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DOE/EA-1196

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**Environmental Assessment
for
Selection and Operation of the Proposed Field Research Centers
for the
Natural and Accelerated Bioremediation Research (NABIR) Program**

March 7, 2000

**U.S. Department of Energy
Office of Science
Office of Biological and Environmental Research**

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SUMMARY

Background

The U.S. Department of Energy (DOE) Office of Biological and Environmental Research (OBER), within the Office of Science (SC), proposes to add a Field Research Center (FRC) component to the existing Natural and Accelerated Bioremediation Research (NABIR) Program. The NABIR Program is a ten-year fundamental research program designed to increase the understanding of fundamental biogeochemical processes that would allow the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites. An FRC would be integrated with the existing and future laboratory and field research and would provide a means of examining the fundamental biogeochemical processes that influence bioremediation under controlled small-scale field conditions. The NABIR Program would continue to perform fundamental research that might lead to promising bioremediation technologies that could be demonstrated by other means in the future.

For over 50 years, DOE and its predecessor agencies have been responsible for the research, design, and production of nuclear weapons, as well as other energy-related research and development efforts. DOE's weapons production and research activities generated hazardous, mixed, and radioactive waste products. Past disposal practices have led to the contamination of soils, sediments, and groundwater with complex and exotic mixtures of compounds. This contamination and its associated costs and risks represents a major concern to DOE and the public.

The high costs, long duration, and technical challenges associated with remediating the subsurface contamination at DOE sites present a significant need for fundamental research in the biological, chemical, and physical sciences that will contribute to new and cost-effective solutions. One possible low-cost approach for remediating the subsurface contamination of DOE sites is through the use of a technology known as bioremediation. Bioremediation has been defined as the use of microorganisms to biodegrade or biotransform hazardous organic contaminants to environmentally safe levels in soils, subsurface materials, water, sludges, and residues. While bioremediation technology is promising, DOE managers and non-DOE scientists have recognized that the fundamental scientific information needed to develop effective bioremediation technologies for cleanup of the legacy waste sites is lacking in many cases. DOE believes that field-based research is needed to realize the full potential of bioremediation.

Purpose and Need

The Department of Energy faces a unique set of challenges associated with cleaning up waste at its former weapons production and research sites. These sites contain complex mixtures of contaminants in the subsurface, including radioactive compounds. In many cases, the fundamental field-based scientific information needed to develop safe and effective remediation and cleanup technologies is lacking. DOE needs fundamental research on the use of microorganisms and their products to assist DOE in the decontamination and cleanup of its legacy waste sites.

The existing NABIR program to-date has focused on fundamental scientific research in the laboratory. Because subsurface hydrologic and geologic conditions at contaminated DOE sites cannot easily be duplicated in a laboratory, however, the DOE needs a field component to permit existing and future laboratory research results to be field-tested on a small scale in a controlled outdoor setting. Such field-testing needs to be conducted under actual legacy waste field conditions representative of those that DOE is most in need of remediating. Ideally, these field conditions should be as representative as practicable of the

types of subsurface contamination conditions that resulted from legacy wastes from the nuclear weapons program activities. They should also be representative of the types of hydrologic and geologic conditions that exist across the DOE complex.

Proposed Action and Alternatives

Proposed Action. The proposed action is to select and operate a field research component of the NABIR Program through the use of an FRC. The proposed FRC would consist of contaminated and uncontaminated, i.e., background areas on DOE lands. Within these areas would be small test plots (less than one acre), along with supporting field site trailers and existing laboratory facilities. The areas would serve as the primary field site for small-scale basic bioremediation research activities. The types of activities that could occur at the proposed FRC can be categorized into passive and active site characterization, obtaining research-quality samples, and *in situ* research. Because the activities at the proposed FRC would be undertaken in an area limited to less than an acre and a depth of 75 feet, the scale of research activities would be considered small (for a description of the proposed action at the FRC see Section 2.0 and Appendix A).

Passive subsurface characterization activities are described as non-intrusive (e.g., ground penetrating radar, electromagnetics, and resistivity) and intrusive (e.g., seismic tomography, radar, direct push penetrometer, creation and use of injection/extraction wells). Active characterization can be defined as the addition of some substance (e.g., air, non-toxic chemical tracers such as bromide, or a gas tracer such as helium or neon) to the subsurface under controlled conditions. The FRC would be a primary source for groundwater and sediment samples for NABIR investigators. Obtaining research-quality samples would be critical to the research conducted under the NABIR program at the FRC. Groundwater would be sampled by pumping water from existing wells or by installing new wells.

In situ research (i.e., research occurring in soils and groundwater at the FRC) would include biostimulation and bioaugmentation studies within the test plots. Biostimulation would involve introducing substances (e.g., electron donors and acceptors) into the subsurface to stimulate naturally occurring microorganisms to bioaccumulate or transform a heavy metal or radionuclide. Bioaugmentation would involve the injection of additional microorganisms into the subsurface to either bioaccumulate heavy metals or radionuclides, or transform them such that they become less toxic or less mobile in the subsurface. *In situ* research would only use non-toxic chemicals. There would be no use of genetically engineered microorganisms, no injections of radioactive materials, and no use of human pathogens. With the exception of the proposed placement of temporary work/sample preparation trailers at the test plots, there would be no new construction involved with the operation of the proposed FRC. Existing utilities would be used, and there would be no impacts to these utilities because of the small-scale research being proposed. Heavy equipment (e.g., drill rigs, brush hogs, augers) would be used when necessary for site clearing prior to conducting research at the background or contaminated sites. The equipment would be used for short periods of time. Best management practices and all applicable rules and regulations would be followed during the use of equipment.

Alternatives. This Environmental Assessment (EA) analyzes two alternative sites: Oak Ridge National Laboratory (ORNL)/Y-12 Site, Oak Ridge, Tennessee; and Pacific Northwest National Laboratory (PNNL)/DOE Hanford 100-H Area, Richland, Washington; and No Action. OBER used a systematic three-phased process to identify suitable alternative sites for the location of a proposed FRC. In Phase I, the requirements for an FRC were developed (e.g., the FRC must be located at a DOE site and must have legacy waste produced during research, design and production of nuclear weapons). DOE sites that met the requirements were identified. Eight sites expressed an interest in competing for FRC status: 1) PNNL/Hanford Site, WA; 2) Idaho National Engineering and Environmental Laboratory, ID; 3) Lawrence

Livermore National Laboratory, CA; 4) Los Alamos National Laboratory, NM; 5) Nevada Test Site, NV; 6) ORNL, TN; 7) Sandia National Laboratory, NM; and 8) Savannah River Site, SC. In Phase II, preferred characteristics for the FRC were identified and provided to the DOE sites along with a request for formal proposals. Of the eight candidate sites, only two indicated that they had field locations that met the preferred characteristics. Those two sites submitted proposals that contained scientific/technical, management and cost information. The two FRC candidate sites that met the criteria and had the preferred characteristics for an FRC, and therefore represent the array of reasonable alternative sites for the proposed FRC are:

- Oak Ridge National Laboratory/Y-12 Site, Oak Ridge, Tennessee
- Pacific Northwest National Laboratory/DOE Hanford Site, Richland, Washington.

Due to budget constraints, Phase III of the alternative site identification process involved a peer review of the two DOE sites that submitted scientific/technical proposals to be considered for the first FRC. Based on results of peer review of the scientific/technical proposals, on-site visits, and on the assessment of environmental impacts provided in this EA, DOE's preferred alternative is the ORNL/Y-12 Site. Pending additional funding for the NABIR Program, the PNNL/Hanford Site might be funded as an FRC at some point in the future.

The ORNL/Y-12 Site FRC would include a previously disturbed 243-acre (98-hectares) contaminated area and a 404-acre (163-hectares) uncontaminated background area on the Y-12 Site. Within these areas would be small (less than one acre) test plots where field research would take place. The contaminated area at the PNNL/Hanford 100-H Area would be approximately 2,950 feet long (900 meters) by 2,300 feet wide (700 meters) and consist of about 160 acres of land. There are two proposed uncontaminated background areas at the PNNL/Hanford Site that are smaller in size than the contaminated area. Test plots of approximately one acre would be located within the contaminated area.

The No Action Alternative consists of not implementing a field-based component to NABIR by not selecting or operating an FRC. This would result in continuing the NABIR Program's laboratory-based fundamental research approach as it is currently conducted by OBER, but without the benefit of focused and integrated field testing under actual legacy waste cleanup situations. Specifically, fundamental bioremediation research supported by OBER would not integrate laboratory-based research with field-based research from the FRC site. Laboratory findings would not be field-tested. The No Action Alternative would not satisfy the purpose and need.

Environmental Consequences

General Considerations. This EA analyzes the potential impacts to the environment at the proposed FRC at Oak Ridge, the alternative site at Hanford, and the No Action alternative. This EA bounds the type of work expected to occur at the FRC based on similar work that has occurred in other research programs on DOE and non-DOE sites. Resource areas analyzed include: earth resources; climate and air quality; water resources; ecological resources; archaeological, cultural and historical resources; land use, recreation and visual/aesthetic resources; socioeconomic conditions; human health; transportation; waste control; and environmental justice. Overall, because of the small-scale nature of the proposed field research; the limited potential for impacts to the environment; the OBER environment, safety and health and scientific review processes; and the regulatory and permitting compliance that would be required, no adverse environmental impacts would be anticipated.

