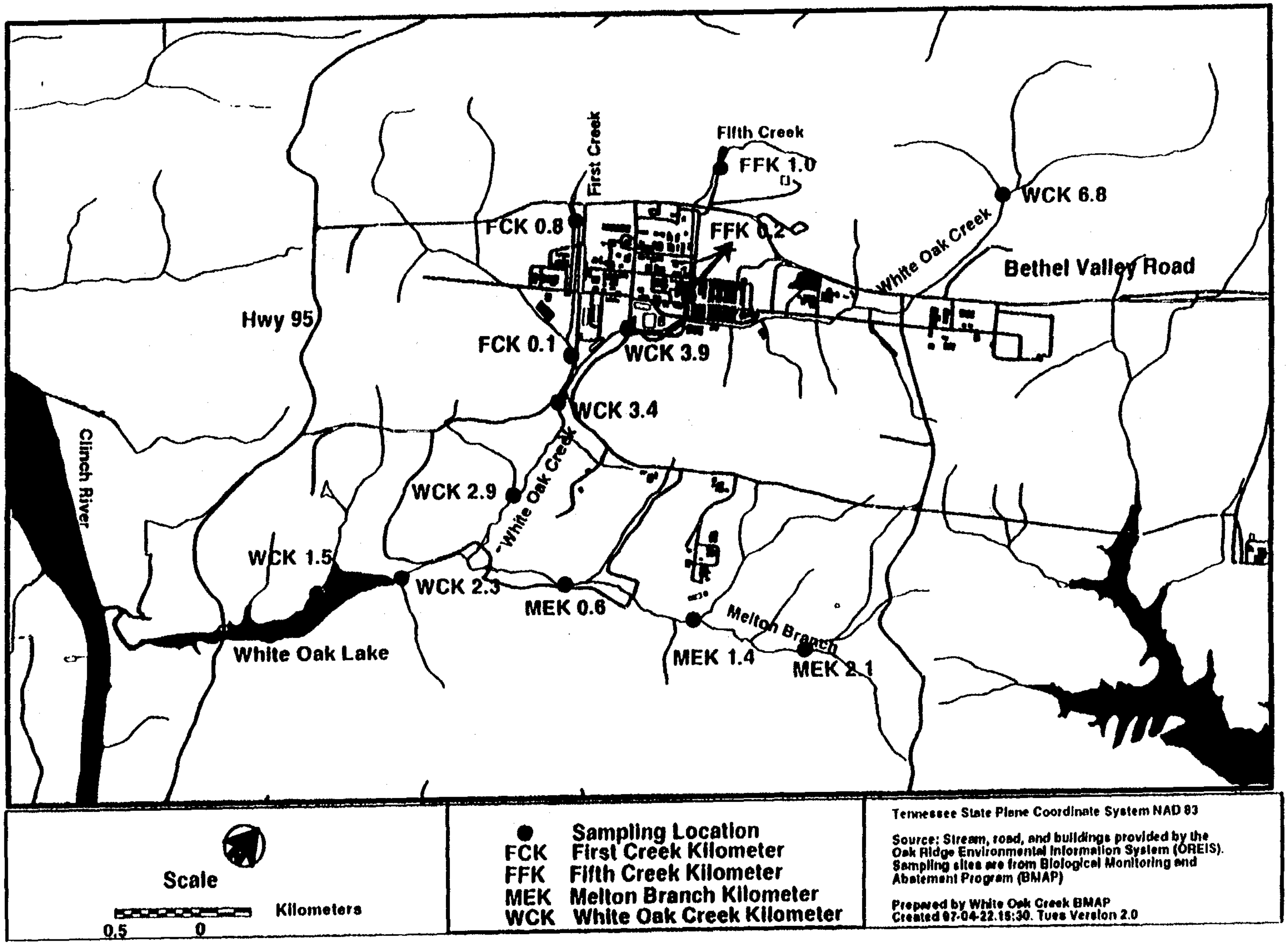

Fig. 3.1. Location of Biological Monitoring and Abatement Program sampling locations. FCK = First Creek kilometer; FFK = Fifth Creek kilometer; MEK = Melton Branch kilometer; WCK = White Oak Creek kilometer.

4. MONITORING TASKS

4.1 BIOLOGICAL COMMUNITIES

The NPDES permit requires that the plan for the ORNL BMAP "continue studies evaluating the receiving streams' biological communities throughout the duration of the permit as appropriate." The components of this BMAP plan will be used to evaluate the health of the benthic invertebrate and fish communities in the streams that receive the majority of ORNL's permitted discharges. Results from analyzing the benthic macroinvertebrate and fish community data in conjunction with NPDES stormwater data will also be used, where possible, to address other issues of importance to ORNL, such as the potential effects of thermal loading, sedimentation, oil and grease, and the chlorine control strategy. For example, excessive siltation can lead to altered invertebrate and fish communities as a result of reduced substrate heterogeneity, limited plant growth, and increased fish egg and larval mortality.