With the exception of the proposed placement of temporary work/sample preparation trailers at the test plots, there would be no new construction involved with the operation of the proposed FRC. FRC research activities would not include actions that would change the landscape (e.g., large-area bulldozing, large-scale clearing, or excavation). Activities to support site characterization, to obtain research-quality samples, and to conduct *in situ* research would not impact the environment of the proposed FRC because of the small-scale nature (less than one acre and to a depth of less than 75 feet) of the proposed activities. Drilling to obtain groundwater and other sampling actions would not produce significant amounts of fugitive dust. It is expected that these activities would generate much less dust than normal farming practices in the surrounding areas. Operation of the FRC would use standard, construction best management practices to control erosion, (e.g., silt fences, berms) and water for dust suppression and to control fugitive emissions during drilling and other activities. It is anticipated that these and other construction/drilling management practices would adequately control fugitive emissions of radionuclides and any other air pollutants. Heavy equipment (e.g., drill rigs, brush hogs, and augers) would be used for supporting research at the FRC through maintenance and by preparing the test plots for well and for core samples. The equipment would be used for short periods of time and would not adversely impact the surrounding environments (e.g., habitats and sensitive receptors). Any shipment of hazardous materials to or from an FRC would follow U.S. Department of Transportation Hazardous Materials Regulations. Collection and transportation of samples within the FRC would follow existing DOE procedures and meet all environmental, safety, and health requirements. Existing utilities would be used, and there would be no impacts to the environment or to the availability of these utilities because of the small-scale of research activities proposed.

ORNL/Y-12 Site. Potential impacts of concern from siting and operating the proposed FRC at the ORNL/Y-12 Site include contamination of groundwater and surface water (Bear Creek), impacts to sensitive species and habitats, and exposure of FRC workers from radiological sources at the contaminated FRC areas.

FRC activities to support site characterizations, obtain research-quality samples, and perform *in situ* research would occur away from all surface waters including Bear Creek. Research would take place approximately 100 feet (30 meters) from Bear Creek. Research activities would be temporary and small in scale. Any potential runoff occurring as a result of ground-disturbing activities, coupled with rain events, would be controlled by implementing best management practices such as silt fencing at site-specific research areas within the FRC.

The potential exists that groundwater additives injected as part of *in situ* research at either the background or contaminated areas might pass through groundwater channels to the surface waters of Bear Creek. Small quantities of nontoxic tracers, nutrients, electron donors or acceptors, microorganisms, or other substances might be injected either in the background or contaminated areas of the FRC in accordance with best management practices and close monitoring of environmental conditions. Procedures for minimizing migration of contaminants during drilling and abandonment of boreholes and wells would be developed and described in the FRC management documents. These procedures may include sealing the upper few feet of shallow boreholes with low permeability bentonite or grout and installing conductor casing across the unconsolidated zone and sealing with grout or bentonite prior to drilling to deeper bedrock zones.

Previous studies in the Bear Creek Valley have used dye tracers to study groundwater flow. At downstream points in Bear Creek where the dye emerged, no adverse effects on aquatic life were detected. Bromide tracers injected less than 100 feet from the creek were not detected above background levels in seeps or in Bear Creek. Based on these studies, tracers injected in the contaminated area appear to be greatly diluted, and in at least one case were not detectable in Bear Creek. This dilution, plus the fact that tracers used by the NABIR Program would be nontoxic, would result in no impact to either groundwater or to the surface waters of Bear Creek.

Previous studies also suggest that when nutrients were "added" to the subsurface, the native microbial community structure was changed in the immediate vicinity of the addition, but the changes lasted only as long as the additional nutrients were present. Native microorganisms that would be used most likely would be strains that would be isolated from the contaminated area and then reinjected. Reinjection of native microorganisms would not be expected to be of concern either at the background or contaminated area. Non-native microorganisms might be obtained from some other field site and then injected at both the contaminated and background areas. Previous studies suggest that non-native microorganisms that would be used at the contaminated area would not move any great distance from the point of injection. The concentrations of microorganisms that would be used and the amounts potentially injected would be very small and would not be expected to create impacts to the environment. Non-native microorganisms on a test plot would not be expected to persist in the environment and would not be expected to reach Bear Creek. Genetically engineered microorganisms would not be injected either into the background or contaminated areas.

The only FRC activities expected to occur within floodplain areas would be well-drilling and monitoring (e.g., installation of piezometers). Procedures for preventing migration of contaminants down well boreholes would be developed and described in the FRC management documents. These procedures may include sealing the upper few feet of shallow boreholes with low permeability bentonite or grout and installing conductor casing across the unconsolidated zone and sealing with grout or bentonite prior to drilling to deeper bedrock zones. No structures or facilities would be situated in the floodplain. Movement of heavy equipment through the floodplain would be a temporary occurrence and would not impact the capacity of the floodplain to store or carry water. The negative effects to floodplains from the movement of heavy equipment alone is expected to be negligible. Because FRC research would take place on small test plots (less than one acre), it is anticipated that any wetlands found in potential research areas would be avoided. In addition, the limited ground-disturbing activities associated with FRC research would preclude damage to adjacent wetlands that might be in proximity to selected research areas. A Floodplain Assessment and Statement of Findings for the Y-12 Site Area of Responsibility has been completed, and actions undertaken by investigators would be covered by this assessment (see Appendix D).

Human health effects could potentially result from FRC worker exposure to contaminated soil and groundwater, from occupational hazards associated with site work such as well drilling and core sampling, and from hazards associated with accidental releases of liquid chemicals. Radiological doses to workers were bounded by evaluating a "bounding analysis" scenario, in the absence of any existing data on worker doses for this kind of work in the field. Workers were assumed to spill small amounts of soil (5 grams per year) and groundwater (5 milliliters per year) on themselves during the course of retrieving and processing the core samples. To maximize the potential dose, it was further assumed that the workers did not wash off the contamination, but actually ingested it. For the soil ingestion pathway, the total dose (for all radionuclides) is estimated to be less than 0.01 mrem/year, which is ten thousand times less than the limit of 100 mrem/year allowed for members of the public under Title 10, *Code of Federal Regulations*, Part 835, Section 208. The groundwater ingestion pathway is three times smaller, with a total dose of approximately 0.003 mrem/year. To estimate the total potential risk to workers from this "bounding analysis" exposure scenario, it is further assumed that the workers were exposed during the entire life of the project, which is ten years. The combined annual dose from both the soil and groundwater ingestion pathways is $1.26\text{E-}02$ mrem per year ($9.47\text{E-}03 + 3.09\text{E-}03$). Over the ten-year lifetime of the project, the total dose is ten times that amount, or $1.26\text{E-}01$ mrem, which yields a lifetime risk of $6.28\text{E-}08$, or roughly six in one hundred million. There are no expected radiological health risks to workers expected from work on the FRC.

Occupational hazards and industrial accidents, such as those associated with well-drilling/sampling and striking a subsurface structure during drilling, have been very few during previous and similar work in the

Bear Creek Valley. Existing wells would be used to the maximum extent possible during NABIR field work on the FRC, thus the amount of new well-drilling work would be minimal. The potential for health effects from accidents on the FRC is expected to be minimal. The expected low radiological doses and the absence of serious accidents during previous field work in the Bear Creek Valley provides a reasonable yardstick for the expectation of minimal impacts to people and the environment during future NABIR studies.

The small scale of the action and its expected minimal level of environmental consequences for the proposed FRC, should not result in any socioeconomic or environmental justice impacts.

PNNL/Hanford 100-H Site. Potential impacts of concern from siting and operating the proposed FRC at the PNNL/Hanford 100-H Site include contamination of groundwater and surface water (Columbia River) and exposure of FRC workers from radiological sources at the contaminated FRC areas.

FRC activities to support site characterizations, obtain research-quality samples, and perform *in situ* research would occur away from all surface waters including the Columbia River. Research would not occur closer than 200 feet (60 meters) from all surface waters, including the Columbia River. The closest point where injection of materials might occur would be in the contaminated area 200 feet from the Columbia River. Tracer injections at the two proposed background areas would be more than 1,500 feet from the Columbia River and concentrations would be expected to be unmeasurable by the time the tracer had traveled only half that distance. PNNL has proposed to install a series of groundwater extraction wells within each test plot to capture any substances injected into upstream injection wells. These extraction wells would be positioned to intercept groundwater flow moving toward the Columbia River. In addition, PNNL could make use of a secondary containment system of existing extraction wells located within 150 feet of the Columbia River to ensure that substances injected as part of *in situ* research by NABIR investigators do not reach the Columbia River. The existing extraction wells are part of an ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Remedial Action that involves pumping and treating for chromium-contaminated groundwater. Filters to extract tracers, electron donors and acceptors, nutrients, microorganisms and other substances would be added to the existing well filtration system, as needed. The pump and treat extraction wells have been operating constantly and will continue to do so. The use of nontoxic and non-persistent tracers coupled with the proposed and existing extraction well systems would ensure that tracers would not reach the Columbia River.

Research activities on the FRC that might disturb the land would be temporary and small in scale; e.g., injecting a small quantity of native microorganisms into the background and contaminated areas of the proposed FRC. Native microorganisms would most likely be strains that would be isolated from the contaminated area and reinjected. Reinjection of native microorganisms would not be expected to be of concern either at the background or contaminated area. Non-native microorganisms would not be injected either at the background or contaminated areas. Similarly, genetically engineered microorganisms would not be used either at the background or contaminated areas. Any potential runoff occurring as a result of ground-disturbing activities, coupled with rain events, would be reduced by implementing best management practices such as silt fencing at site-specific research areas within the FRC.

No structures or facilities would be constructed in the floodplain. Movement of heavy equipment through the floodplain would be a temporary occurrence and would not impact the capacity of the floodplain to store or carry water. The negative effects to floodplain from the movement of heavy equipment alone is expected to be negligible. To the extent practicable, staging areas and access roads would be temporary, construction would be limited to periods of low precipitation, and stabilization and restoration of the

affected areas would be initiated promptly. Wetlands in association with the Columbia River occur on the banks of the Columbia in proximity to the proposed contaminated area and background area. These wetlands are small in scale and are generally associated with the immediate bank of the Columbia River. Proposed FRC research would not occur in proximity to the wetlands and would not impact them.

Human health effects could potentially result from FRC worker exposure to contaminated soil and groundwater, from occupational hazards associated with site work such as well drilling and core sampling, and from hazards associated with accidental releases of liquid chemicals. Radiological doses to workers were bounded by evaluating a "bounding analysis" scenario, in the absence of any existing data on worker doses for this kind of work in the field. Workers were assumed to spill small amounts of soil (5 grams per year) and groundwater (5 milliliters per year) on themselves during the course of retrieving and processing the core samples. To maximize the potential dose, it was further assumed that the workers did not wash off the contamination, but actually ingested it. For the soil ingestion pathway, the total dose (for all radionuclides) is estimated to be less than 0.01 mrem/year, which is ten thousand times less than the limit of 100 mrem/year allowed for members of the public under Title 10, *Code of Federal Regulations*, Part 835, Section 208. The groundwater ingestion pathway is three times smaller, with a total dose of approximately 0.003 mrem/year. To estimate the total potential risk to workers from this "bounding analysis" exposure scenario, it is further assumed that the workers were exposed during the entire life of the project, which is ten years. The combined annual dose from both the soil and groundwater ingestion pathways is 1.26E-02 mrem per year (9.47E-03 + 3.09E-03). Over the ten-year lifetime of the project, the total dose is ten times that amount, or 1.26E-01 mrem, which yields a lifetime risk of 6.28E-08, or roughly six in one hundred million. There are no expected radiological health risks to workers expected from work on the FRC.

Occupational hazards and industrial accidents, such as those associated with well-drilling/sampling and striking a subsurface structure during drilling, have been very few during previous and similar work at the Hanford Site. Existing wells would be used to the maximum extent possible during NABIR field work on the FRC, thus the amount of new well-drilling work would be minimal. The potential for health effects from accidents on the FRC is expected to be minimal. The expected low radiological doses and the limited number of accidents during previous field work at the Hanford Site provide a reasonable yardstick for the expectation of minimal impacts to people and the environment during future NABIR studies.

No Action. Under the No Action alternative, there would be no FRC at the Oak Ridge or Hanford sites. As a result, DOE would not be able to conduct integrated field-based research and no intrusive actions would be taken by the NABIR Program, resulting in no impacts to the affected environment at Oak Ridge and Hanford.

Stakeholder Involvement

In January 2000, DOE provided the Federal, State, and local government agencies, the local communities, and Tribes with the draft EA for a 30-day review. There were no comments from the Tribes or community members and the comments received from the Federal and State and local government agencies were addressed in this final EA. Appendix B provides a list of commentors, their comments, and the location within the EA where each comment is addressed.

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LIST OF ACRONYMS AND ABBREVIATIONS

BASIC	Bioremediation And Its Societal Implications and Concerns
BCBG	Bear Creek Burial Grounds
BCV	Bear Creek Valley
BJC	Bechtel Jacobs Company, Limited Liability Corporation
BMP	Best Management Practice
BY/BY	Boneyard/Burnyard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	U.S. Code of Federal Regulations
DOE	U.S. Department of Energy
DOT	Department of Transportation
EA	Environmental Assessment
EFPC	East Fork Poplar Creek
EH	DOE Office of Environment, Safety and Health
EIS	Environmental Impact Statement
EM	DOE Office of Environmental Management
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ES&H	Environment, Safety and Health
ETF	Effluent Treatment Facility
ETTP	East Tennessee Technology Park
FA	Functional Area
FONSI	Finding Of No Significant Impact
FRAP	Field Research Advisory Panel
FRC	Field Research Center
FY	Fiscal Year
GEM	Genetically Engineered Microorganism
GPR	Ground Penetrating Radar
HASP	Health And Safety Plan
HEHF	Hanford Environmental Health Foundation
LLBG	Low Level Burial Grounds
LLW	Low Level Waste
NAAQS	National Ambient Air Quality Standards
NABIR	Natural and Accelerated Bioremediation Research Program
NEPA	National Environmental Policy Act

NERP	National Environmental Research Park
NRHP	National Register of Historic Places
NESHAP	National Emissions Standard for Hazardous Air Pollutants
OBER	DOE SC's Office of Biological and Environmental Research
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PM	Particulate Matter
PNL	Pacific Northwest Laboratory, before c.1995
PNNL	Pacific Northwest National Laboratory, after c.1995
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SC	DOE Office of Science
SCFA	Subsurface Contaminants Focus Area
SSP	DOE's Subsurface Science Program
STEPS	Short-Term Experimental Field Sites
SWTP	Sanitary Waste Treatment Plan
TDEC	Tennessee Department of Environment and Conservation
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WETF	West End Treatment Facility

1.0 INTRODUCTION

The U.S. Department of Energy's (DOE) Office of Biological and Environmental Research (OBER), within the Office of Science (SC), proposes to add a Field Research Center (FRC) component to the existing Natural and Accelerated Bioremediation Research (NABIR) Program. The purpose of the NABIR Program is to increase the understanding of fundamental biogeochemical processes that allow the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites. A Field Research Center would be integrated with existing and future laboratory and field research and would provide a means of examining the fundamental biogeochemical processes that influence bioremediation approaches under field conditions.

This National Environmental Policy Act (NEPA) Environmental Assessment (EA) is the first of a two-tiered NEPA process for the NABIR Program. The first tier describes OBER's approach to implement the existing NABIR Program, and analyzes the potential environmental consequences associated with the selection and operation of a Field Research Center (FRC) within the program. (See Section 2.0 and Appendix A for a description of the proposed action.)

As required, the No Action alternative is also evaluated. The second tier of the NABIR NEPA compliance process would be the evaluation of the appropriate level of NEPA documentation that would be prepared for the specific field research proposed to be conducted at the FRC. The evaluation would consider whether the proposed field research is bound by this EA. If it were found that a proposed project was not bound by this EA but might significantly affect the human environment, DOE would undertake appropriate, specific NEPA revisions.

In January 2000, DOE provided the Federal, State, and local government agencies, the local communities, and Tribes with the draft EA for a 30-day review. There were no comments from the Tribes or community members and the comments received from the Federal and State and local government agencies were addressed in this final EA. Appendix B provides a list of commentors, their comments, and the location within the EA where each comment is addressed.

This document complies with NEPA of 1969 (42 U.S.C. 4321-4347), the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of NEPA (Title 40, *Code of Federal Regulations*, Parts 1500-1508) and DOE's NEPA Implementing Procedures (Title 10, *CFR*, Part 1021).

1.1 Background

For over 50 years, DOE and its predecessor agencies have been responsible for the research, design, and production of nuclear weapons, as well as other energy-related research and development efforts. DOE's weapons production and research activities generated hazardous, mixed, and radioactive waste products. Past disposal practices have led to the contamination of soils, sediments, and groundwater with complex and exotic mixtures of compounds. This contamination and its associated costs and risks can be considered a "Cold War Mortgage," and represents a major concern to DOE and the public (DOE 1995a). Within DOE, the Office of Environmental Management (EM) is responsible for

The purpose of the NABIR Program is to increase the understanding of fundamental biogeochemical processes that allow the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites.

managing the cleanup efforts. Currently, EM has 353 cleanup projects at 53 sites in 30 states and territories of the U.S. (BEMR 1995; Accelerating Cleanup: Paths to Closure 1998). The 53 sites span a range of geologic, hydrologic, and climatic conditions. The differences in these conditions can have a large impact on the cost, efficiency, and practicability of any single remediation technology. In addition, EM believes that the remediation approaches for many of these sites are inadequate or unacceptable due to excessive costs, long remediation schedules, or generation of secondary wastes (Subsurface Contaminants Focus Area [SCFA] Web site Problem Statement 1999; and SCFA Annual Report 1997). With 200 million cubic meters of contaminated sediment and 600 billion gallons of contaminated groundwater, EM estimates the life cycle costs of the cleanup (over 75 years) at close to \$189 billion to \$265 billion (DOE 1998a). The high costs, long duration, and technical challenges associated with remediating the subsurface contamination at DOE sites present a significant need for fundamental research in the biological, chemical, and physical sciences that will contribute to new and cost-effective solutions.