4.1.1 Benthic Macroinvertebrates Communities *(J. G. Smith)*

4.1.1.1 Introduction and Rationale

The close association of benthic macroinvertebrates with stream sediments, their relative immobility, and their sensitivity to changes in water quality make the study of these organisms an excellent means of evaluating the condition of a body of water. These same characteristics make the benthic macroinvertebrates useful for determining the potential ecological consequences of factors such as changes in effluent discharges, thermal loading, sedimentation, exposure to oils and grease, and the effectiveness of abatement actions such as the dechlorination of effluents.

Since the ORNL BMAP was initiated in 1986, benthic macroinvertebrates have effectively been used for assessing existing ecological conditions and the effects of changes in water quality (i.e., temporal changes) in streams of the WOC watershed. Significantly altered or depauperate macroinvertebrate communities have been found at all ORNL study areas downstream of effluent discharges in First Creek, Fifth Creek, Melton Branch, and WOC (Southworth et al. 1994; Kszos 1996, 1997). However, most of these sites have exhibited some degree of recovery since the ORNL BMAP was initiated. Melton Branch, in particular, recovered rapidly and extensively after the High Flux Isotope Reactor (HFIR) shut down in late

1986, and detailed data analyses suggest that current impacts are only slight after treatment upgrades that were completed in 1990 (Southworth et al. 1994). Improvements have been much less obvious in First Creek, Fifth Creek, and WOC, but results to date have shown a general trend of improvement in water quality through time.

The primary objectives of the benthic macroinvertebrate task are to monitor the condition of the macroinvertebrate communities of the streams of the WOC watershed and to evaluate the response of the macroinvertebrates to abatement actions. These objectives will also help meet the overall BMAP objective of determining whether the classified uses of the streams (i.e., growth and propagation of fish and aquatic life as well as livestock watering and wildlife) are being protected.

4.1.1.2 Locations and schedule

Quantitative samples will continue to be collected from nine stream sites in the WOC watershed twice each year (in April and October). These sites will include three in WOC (WCK 2.3, WCK 3.9, and WCK 6.8) and two each in First Creek (FCK 0.1 and FCK 0.8), Fifth Creek (FFK 0.2 and FFK 1.0), and Melton Branch (MEK 0.6 and MEK 2.1) (Fig. 3.1). Since Melton Branch exhibits only minimal impacts, samples from this stream will be processed only if needed. For the remaining sites, only those samples collected during the April sampling period will be processed unless data from the October sampling period(s) are needed for further clarification.

4.1.1.3 Methods

At each site on each sampling date, three random samples will be collected by means of a Surber sampler (0.09 m^2 or 1 ft^2) equipped with a 363-μm mesh net. Samples will be placed in prelabeled, polyurethane-coated, glass jars and preserved with 95% ethyl alcohol. To prevent sample decomposition due to dilution of the original preservative, the ethanol in each jar will be replaced within seven days of collection. Samples will be returned to a laboratory, where the organisms will be sorted from the other sample debris with the aid of an illuminated lamp with a magnifying glass. Organisms will be identified to the lowest practical taxon and enumerated. The data will be input electronically into an ASCII file, and the accuracy will be verified. The ASCII file will be loaded to the BMAP workstation where data managers will process it into ready-to-load format for the Oak Ridge Environmental Information System (OREIS).

4.1.2 Fish Communities *(E. M. Schilling)*

4.1.2.1 Introduction and rationale

Fish population and community studies can be used to assess the ecological effects of changes in water quality and habitat. In addition, statements about the condition of the fish community are understood by the general public (Karr 1981). These studies offer several advantages over other indicators of environmental quality (see Karr 1991) and are relevant to the assessment of the biotic integrity of streams such as WOC. For example, fish communities include several trophic levels and species that are at or near the end of food chains. Consequently, they potentially integrate the direct effects of water quality as well as the indirect effects that water quality and habitat changes have on primary producers (periphyton) and primary consumers (benthic invertebrates) that fish use for food. Because of these trophic interrelationships, the well-being of fish populations has often been used as an index of water quality (e.g., Weber 1973; Greeson et al. 1977; Karr et al. 1986). Monitoring of fish communities has been used as a means of evaluating receiving streams at the Y-12 Plant, the East Tennessee Technology Park (formerly the K-25 Site), the Paducah Gaseous Diffusion Plant, the Portsmouth Gaseous Diffusion Plant, and ORNL, and some programs have been operational since 1984. Changes in the fish communities at these sites have indicated recovery as well as have documented impacts (Ryon 1993; Schilling 1994a, 1994b, 1996; Schilling and Carrico 1996).