The high costs, long duration, and technical challenges associated with remediating the subsurface contamination at DOE sites present a significant need for fundamental research in the biological, chemical, and physical sciences that will contribute to new and cost-effective solutions.

One possible low-cost approach for remediating the subsurface contamination of DOE sites is through the use of a technology known as bioremediation. Bioremediation has been defined as the use of microorganisms to biodegrade or biotransform hazardous organic contaminants to environmentally safe levels in soils, subsurface materials, water, sludges, and residues. While bioremediation

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technology is promising, DOE managers and non-DOE scientists have recognized that the fundamental scientific information needed to develop effective bioremediation technologies for cleanup of the legacy waste sites is lacking in many cases. DOE believes that field-based research is needed to realize the full potential of bioremediation.

For a number of years, one of OBER's missions has been to fund basic research in areas related to bioremediation. Recently, OBER recognized the need to obtain new fundamental scientific

information on bioremediation to assist DOE's legacy waste cleanup needs. During 1995 and 1996, OBER held a series of workshops with scientists and engineers from the DOE sites, the scientific community, and the private sector. The workshops identified a series of key themes to meet the needs identified by DOE and the scientific community, and to guide OBER's development of a new, field-based, fundamental research program in bioremediation. The major themes included:

- *interdisciplinary fundamental research* focused on complex contaminated subsurface systems;
- *field research centers* to serve as vehicles for integrating research, identifying crucial research needs, and focusing the program on DOE's most significant problems;
- *ethical, legal, and social issues associated with bioremediation* to be identified and addressed;
- *linkages to other, related programs* to be established and maintained.

OBER subsequently combined the bioremediation-related elements of several former and existing OBER programs, including the former Subsurface Science Program (SSP), with other resources, and reorganized portions of its research efforts to focus on fundamental bioremediation research to create a new NABIR Program. OBER then began the planning and internal scoping processes to develop the proposed field component of the program that would implement the key themes, and form the proposed action for the NABIR EA.

In October 1996, Dr. Martha Krebs, Director of the Office of Science, signed a NEPA Determination for the preparation of an EA. At that time, OBER's budget for the NABIR program was \$40 million per year for the ten-year life of the program. In addition, OBER planned to select up to three FRCs for immediate operation upon completion of the NEPA review. Also, OBER intended to conduct genetically engineered microorganism (GEM) research. Since 1996, OBER's funding for the NABIR Program has been significantly reduced to \$15 million per year) and therefore could establish only one FRC at this time. Following careful consideration and communication with scientists in the field of bioremediation, OBER has decided not to pursue research using GEMs (see Section 1.2.1 for additional details).

1.2 Description of the Existing NABIR Program

The NABIR Program is a ten-year fundamental research program designed to better understand the biotic and abiotic processes in the subsurface, to understand how to control and accelerate these processes, and to provide dedicated field sites for small-scale (less than one acre and to depths of less than 75 feet) field-based research. (See Appendix C for details on management of the NABIR Program.) The program is directed at the specific goal of supporting fundamental research to understand bioremediation processes on complex mixtures of heavy metals and radionuclides in the subsurface. The NABIR Program supports the funding of laboratory-based research as well as computer modeling and other types of research. Currently funded research focuses on the subsurface environment, and includes investigations of both the saturated (e.g., groundwater) and unsaturated (e.g., vadose) zones.

The NABIR Program will only be funding basic fundamental research on promising new methods and technologies that might have the potential to be used by another part of DOE or some other agency for a full cleanup at a future time. The NABIR Program will not fund a DOE Environmental Management cleanup project involving the use of bioremediation. Research involving organic contaminants is only considered to the extent that it influences the primary goal of understanding the fundamental biogeochemical factors that affect bioremediation of heavy metals and radionuclides. Research to evaluate the risk to humans or to the environment, and research on phytoremediation are outside the scope of the NABIR Program. Finally, the NABIR Program will not fund any research that would involve the use of microbes that are human pathogens and field releases of any GEMS.

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NABIR-funded projects require short-term use of field sites with specific geologic or hydrologic characteristics. The NABIR Program calls these Short-Term Experimental Field Sites (STEPS), and distinguishes them from an FRC. STEPS are small-scale field research areas for special studies that may be on or off DOE lands. STEPS are not user facilities, and they accommodate only a few focused projects

and a few researchers for very short duration. STEFS have characteristics that are analogous to the range of hydrologic and geologic conditions (e.g., rainfall, groundwater, soil types) on DOE sites; however, these sites have been used primarily for subsurface characterization. These sites provide useful technical information for research that would be conducted at the proposed FRC. STEFs may also serve as "sites of opportunity" for collection of small volumes of sediment and groundwater (1.3 cubic yard [less than one cubic meter]) for lab-based experiments. STEFS have no on-site staff, permanent trailers or laboratories. STEFS are not in the scope of analysis in this EA but are provided as examples of research similar to that proposed by NABIR.

An example of a STEFS is in Oyster, Virginia. For several years, NABIR investigators have been conducting fundamental research into the mechanisms by which microorganisms are transported in the subsurface environment of unconsolidated sediments (sand) on non-DOE land. Scientific knowledge gained from this research in a simple system of unconsolidated sediments is useful to the broad community of NABIR researchers. Appendix F contains NEPA documentation for the Oyster Site.

1.2.1 Existing Science-Based Program Elements

The NABIR Program is an integrated effort containing seven interrelated science-based technical program elements (Figure 1-1). A societal/legal/educational program element also investigates the societal issues and concerns associated with bioremediation. The first five of the science elements study the biology of microorganisms, their ecology and physical environment, their effects on various contaminants, and various mechanisms to enhance or accelerate their bioremediative processes. The sixth science element provides the means to assess and quantify these processes. The last scientific element integrates research results so that predictive models can be developed.

Biotransformation and Biodegradation—Research focused on understanding the mechanisms of how microorganisms actually transform, degrade, and immobilize complex contaminant mixtures into detoxified materials.

Community Dynamics and Microbial Ecology—Research focused on the natural ecological processes and interactions of biotic and abiotic components of microbial subsurface ecosystems in order to understand their natural influence on the degradation, persistence, and toxicity of mixed contaminants.

Biomolecular Science and Engineering—Research in molecular and structural biology focused on improving the efficiency of bioremediation activities by genetically modifying molecules and organisms to detoxify contaminants of concern to DOE. This research would be conducted strictly in a controlled laboratory setting. There would be no field-based research with genetically modified molecules or organisms at FRCs.¹ Therefore, biomolecular science and engineering are not part of the proposed action assessed in this EA.

¹ Scientists have been investigating the use of genetically engineered microorganisms (GEMs) for bioremediation. Genetic engineering is the manipulation of genes to enhance the metabolic capabilities of an organism (LBNL NABIR Primer, January 1999). While the NABIR Program is funding laboratory-based genetic engineering research, at this time, the release of a GEM, according to the EPA definition (TSCA Final Rule, 1997), in the field is not considered to be a part of the NABIR Program. NABIR Program management has determined that the fundamental laboratory research that is prerequisite to the introduction of GEMs for radionuclides and heavy metals in the field has not progressed scientifically to the point where the NABIR Program use of such GEMs in the field within the immediate future can be reasonably assumed, planned or approved. NABIR Program management will re-evaluate at a later time the status of GEMS research to determine whether the program will ever support GEMs research in the field. The final decision on whether to include GEMs field research as part of the future NABIR Program would be evaluated in a separate NEPA process, when appropriate.

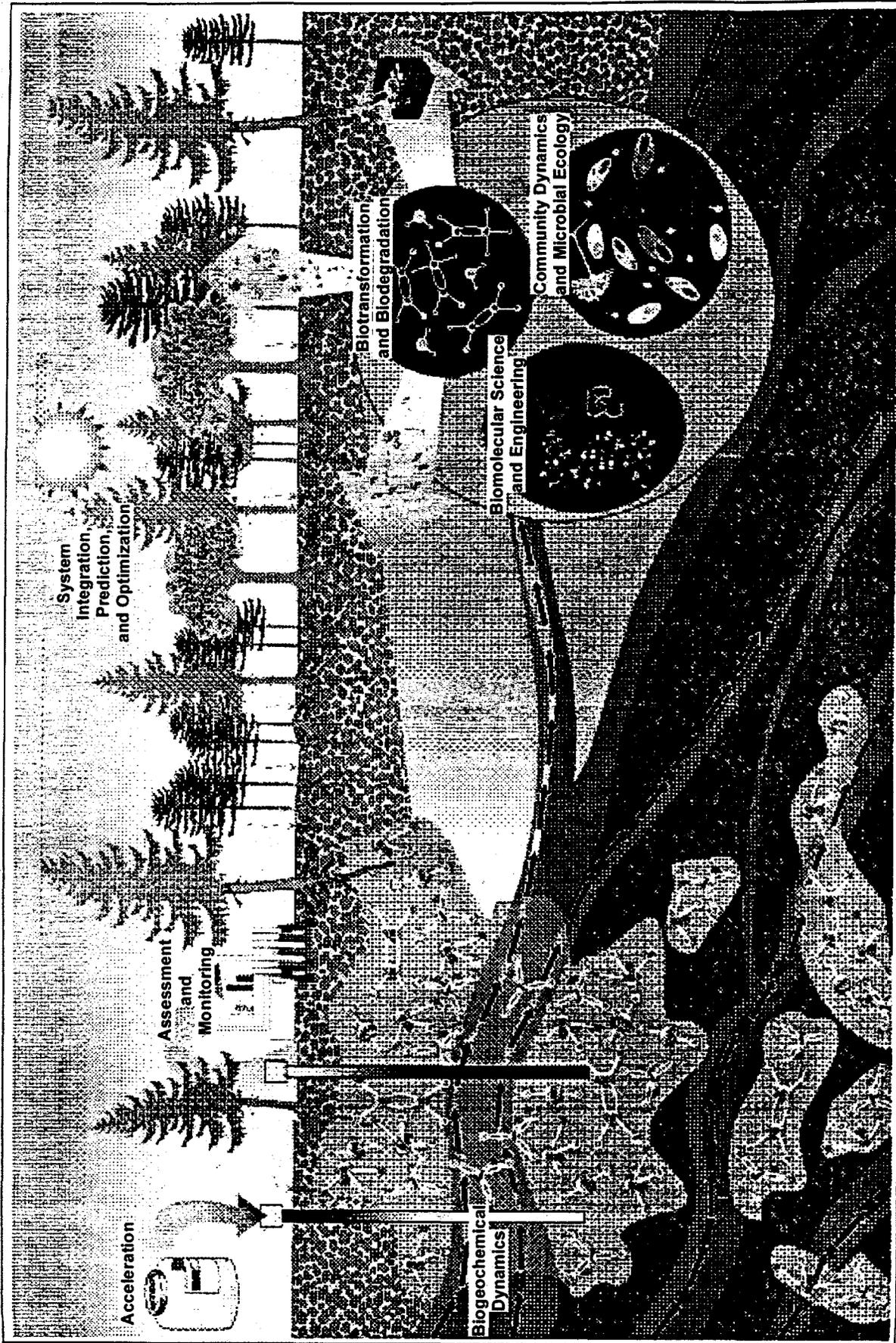


Figure 1-1 NABIR science-based program elements

Biogeochemical Dynamics—Research focused on understanding the relationships among several environmental factors that interact or interfere with the survival, growth, and activity of microbial communities and their ability to bioremediate contaminants. The environmental factors are related to the dynamic relationships among geochemical, geological, hydrological, and microbial processes.

Bacterial Transport—Research focused on bioaugmentation of bioremediation by the addition of microorganisms. Microbial degradation activity might be enhanced by altering the flow and transport of microorganisms. This element would develop effective methods for accelerating and optimizing bioremediation rates.

Assessment—Research focused on developing methods to measure, monitor, and characterize the success of bioremediation processes and the rates at which they work.

System Engineering, Integration, Prediction, and Optimization—Research focused on integrating the results of all of the program elements and on synthesizing the information so that the effectiveness of bioremediation can be predicted and optimized.

The NABIR program is based on an interdisciplinary research approach to the study of bioremediation. Each science program element supports researchers from a broad spectrum of disciplines besides microbiology; other disciplines include, biology, ecology, hydrology, geology, chemistry, and computer modeling. Some of these researchers conduct independent research studying individual problems within a science element. Other projects involve collaborative efforts on specific problems and include researchers from various science program elements to draw on a variety of different perspectives, disciplines, and experiences.

1.2.2 Facilitating Coordination/Communication of Research Opportunities and Results

The NABIR Program is managed by a team of program managers from OBER. The management team's areas of responsibility involves overall management of research funded under the NABIR Program, and would include the management of a proposed FRC, including the management of potential risks to the human environment. Specifically, two OBER program managers coordinate the NABIR Program (co-coordinators); several OBER program managers provide leadership for a number of technical areas of focus (elements) within the NABIR Program (program element managers); and one OBER program manager would oversee the NABIR FRC (field activities manager). The NABIR Program co-coordinators and the program element managers are responsible for developing and soliciting new research for the NABIR Program through the publication of research announcements in the *Federal Register*.

A critical role for the management of the NABIR Program is to facilitate the coordination and communication of research opportunities and results of NABIR-funded research. This coordination and communication is fostered through an annual meeting at which investigators are encouraged to present the results of their research. In addition, the NABIR Program periodically sponsors small workshops on specific topics of interest to investigators. Publication of peer-reviewed research in open scientific literature is strongly encouraged, as is participation in open scientific meetings.

In addition to OBER program managers, OBER uses national experts in bioremediation from several DOE National Laboratories. Their efforts are consolidated under the NABIR Program Office. The role of the NABIR Program Office is to assist OBER program managers with the development of technical documents and communication tools to facilitate communication among

researchers and other interested parties. For example, in addition to providing assistance with the annual meeting, the NABIR Program Office currently provides information concerning ongoing bioremediation research on the World Wide Web, (<http://www.lbl.gov/NABIR>), and distributes a NABIR Program newsletter. Recently the NABIR Program Office developed a primer on bioremediation for use by researchers and other interested parties (LBNL NABIR Primer January 1999, available from OBER.)

Individuals external to DOE are also asked to provide advice to OBER concerning the NABIR Program and to assist with communication and coordination of NABIR Program research. A NABIR subcommittee of the Biological and Environmental Research Advisory Committee (established by the Federal Advisory Committee Act) has been established to: a) advise OBER program managers on future research directions in bioremediation, b) ensure coordination with other, complementary federal programs, and c) identify opportunities for leveraging scientific and infrastructure investments.

1.3 Purpose and Need

DOE faces a unique set of challenges associated with cleaning up waste at its former weapons production and research sites. These sites contain complex mixtures of contaminants in the subsurface, including radioactive compounds. In many cases, the fundamental field-based scientific information needed to develop safe and effective remediation and cleanup technologies is lacking. DOE needs fundamental research on the use of microorganisms and their products to assist DOE in the decontamination and cleanup of its legacy waste at DOE research and production sites (i.e., historic wastes generated by DOE's weapons research and production).

The existing NABIR program to-date has focused on fundamental scientific research on a laboratory scale. Because subsurface hydrologic and geologic conditions at contaminated DOE sites cannot easily be duplicated in a laboratory, the DOE needs a field component to permit existing and future laboratory research results to be field-tested on a small scale. Such field-testing needs to be conducted under actual legacy waste field conditions representative of those that DOE is most in need of remediating. These field conditions should be as representative as practicable of the types of subsurface contamination conditions that resulted from legacy wastes from the nuclear weapons program activities. They should also be representative of the types of hydrologic and geologic conditions that exist across the DOE complex.

DOE needs fundamental research on the use of microorganisms and their products to find new bioremediation technologies that could assist DOE in its nationwide waste cleanup effort. Because subsurface hydrologic and geologic conditions at contaminated DOE sites cannot easily be duplicated in a laboratory, DOE needs a field component to permit existing and future laboratory research results to be field-tested.

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2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

DOE's proposed action is to select and operate a field research center component of the NABIR Program through the use of an FRC. FRC-focused research would allow NABIR Program managers to apply an integrated approach to the program's overall goal of understanding the fundamental biogeochemical processes that determine the success of any bioremediation technology. The FRC would be of sufficient size to accommodate multi-investigator studies over the ten-year lifespan of the NABIR Program.

The proposed FRC would consist of contaminated and uncontaminated background areas on DOE lands. Within these areas would be small test plots (less than one acre), along with supporting field site trailers and existing laboratory facilities. The areas would serve as the primary field site for small-scale basic bioremediation research activities. The types of activities that could occur at the proposed FRC can be categorized into passive and active site characterization, obtaining research-quality samples, and *in situ* research. Because the activities at the proposed FRC would be undertaken in an area limited to less than an acre and a depth of 75 feet, the scale of research activities would be considered small (for a detailed description of the proposed action at the FRC see Appendix A).

The proposed action is to select and operate a field research center component of the NABIR Program through the use of an FRC.

Passive subsurface characterization activities are described as non-intrusive (e.g., ground penetrating radar, electromagnetics, and resistivity) and intrusive (e.g., seismic tomography, radar, direct push penetrometer, creation and use of injection/extraction wells). Active characterization can be defined as the addition of some substance (e.g., air, non-toxic chemical tracers such as bromide, or a gas tracer such as helium or neon) to the subsurface under controlled conditions. These active characterization studies would allow the NABIR investigators to better understand the hydraulic properties of the subsurface, provide a detailed understanding of groundwater flow paths and the speed at which groundwater and other substances might move through the aquifer, and could assist in determining additional chemical and physical properties of an aquifer. These activities would allow researchers to better understand the subsurface environment.