Monitoring of the fish communities was initiated under the ORNL BMAP in 1986 to determine if the effluent limits established at ORNL protect and maintain the classified uses of WOC and its major tributaries, including the growth and propagation of fish and aquatic life. Fish population and community analyses have been used for assessing the ecological effects of changes in water quality and habitat in streams of the WOC watershed. Significantly altered or depauperate fish communities have been found in WOC and its tributaries; however, most of the sites have exhibited some degree of recovery. Sampling at FFK 0.2 did not reveal the presence of fish from spring 1986 through fall 1988. Fish were not consistently present at FFK 0.2 until fall 1991 when the population began to become established. Fish were also absent from MEK 1.4 during spring 1986 through fall 1988, before the fish community began to recover. Overall, the fish community in WOC remains depauperate in terms of species richness in comparison to other area streams.

4.1.2.2 Locations and schedule

The proposed program for the WOC watershed will consist of quantitative sampling twice a year (in the spring and fall) at six sites (WCK 3.4, WCK 3.9, FCK 0.1, FCK 0.8, FFK 0.2, and MEK 1.4) and once a year (in the spring) at three sites (WCK 2.3, WCK 6.8, and FFK 1.0). The downstream sites on WOC, First Creek, and Fifth Creek will be sampled because they receive the majority of the inputs from plant operations. Continued sampling of the fish community in Melton Branch (MEK 1.4) is important because historically this site has been thermally affected by HFIR operations. From 1987 through 1993, with the exception of 1991, water temperatures at MEK 1.4 exceeded 30.5°C at various times each year. Moreover, temperatures have exceeded the upper lethal temperatures of 29.3 to 31.9°C for blacknose dace and 30.3 to 33°C for creek chub (Talmage and Opresko 1981).

Sampling of the upstream sites at WCK 6.8 and FFK 1.0 will be continued because these sites are reference sites for comparisons with downstream sites. The furthest downstream site within the program (i.e., WCK 2.3) is important to maintain because it integrates a multitude of inputs to WOC and is located downstream of NPDES ambient stations X14 and X13. This site has indicated some recovery with the upstream movement and establishment of the logperch (*Percina caprodes*). Single specimens of the striped shiner (*Luxilus chrysocephalus*) and spotted sucker (*Minytrema melanops*) have also been collected at WCK 2.3. Data from this site will be used for comparisons regarding the recovery of upstream sites, because migrants into the WOC watershed will first be encountered at this location.

An additional quantitative fish community sampling site will be established within the main plant area in an effort to evaluate the chlorine control strategy. This site will be sampled twice a year and will be valuable for establishing the effects of the dechlorinators that became operational in July 1996. Laboratory studies have shown that central stonerollers and striped shiners were able to detect and avoid total residual chlorine at concentrations of ≤0.07 mg/L (Etnier et al. 1996). Review of the literature suggests that chlorine concentrations as low as 0.05–0.10 mg/L can have adverse effects on freshwater fish when exposure is chronic (Degraeve and Clement 1991). The addition of a quantitative fish community sampling site in close proximity to outfalls that have historically released high levels of chlorinated water to WOC will provide data on the impact that the chlorine control strategy has on stream biota.

4.1.2.3 Methods

All stream sampling will be conducted by means of one or two Smith-Root backpack electrofishers, depending on the stream size. Each unit has a self-contained, gasoline-powered generator capable of delivering up to 1200 volts of pulsed direct current. Block nets will be used at the upper and lower boundaries of the fish sampling site to restrict fish movement. Fish that are collected will be anesthetized with tricaine methanesulfonate, identified, measured to the nearest 0.1 cm (total length), weighed on Pesola spring scales to the nearest tenth of a gram (for fish less than 100 g) or nearest gram (for fish greater than 100 g), and returned to the stream. Population estimates will be based on the removal method, preferably with three passes at each site.

Quantitative data analysis will include determinations of species richness, density, and biomass. Data will be compiled and analyzed by a comprehensive Fortran 77 program developed by Railsback et al. (1989). Species population estimates will be calculated using the three-pass removal method of Carle and Strub (1978). Biomass will be estimated by multiplying the population estimate by the mean weight per individual. Annual production will be estimated at each site using a size-frequency method (Garman and Waters 1983). Length-frequency data will be compiled according to 1- or 2-cm size classes so researchers can evaluate the population age structure. Total numbers, biomass, and production will be divided by the surface area (in square meters) of the sampling site to calculate density, biomass, and annual production per unit area. For each sampling site, surface area will be estimated by multiplying the length of the sampling reach by the mean width. The mean width will be based on stream width measurements taken at 5-m intervals. The data will be input electronically into an ASCII file, and the accuracy will be verified. The ASCII file will be loaded to the BMAP workstation where data managers will process it into a ready-to-load format for OREIS.

4.2 TEMPERATURE LOADING *(S. M. Gregory and G. E. Anderson)*

4.2.1 Introduction and rationale

ORNL's NPDES permit contains a requirement for the ORNL BMAP to evaluate temperature loadings from ORNL outfalls that discharge to streams. Temperature loadings must not cause exceedance of state water quality criteria for the protection of fish and aquatic life. These water quality criteria are summarized in the permit as follows. The discharges must not cause the temperature change in the receiving waters (after mixing) to exceed 3°C relative to a control point upstream of the discharge. Also, the discharges must not cause the temperature of the receiving waters (after mixing) to exceed 30.5°C (except as a result of natural causes), and the discharges must not cause the maximum rate of temperature change in the receiving waters (after mixing) to exceed 2°C per hour (except as a result of natural causes). The permit requires that compliance with these conditions be verified annually during summer conditions by means of a temperature profile of the creek.

Some reaches of WOC and reaches of the larger tributaries to WOC have high densities of outfalls, and thus the effects on instream temperature are best determined collectively by performing a temperature profile of the stream. However, some of ORNL's outfalls discharge to small tributaries or to reaches of streams where outfall spacing is great enough that thermally loaded outfalls can be individually evaluated for temperature loadings. Temperature impacts of ORNL discharges will be determined by means of both temperature profiles and instream monitoring near individual outfalls.

4.2.2 Locations and Schedule

To choose appropriate monitoring locations for determining temperature loadings to streams outside of the main plant area, outfalls were considered individually for their potential to contribute to temperature loading. Source knowledge and historical temperature data were used to help identify outfalls that have thermal loadings. Monitoring will be conducted during base flow conditions (when stormwater runoff is absent) so that maximum impact can be detected. Therefore, outfalls that discharge only stormwater runoff were eliminated from consideration. In addition, outfalls that have no thermal loading (e.g. outfalls with groundwater discharge, sump discharges, etc.) will not be evaluated for temperature loading..

For the reaches of WOC, Fifth Creek, First Creek, and Northwest Tributary where outfalls are concentrated (mainly in the main plant area), cumulative effects of thermally loaded discharges will be evaluated with temperature profiles of the streams. Monitoring locations were chosen to bracket outfalls that potentially have significant thermal loading (as determined from past temperature data, source knowledge, and a field screening of instream temperature conducted in spring 1997).

4.2.2.1 Outfall 081

Outfall 081 is located on the west side of the HFIR complex. Nonstormwater discharges from this outfall include cooling water and steam condensate. Outfall 081 discharges to an ephemeral tributary of Melton Branch. After a period of dry weather, the ephemeral stream is dry upstream of the outfall, and thus there is no place to take an upstream measurement. Therefore, the requirement that the outfall not cause a temperature change in the receiving stream of more than 3°C relative to an upstream control point, does not apply. When no flow is present upstream of the outfall, compliance with the 30.5°C criteria and the 2°C per hour rate of change criteria will be evaluated by measuring instream temperature at a suitable location downstream of the outfall.

4.2.2.2 Outfall 082

Outfall 082 is located on the east side of the Molten Salt Reactor Experiment (MSRE) area. In dry weather, the outfall has a small discharge, part of which, is from an air-conditioning unit. The outfall discharges to a small tributary of Melton Branch. The tributary has a relatively low flow rate at the point where effluent from Outfall 082 enters, and the flow may be seasonal. If flow is present in the small tributary when the temperature profile is conducted, temperature loading will be evaluated by measuring the water temperature upstream and downstream of the point where discharge from Outfall 082 joins the tributary. Because the amount of cooling water discharged through this outfall is so small, temperature loading for this outfall will not be evaluated when the tributary is dry upstream of the discharge point.

4.2.2.3 Outfall 234

Outfall 234 is located west of the 7000 area. Water discharged from this outfall flows through a ditch for approximately 100 m before entering WOC. It discharges to a reach of WOC that is typically dry after a short period without precipitation. The outfall drains stormwater from much of the 7000 area and also has a small cooling water source. If flow is present in WOC upstream of the point of discharge at the time of sampling, temperature loading will be assessed by measuring the instream temperature both upstream and downstream of the outfall. If no flow is present in the creek upstream of the outfall, compliance with the 30.5°C criteria and the 2°C per hour rate of change criteria will be evaluated by measuring the instream temperature at a suitable location downstream of the outfall.