The FRC would be a primary source for groundwater and sediment samples for NABIR investigators. Obtaining research-quality samples would be critical to the research conducted under the NABIR program at the FRC. Groundwater would be sampled by pumping water from existing wells or by installing new wells. Approximately 200 groundwater samples per year would be expected. These would be small quantity samples, approximately one liter each and totaling less than 20,000 gallons (76,000 L) per year, and would not change the groundwater flow rates or availability of groundwater. Approximately 600 core samples of sediments would be taken over the ten-year life of the proposed FRC through the use of a drill rig or split-spoon sampler. Again, the sediment samples would be small in volume (approximately less than one cubic meter) and the drilling holes would be backfilled when no longer needed.

Collection and transportation of samples within the boundaries of the host DOE site would follow existing DOE procedures and meet all environmental, safety and health requirements. Samples could

be shipped offsite to researchers at universities and commercial laboratories. Any shipment of hazardous materials to or from an FRC would follow U.S. Department of Transportation Hazardous Materials Regulations.

Approximately 40 *in situ* research activities would be conducted over the ten-year life of the proposed FRC. Two types of *in situ* research activities are proposed to take place – biostimulation and bioaugmentation. Biostimulation would involve introducing substances into the subsurface to stimulate naturally occurring microorganisms *in situ* to bioaccumulate or transform a heavy metal or radionuclide.

Biostimulation activities might include: 1) injection of electron donors or electron acceptors to change part of the chemical environment of the subsurface so that it is more favorable for microbial activity or growth, 2) injection of gases or nutrients to stimulate the growth of selected microorganisms, 3) injection of chelators to test the extent of contaminate mobilization, or 4) injection of surfactants to reduce the toxicity of a specific contaminant to microorganisms.

Bioaugmentation would involve the injection of additional microorganisms (either native or non-native) into the subsurface to either bioaccumulate heavy metals or radionuclides, or transform them such that they become less toxic or less mobile in the subsurface.

With the exception of the proposed placement of temporary work/sample preparation trailers at the test plots, there would be no new construction involved with the operation of the proposed FRC. Existing utilities would be used. Heavy equipment (e.g., drill rigs, brush hogs, augers) would be used when necessary for site clearing prior to conducting research at the background or contaminated sites. The equipment would be used for short periods of time. Best management practices and all applicable rules and regulations would be followed during the use of equipment.

2.2 Alternatives

2.2.1 Alternatives Identification Process

OBER has used a systematic three-phased process to identify suitable alternative sites for the location of a proposed FRC. In Phase I, mandatory requirements for an FRC were identified, along with DOE sites that met the requirements. In Phase II, preferred characteristics were developed and provided to the DOE sites along with a request for proposals. Phase III involved a peer review of DOE sites that submitted scientific/technical proposals to be the first FRC.

2.2.1.1 Phase I: Mandatory Required Criteria

Phase I of the process began by identifying the mandatory requirements of an FRC location. The two mandatory requirements were that the FRC: (1) must be located at a DOE site; and (2) must have legacy waste produced during research, design, and production of nuclear weapons or other energy-related research and development.

In October 1996, OBER requested a statement of interest from an array of DOE sites that met the initial mandatory requirements. The following eight sites expressed an interest in competing for FRC status: 1) PNNL/Hanford Site, WA; 2) Idaho National Engineering and Environmental Laboratory, ID; 3) Lawrence Livermore National Laboratory, CA; 4) Los Alamos National Laboratory, NM; 5)

Nevada Test Site, NV; 6) ORNL, TN; 7) Sandia National Laboratory, NM; and 8) Savannah River Site, SC.

2.2.1.2 Phase II: Preferred Characteristics

Under Phase II of the site-selection process, OBER developed a set of Preferred Characteristics for an FRC location. The NABIR program managers, staff from the NABIR Program Office, and others developed the characteristics. The characteristics were used to further screen the array of interested DOE sites. They are as follows:

Ownership—All proposed FRC field sites should be located on DOE-owned lands. Proposed field sites would be expected to be on government-owned, contractor-operated DOE sites.

Field site characteristics—The proposed FRC should include one primary contaminated area and one uncontaminated background area with comparable hydrology and geology. The contaminated site should preferably offer both a contaminated vadose zone and zone of saturation. At a minimum, the zone of saturation needs to be contaminated. Hydrologic control of the FRC and the contaminated plume(s) needs to be as complete as possible.

Site size and duration—The contaminated and background areas must be of sufficient size to accommodate subsurface sampling and *in situ* research over the ten-year lifespan of the NABIR Program.

Access—Access to the proposed field sites should be controlled to accommodate ES&H concerns, but should be easily accessible to outside (non-DOE) researchers funded under NABIR. A capability for subsurface drilling and other sampling/monitoring equipment and year-round access would be required.

Types of contaminants—Both radionuclides and heavy metals should be present at the contaminated area. The proposed field sites would need to provide easy access to the subsurface. Contaminants or the contaminated plume at the contaminated area could not be located under a building or structure (roads excluded.)

Levels of contamination—At least part of the proposed contaminated area should contain sufficient levels of contamination to require monitoring or eventual cleanup action.

Source terms of contamination—The source term of contamination, e.g., landfills, tanks, trenches, etc., if still active, should be reasonably well defined and consistent over the ten-year lifespan of the NABIR Program.

In January 1999, the eight potential FRC candidates (as identified above) that responded to the call for statements of interest were provided these preferred characteristics and other solicitation materials. The candidates were asked to conduct their own systematic site-selection processes to identify specific field locations on their DOE sites for their proposed FRC. In addition, OBER requested that the candidates submit specific information that could be used to support the review and analysis of the potential environmental impacts. Of the eight candidate sites, only two felt that they had field locations that met the preferred characteristics. Those two sites submitted proposals that contained scientific/technical, management and cost information. (That information is included in the description of the proposed action and the description of the affected environment at the two sites analyzed in this EA.)

2.2.1.3 Phase III: Scientific Peer Review

Phase III of the process involved peer review of the scientific/technical proposals. The peer review process included both a review of the written scientific/technical proposals as well as an onsite visit and interviews. The two FRC candidate sites met the criteria and had the preferred characteristics for an FRC, and they responded with proposals and with information to support the environmental analysis. These two sites, therefore, represent the array of reasonable alternative sites for the proposed FRC:

- Oak Ridge National Laboratory/Y-12 Site, Oak Ridge, Tennessee
- Pacific Northwest National Laboratory/DOE Hanford Site, Richland, Washington

2.2.2 Alternative One: Oak Ridge National Laboratory/Y-12 Site

Oak Ridge National Laboratory (ORNL) has recommended that the host site for the proposed FRC would be the Y-12 Site on the Oak Ridge Reservation. The proposed FRC would include a 243-acre (98-ha) previously disturbed contaminated area and a 404-acre (163-ha) background area on the Y-12 Site. The proposed contaminated area would be used for conducting experiments on contaminated groundwater and subsurface sediments. The proposed background area would provide for comparison studies in an uncontaminated area. The proposed contaminated area and background areas would be located in Bear Creek Valley (BCV). The BCV is approximately ten miles (16 kilometers [km]) long and extends from the eastern end of the Oak Ridge Y-12 Site to the Clinch River on the west. Bear Creek is a tributary to East Fork Poplar Creek, which drains into the Clinch River at the East Tennessee Technology Park. Except for the extreme eastern end of the contaminated area of the proposed FRC, the area is outside of any security fences, adjacent to public use roads, but protected from unwarranted passersby. Initially, test plots of less than one acre would be situated in proximity to the S-3 Ponds Site parking lot. (See Section 3.0 for maps and a detailed description of the proposed FRC affected environment). A Remedial Investigation Report was completed on the Bear Creek Valley in 1997; the report provided a significant amount of characterization data on the S-3 Ponds Site as well as other areas of the BCV.

The soils of the contaminated area include low levels of uranium, technetium-99 (Tc^{99}), strontium, nitrate, barium, cadmium, boron, and volatile organic contaminants (VOCs). Contaminants in the groundwater include uranium, Tc^{99} , strontium, nitrate, barium, cadmium, boron, mercury, chromium, and VOCs.

There would be no new construction needed for operation of the FRC. Existing ancillary facilities (e.g., equipment sheds) would be used to support FRC activities. Staff and researchers would use existing facilities at ORNL, including offices and research laboratories. An existing office trailer near the S-3 Ponds Site could be used for FRC purposes.

2.2.3 Alternative Two: Pacific Northwest National Laboratory/Hanford 100-H Area

Pacific Northwest National Laboratory (PNNL) has recommended the 100-H Area of the Hanford Site for an FRC. The proposed FRC would include a contaminated area that encompasses a tract approximately 2,950 feet long by 2,300 feet wide (900m by 700m). The shape of the contaminated area is irregular so that other construction and waste-remediation activities planned and on-going

could continue uninterrupted. Two smaller background areas are located just southeast and southwest of the contaminated area. Test plots of approximately one acre would be established within the background and contaminated areas. (See Section 3.0 for maps and a detailed description of the affected environment). The proposed contaminated area would be used for conducting experiments on contaminated groundwater and subsurface sediments. The proposed background areas would provide for comparison studies in uncontaminated areas. Although the 100-H Area has several operable units that are included in a Tri-Party Agreement (between DOE, U.S. EPA and the State of Washington) very little site characterization has taken place in the proposed FRC areas (DOE 1993).