4.2.2.4 Outfall 281

Outfall 281 is on the south side of the HFIR complex. Cooling tower blowdown is discharged from this outfall to an unnamed tributary of Melton Branch. At times, the discharge rate is significant in comparison with the flow rate in the tributary into which it discharges. Thermal loading to this tributary will be evaluated by measuring temperatures in the tributary upstream and downstream of the point where Outfall 281 discharges.

4.2.2.5 Outfall 282

Outfall 282 is located west of the MSRE area, and it discharges cooling water and stormwater to an unnamed tributary of Melton Branch. Because no natural flow occurs upstream of Outfall 282 during dry weather, an upstream measurement cannot be taken. Therefore, the requirement that the outfall not cause a temperature change in the receiving stream of greater than 3°C relative to an upstream control point does not apply. However, it is possible to evaluate whether the effluent causes an instream temperature to exceed 30.5°C or causes a rate of change that exceeds 2°C per hour. Compliance with these two requirements will be evaluated by measuring temperature at the normal monitoring point of the outfall.

4.2.2.6 Outfall 283

Outfall 283 is located southwest of the Nuclear Safety Pilot Plant area. The outfall has a thermal loading and it discharges directly to a small unnamed tributary of Melton Branch. The tributary disappears underground and reemerges downslope before joining another slightly larger tributary of Melton Branch. The confluence of these two tributaries is approximately 75 to 100 m from Outfall 283's discharge point. Because no flow is present in the smaller tributary upstream of Outfall 283 during dry weather and because the smaller tributary disappears underground downstream of the outfall, thermal loading from Outfall 283 will be evaluated by monitoring temperature in the larger tributary upstream and downstream of the confluence with the smaller tributary.

4.2.2.7 Temperature profile of White Oak Creek, Fifth Creek, First Creek and Northwest Tributary

Because of the close spacing of outfalls along WOC in the main plant area, Fifth Creek in the main plant area, First Creek west of the main plant area, and Northwest Tributary in the

1500 area, temperature loading to these parts of the creeks will be evaluated by looking at shorter sections of the creeks to which multiple outfalls discharge (i.e., a temperature profile will be performed). Monitoring locations are described in Table 4.1.

Table 4.1. Monitoring locations for temperature profiles of White Oak Creek (WOC), Fifth Creek (5THCR), First Creek (1STCR), and Northwest Tributary (NWT)

Location	Location Description
	White Oak Creek
WOC-1	Just upstream of Outfall 314
WOC-2	Just upstream of Outfall 115
WOC-3	Just upstream of Outfall 231
WOC-4	Just upstream of Outfall 230
WOC-5	Just upstream of Outfall 226
WOC-6	Just upstream of Outfalls 021 and 221
WOC-7	Just upstream of Outfall 112
WOC-8	Just upstream of Outfall 218
WOC-9	Just upstream of Outfall 216
WOC-10	Just upstream of Outfall 213
WOC-11	Just upstream of Outfall 211
WOC-12	Just upstream of Outfall 106
WOC-13	Just upstream of Outfall 210
WOC-14	At the Building 4515 foot bridge (upstream of the confluence with Fifth Creek)
WOC-15	Just upstream of Outfall 207 (downstream of the confluence with Fifth Creek)
WOC-16	At the flume on WOC (approximately 15 m downstream of Outfall 101)
WOC-17	Approximately 30 m downstream of the X12 discharge
WOC-18	Approximately 30 m downstream of Outfall 302
WOC-19	Approximately 100 m upstream of the X02 discharge (near the upper end of the coal yard runoff collection basin)

Table 4.1 (continued)

Location	Location Description
WOC-20	Approximately 15 m downstream of where the combined discharges of Outfalls X01 and 235 enter White Oak Creek
	Fifth Creek
5THCR-1	At the downstream end of the culvert under Fifth Street
5THCR-2	Just upstream of Outfall 267
5THCR-3	Just upstream of the culvert where Hillside Avenue crosses Fifth Creek
5THCR-4	Just upstream of Outfall 367
5THCR-5	Just upstream of Outfall 264 (south of Central Avenue)
5THCR-6	Just before Fifth Creek goes underground near Building 3500
5THCR-7	Fifth Creek just upstream of the confluence with White Oak Creek
	First Creek
1STCR-1	Just upstream of Outfall 250
1STCR-2	Just upstream of Outfall 247
1STCR-3	Just upstream of Outfall 341
1STCR-4	Just upstream of the bridge where White Oak Avenue crosses First Creek
1STCR-5	Approximately 10 m downstream of Outfall 141
	Northwest Tributary
NWT-1	Just upstream of where the ditch from Outfall 058 enters Northwest Tributary
NWT-2	Just upstream of Outfall 057
NWT-3	Just upstream of where the ditch from Outfall 051 enters Northwest Tributary
NWT-4	At the monitoring weir on Northwest Tributary

The NPDES permit requires that temperature loadings be assessed annually during warm summer conditions. The ORNL BMAP will assess temperature loadings once per calendar year, sometime in the third quarter (July through September). During this part of the year, instream temperatures are naturally higher (closer to the 30.5°C limit) and seasonal cooling water sources are typically present.

4.2.3 Methods

Temperature loadings to streams will be assessed by a series of manual temperature measurements made throughout a work day at points described in Sect. 4.2.2 (changes in monitoring locations may be necessary to adjust to instream flow conditions). Temperature profiles of different streams, and outfalls evaluated individually, need not be monitored on the same day. As much as possible, each round of measurements will be made approximately one hour apart. Measurement shall begin in the morning, when cooling demand is likely to be low, and shall continue into the afternoon, when cooling demand is likely to be high. Where possible, measurements downstream of outfalls will be made at locations of adequate mixing but upstream of other discharges. Monitoring will be done on a warm sunny day at least 24 hours after a measurable rainfall so that cooling systems will likely be operating and discharge of stormwater runoff from outfalls will be absent.

4.3 MERCURY AND POLYCHLORINATED BIPHENYLS

(M. J. Peterson and G. R. Southworth)

4.3.1 Introduction and rationale

This Section of the ORNL BMAP plan addresses two NPDES permit requirements of the BMAP at ORNL: (1) to evaluate whether mercury at the site is being contributed to the stream to a degree that will impact fish and aquatic life or violate the recreational criteria (instream water analyses for mercury should be part of this activity) and (2) to monitor the status of polychlorinated biphenyl (PCB) contamination in fish tissue in the WOC watershed. Previous monitoring has shown that mercury and PCB concentrations in WOC fish have been high enough to be a human health concern and that concentrations in fish can increase dramatically from one year to the next. For example, PCB concentrations in WOC fish increased approximately five-fold in 1994 and have remained elevated. Continued monitoring of mercury and PCBs in WOC fish will address the NPDES requirements and ensure that local state waters that have been classified for the purpose of "capture and subsequent consumption of fish and wildlife" are being protected (Tennessee Environmental Safety Regulations, Sect. 1200-4-3-.03).

Because fish are readily consumed by humans and many wildlife species, the monitoring of contamination in fish provides a direct measure of the potential human and ecological health concerns associated with discharges to the creek. Unlike periodic measurements of chemicals in water, bioaccumulation monitoring can integrate the cumulative impacts of various discharges. Thus, fish contaminant data can provide strong evidence, for example, that a costly cleanup of mercury sources (deemed necessary on the basis of short-term, aqueous chemical measurements) is unnecessary. Conversely, direct biomonitoring ensures that the environment is being protected when chemicals such as PCBs, which can accumulate to significant levels in biota, cannot be routinely detected in surface water.

To evaluate whether mercury impacts fish and aquatic life or violates the recreational criteria, measurements of mercury in water from upper WOC will be conducted in conjunction with measurements of mercury in fish. Routine sampling of total mercury in water will be compared with the Tennessee recreational criterion for mercury in water (0.15 μg/L) and the criterion for the protection of fish and aquatic life (0.012 μg/L). Mercury concentrations in fish fillets from two sites in WOC will be compared with human health threshold limits and State of Tennessee advisory concentrations. Comparisons of current mercury-in-fish results and ORNL BMAP's long-term record at these locations enables changes in mercury inputs as a consequence of facility actions to be detected and addressed.

The status of PCB contamination in fish will be addressed primarily by determining PCB concentrations in game fish fillets. Assessing PCB concentrations in edible fish tissue is the most appropriate means of evaluating PCB contamination in state waters because aqueous PCB measurements made using routine analytical methods are not very useful in evaluating water quality concerns. The State of Tennessee's recreational criteria, and fish and aquatic life criteria for PCBs are 0.00045 μg/L and 0.014 μg/L, respectively; both values are below the detection limits of routine analytical methods. To evaluate the level of concern to wildlife that eat fish from WOC, forage fish will be collected from one site every other year and analyzed for PCBs.

4.3.2 Locations and Schedule

Game fish (sunfish or bass) will be obtained annually from two WOC sites (WCK 2.9 and WCK 1.5) (Fig. 3.1). These two sites focus on areas of known high contamination and where changes or trends in mercury and PCB concentrations in fish have been observed over time. For comparison, fish will be collected from an uncontaminated reference stream (Hinds Creek) and analyzed for the same contaminants. In the late 1980s and early 1990s, monitoring of seven additional sites in the WOC watershed (in WOC, Northwest Tributary, Melton Branch, WOC embayment, and the Clinch River) showed that these other sites are generally less of a concern (although significantly elevated concentrations were observed at some sites). Whole stonerollers from WCK 3.9 will be collected every other year (beginning in winter 1999) to provide data to assess current ecological concerns due to PCB contamination.