The primary surface water closest to the proposed FRC is the Columbia River. At the closest point, the FRC boundary is located approximately 215 feet (60 m) from the Colombia River. The 100-H Area is closed to the public.

Soil contaminants include uranium, technetium-99 (Tc^{99}), strontium, and chromium. Contaminants in the groundwater include uranium, Tc^{99} , nitrate, and chromium.

There would be no new construction needed for operation of the FRC. Ancillary facilities would be used to support the FRC activities. Staff and researchers would use existing facilities at PNNL, including offices and research laboratories. Space in existing trailers at the 100-H Area would be available for use by FRC staff and researchers.

2.2.4 Preferred Alternative

Based on results of peer review of the scientific/technical proposals, on-site visits, and on the assessment of environmental impacts provided in this EA, DOE's preferred alternative is the ORNL/Y-12 Site.

2.2.5 No Action

The No Action Alternative consists of not implementing a field-based component to NABIR by not selecting or operating an FRC. This would result in continuing the NABIR Program's laboratory-based fundamental research approach as it is currently conducted by OBER, but without the benefit of focused and integrated field testing under controlled outdoor conditions that represent actual legacy waste cleanup situations. Specifically, fundamental bioremediation research supported by OBER would not integrate laboratory-based research with field-based research from FRC sites. Research would be less likely to occur in a way that permitted laboratory findings to be field-tested. The No Action Alternative does not satisfy the purpose and need.

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3.0 DESCRIPTION OF AFFECTED ENVIRONMENT OF THE PROPOSED FRC ALTERNATIVES

This section describes the affected environment of the three alternatives for the proposed action—the ORNL/Y-12 Site, the PNNL/Hanford 100-H Area, and No Action. Each description includes the site location and a summary of the existing environmental conditions on and in the vicinity of the site. Included in this section are descriptions of the existing earth resources; climate and air quality; water resources; ecological resources; archaeological, cultural and historical resources; land use; recreation and visual/aesthetic resources; socioeconomic conditions; waste control; human health; and environmental justice.

3.1 Oak Ridge National Laboratory/Y-12 Site

A proposed host site for the FRC would be the DOE Oak Ridge Reservation (ORR) in East Tennessee. The ORR consists of approximately 34,516 acres (13,968 hectare [ha]) of land and is the site for three major DOE facilities—the Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the East Tennessee Technology Park (ETTP), formerly known as the K-25 Site. Figure 3-1 shows the general location of the ORR, surrounding counties, and the location of the three major DOE facilities within the Oak Ridge and Knoxville region.

The majority of the ORR falls within the corporate limits of the city of Oak Ridge in Anderson and Roane counties. The Clinch River borders the ORR to the east, south and west, while the residential and commercial portions of the city of Oak Ridge are located to the north of the ORR.

The ORR was placed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List in 1989. Remediation efforts at ORR, including individual sites in Bear Creek Valley, are governed by the Federal Facility Agreement (FFA) among DOE, Region IV of the U.S. EPA, and the Tennessee Department of Environment and Conservation (TDEC). Subsequently, the Remedial Investigation/Feasibility Study (RI/FS) for the Bear Creek Watershed has been completed to address contamination associated with former waste disposal activities in Bear Creek Valley. The Record of Decision (ROD) is scheduled to be signed in calendar year 2000. Several CERCLA remedial actions have been identified for implementation in the Bear Creek Valley Watershed. Proposed CERCLA actions that could impact levels of groundwater and soil contamination within the proposed FRC boundaries include but are not limited to the following: hot spot removal and capping of the BY/BY, S-3 Ponds plume tributary interception, and removal of soil and sediment hot spots of contamination within the Bear Creek floodplain.

The proposed FRC contaminated area and background area lie within the Y-12 Plant area of responsibility on the ORR. The Y-12 area of responsibility, including the area located outside the Y-12 perimeter security fence, includes 4,468 acres (1,808 ha). The Y-12 Plant is located in Bear Creek Valley (BCV) adjacent to the city of Oak Ridge. The developed portion of the plant covers an area of 811 acres (328 ha), with some 250 buildings that house about 7 million square feet of laboratory, machining, dismantlement, and research and development areas. The Y-12 Plant is operated by Lockheed Martin Energy Systems, the Management and Operations contractor. Bechtel Jacobs Company, Limited Liability Corporation (BJC) is the Management and Integration contractor responsible for environmental management activities.

The proposed FRC would include a 243-acre (98-ha) previously disturbed contaminated area and a 404-acre (163-ha) background area (Figure 3-1). The contaminated area would be used for conducting experiments on contaminated groundwater and subsurface sediments. The background area would provide for comparison studies in an uncontaminated area.

Initially, test plots of approximately one-half acre, situated in proximity to the S-3 Ponds Site parking lot (Figure 3-2 and Figure 3-3) would be used. As the course of NABIR investigations proceed, other test plots might be used farther down BCV.

The proposed contaminated area and background area would be located in BCV (Figure 3-2 and Figure 3-3). BCV is approximately 10 miles (16 kilometers [km]) long and extends from the eastern end of the Oak Ridge Y-12 Plant to the Clinch River on the west (Figure 3-1). Bear Creek is a tributary to East Fork Poplar Creek, which drains into the Clinch River at ETP. Except for the extreme eastern end of the contaminated part of the proposed FRC, the area is outside of any security fences, adjacent to public use roads, but protected from unwarranted passersby.

3.1.1 Earth Resources

3.1.1.1 Topography

The ORR lies within the Valley and Ridge Physiographic Province, which is characterized by steep-sided parallel ridges with broad intervening valleys, generally oriented in a northeast-southwest direction. The valleys are generally underlain by softer rocks that are not as resistant to erosion as the rocks beneath the ridges. BCV is bordered by Pine Ridge on the northwest and by Chestnut Ridge on the southeast. Topographic relief from the crest of Pine Ridge to the floor of BCV ranges from 260 to 300 feet (79 to 91 meters [m]); relief from the crest of Chestnut Ridge to the floor of BCV ranges from 280 to 400 feet (85 to 122 m). The average elevation of the ridges is approximately 1,100 feet (335 m) above mean sea level (amsl), with elevation of the floor of BCV ranging from 800 feet (244 m) to 1,000 feet (305 m) amsl.

3.1.1.2 Geology

The western Appalachian Valley and Ridge Province is characterized by northwestward-moving, southeast-dipping imbricate thrust sheets. The Copper Creek and White Oak Mountain fault thrust sheets are traceable through the ORR. Bear Creek Valley is part of the White Oak Mountain fault thrust sheet.

The geological units in the ORR (Hatcher et al. 1992) can be grouped into low permeability shales and higher permeability carbonates (Solomon et al. 1992). On a regional scale, the geology of Bear Creek Valley is limestone- and dolomite-dominated (carbonate) rock groups interbedded with predominantly clastic shale groups. On an outcrop scale, clastic shale beds are interlayered with carbonate beds. The geologic units are parallel to the valleys and ridges.

Bear Creek Valley is underlain by the Rome Formation, the Conasauga Group, and the Knox Group (Figure 3-4). All of these rocks were formed over 500 million years ago. The Rome Formation and the Conasauga Group crop out in BCV on Pine Ridge and dip to the southeast beneath BCV.