A water sample will be collected six times per year from three WOC sites where mercury has been of potential concern in fish (WCK 3.5, WCK 2.9, and WOL) and from an upstream reference site (WCK 6.8).

Fish from WOC will be collected annually between January and March. Large year-to-year increases and decreases in mercury and PCB concentrations in fish have occurred in WOC as well as at other sites on the ORR. Continued annual monitoring of WOC fish will ensure that any increase or decrease in contamination will be detected, and it will reassure the public and regulators that effective actions have been taken and that the classified uses of the stream are protected. Water samples for total mercury analysis will be collected six times per year at approximately two-month intervals.

4.3.3 Methods

Fish will be collected by electrofishing using a crew of two or three persons. Redbreast sunfish (*Lepomis auritus*) will be collected from WCK 2.9, and bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*), from WCK 1.5. Sunfish represent current exposure at the site of collection and ensure that any increase or decrease in contamination (as a consequence of change in inputs) will be detected. Largemouth bass, a game fish of large size and high lipid content, will be collected from WOL to evaluate the maximum concentrations likely in the WOC watershed. Collections will be restricted to fish of a size large enough to be taken by sport fisherman (>50 g for sunfish and >500 g for bass). This restriction will minimize the effects of covariance between size and contaminant concentrations and provide data directly applicable to assessing human health concerns. Six fish of each species will be collected and placed on ice in a cooler prior to delivery to the processing laboratory. Upon arrival at the laboratory, the fish will be weighed and measured, the scales will be removed, and the fish will be filleted. Subsamples of muscle fillet from each fish will be prepared for analysis of mercury and PCBs and stored in a freezer prior to submittal to the analytical laboratory. WOC fish samples will be submitted with an appropriate number of QA/QC samples, including reference fish and standards, blind spiked samples, and duplicate samples.

Stoneroller minnows (*Campostoma anomalum*) will be the species of choice in evaluating ecological concerns associated with PCB contamination in forage fish in WOC. Three composite samples of ten fish will be collected from WCK 3.9 and the reference stream. The forage fish will be sorted, weighed, and measured in the laboratory so that a similar size range is represented in each sample. After freezing, each ten-fish composite sample will be thoroughly homogenized, and subsamples will be prepared for PCB analysis.

Standard grab sampling techniques will be used to obtain water samples for total mercury determination. Water samples will be submitted to the analytical laboratory, where state-of-the-art analytical methods capable of detecting mercury concentrations that are ≤ 0.010 μg/L will be used to effectively compare mercury concentrations in WOC with state standards. Five of the six samplings will be conducted under dry weather flow conditions. The sixth sampling will be taken during wet flow conditions. Total suspended solids will be measured in water sampled simultaneously with the mercury samples.

After the analytical results are received from the analytical laboratories, the QA data will be used to verify the accuracy of the data set. Once the quality of the data is assured, the analytical results will be combined with related field data in a spreadsheet format, interpreted, and then reported. The raw spreadsheet data will be loaded to the BMAP workstation in an ASCII format and it will be processed by data managers into a ready-to-load format for OREIS.

5. QUALITY ASSURANCE AND QUALITY CONTROL

(T. L. Phipps)

Field sampling and laboratory analyses of environmental samples will be performed according to requirements of the BMAP program and project-specific quality assurance plans. The BMAP's program QA plan (Phipps 1994) was developed on the basis of the organizational structure of DOE Order 5700.6C (*Quality Assurance*) (Table 5.1). A graded approach was used to incorporate QA requirements identified in the DOE order. The BMAP program QA plan also incorporates applicable Lockheed Martin Energy Research, Corp. and ORNL QA requirements for non-nuclear facilities. The plan was internally reviewed and approved and is determined to be necessary and sufficient to meet the needs of all BMAP sponsors.

Table 5.1 Elements of the Biological Monitoring and Abatment Program (BMAP) quality assurance plan (QAP)

QA element	Procedure number
Program	QAP-1
Training and Qualification	QAP-2
Quality Improvement	QAP-3
Documents and Records	QAP-4
Work Processes	QAP-5
Design	QAP-6
Procurement	QAP-7
Inspection and Acceptance Testing	QAP-8
Management Assessment	QAP-9
Independent Assessment	QAP-10

Quality assurance is achieved through management, planning and controlling of work processes, establishing performance criteria, assessing achievement of quality criteria, evaluating technical capabilities, and ensuring the traceability of data. The QA objectives for the BMAP are that scientific data generated will withstand scientific scrutiny, and that data will be gathered in accordance with controlled procedures for field sampling, chain-of-custody, and laboratory analyses.

Projects within BMAP require varying degrees of quality assurance; therefore, each individual project has a separate, abbreviated QA plan that identifies QA requirements specific to the project. The abbreviated plans reference sections in the program QA plan that are applicable to the project, with special attention directed to unique QA circumstances and requirements within the individual project. These requirements are documented as a feature distinctive to the project.

5.1 SAMPLE COLLECTION

Samples will be collected according to project-specific standardized procedures to ensure quality and integrity. These procedures are contained in the following individual project QA plans:

- QAP-X-90-ES-065, Rev. 1: Biological Monitoring and Abatement Program Quality Assurance Plan, Bioaccumulation Monitoring—Aquatic (Peterson et al. 1995);
- QAP-X-90-ES-067, Rev. 1: Biological Monitoring and Abatement Program Quality Assurance Plan, Fish Community Studies (Schilling and Ryon 1995);
- QAP-X-90-ES-068, Rev. 1: Biological Monitoring and Abatement Program Quality Assurance Plan, Benthic Macroinvertebrate Community Studies (Smith and Smith 1995).

Copies of the program QA Plan and the project QA plans may be obtained from the BMAP QA Coordinator upon request.

5.2 QUALITY OF FIELD DATA

Field quality control (QC) includes but is not limited to sample collection, custody, processing, preservation, container selection, transport, and field record keeping. These activities will be performed in accordance with procedures in the individual project QA plans.

Sample custody will be established by the sampling personnel at the time of sample collection through the use of chain-of-custody forms. Custody will be maintained throughout sample processing and delivery to the analytical laboratory.

5.3 QUALITY OF ANALYTICAL DATA

The Oak Ridge Sample Management Office (OR-SMO) is responsible for the procurement and approval of subcontractors for direct analytical support. The OR-SMO approval includes analytical methods, QA/QC requirements, deliverables, appropriateness of the laboratory to accomplish the work, and any other requirements in the analytical plan. The OR-SMO is responsible for assessing the laboratory to ensure compliance with quality and technical standards.

5.4 REVIEW AND VERIFICATION OF DATA

Data generated as a result of activities performed within the BMAP will be reviewed and verified by project personnel to ensure the following:

- data have been accurately recorded, transcribed, and quantified;
- procedures have been followed;
- data appear to be reasonable and consistent; and
- analyses were performed within specified parameters.

Data review and verification will be an ongoing process. The frequency and/or degree of verification and review will be commensurate with the project data quality requirements. Appropriate data verification activities are identified and included in the individual project QA plans.

5.5 DEVIATIONS FROM PRESCRIBED METHODS

Sampling personnel may modify the sampling techniques in the project technical procedures to improve performance or reduce sampling costs, provided that samples are not contaminated or altered. Any signficant planned or anticipated modifications to procedures must be approved by the project's Principal Investigator and OECD personnel, and all major modifications and deviations must be documented in field sampling or laboratory logbooks.

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Appendix

PART III(I) OF THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR OAK RIDGE NATIONAL LABORATORY

I. BIOLOGICAL MONITORING AND ABATEMENT PROGRAM

No later than 180 days from the effective date of the permit, the permittee shall submit to the Division of Water Pollution Control a revised plan for biological monitoring of the Clinch River, White Oak Creek, Northwest Tributary of White Oak Creek, Melton Branch, Fifth Creek, and First Creek. Revisions shall be included to address the following objectives.

1. Temperature loadings are within state water criteria for protection of fish and aquatic life for warm summer conditions. This should be verified and reported annually.
2. Whether mercury at the site is not being contributed to the stream that will impact fish and aquatic life or violate the recreation criteria. In-stream water analyses for mercury shall be part of the Biological Monitoring and Abatement Program.
3. Sediment and oil and grease from storm discharges are not creating stream impacts.
4. The status of PCB contamination in fish tissue in the White Oak Creek watershed.
5. Assessment of chlorine control strategy in protecting the stream in the main plant area.

The plan shall continue studies evaluating the receiving streams' biological communities throughout the duration of the permit as appropriate. The permittee's representatives shall contact the Division's representatives for consultation during the preparation period of the monitoring plan. Plans for this work must have the Division's approval prior to the work execution. The present plan for White Oak Creek watershed and the Clinch River may be included by reference. The program may be modified with the approval of the Division. Any revisions to the program must have the Division's approval prior to the implementing significant changes to the program.

Upon the Division's review of data from the Biological Monitoring Plan and Abatement Program, this permit may be modified, or alternatively, revoked or reissued, in order to reflect appropriate permit conditions.

ORNL/TM-13423

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