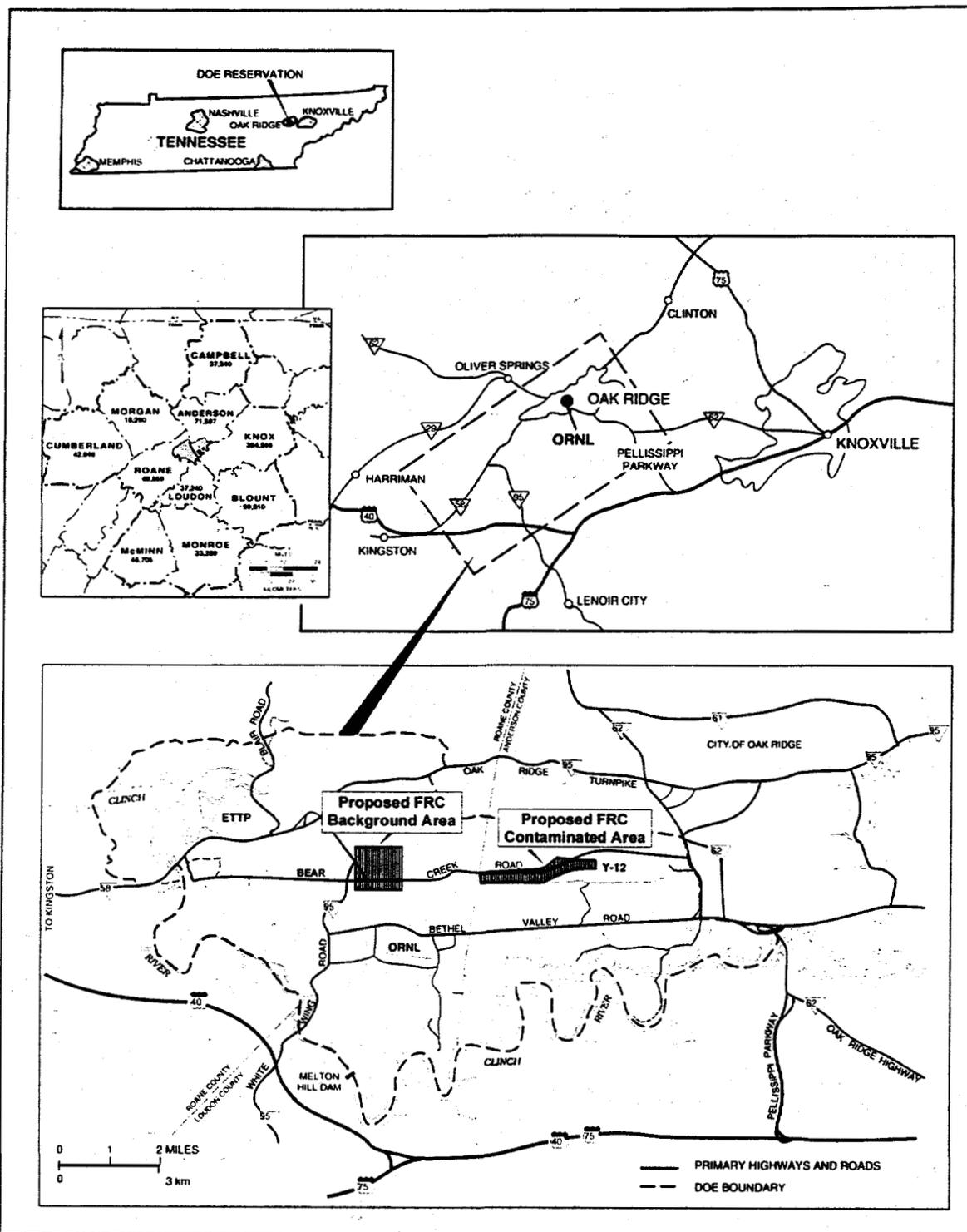


Figure 3-1 Location of Proposed FRC in Oak Ridge, Tennessee

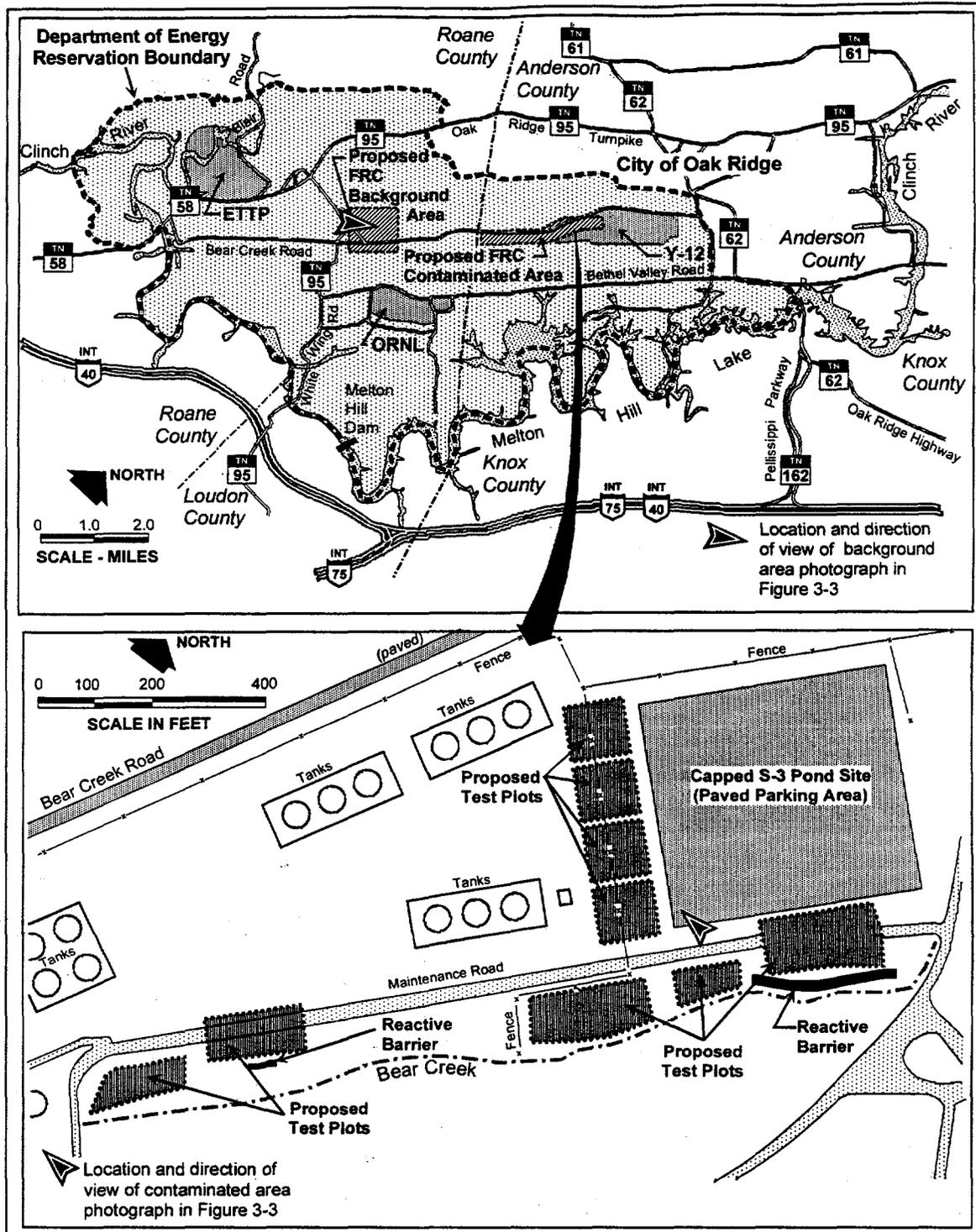
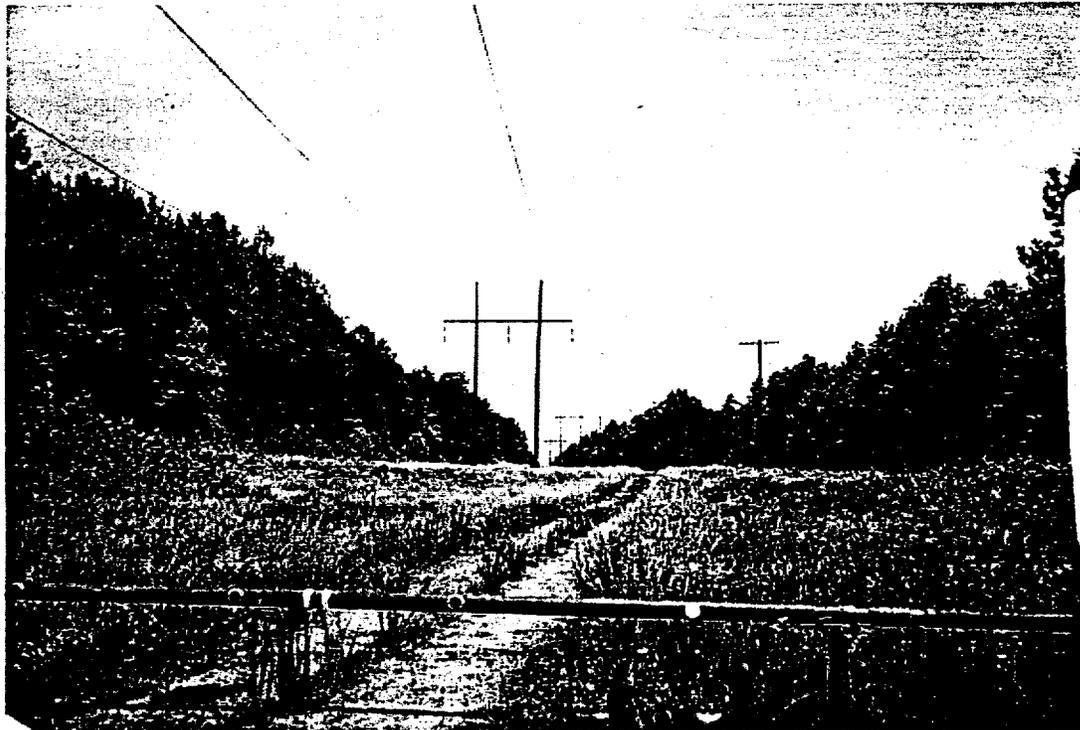


Figure 3-2 Locations of the Background Area, and the initial test plots within the Proposed FRC Contaminated Area



A portion of the Proposed FRC Contaminated Area located adjacent the S-3 Ponds at ORNL/Y-12 Site



A portion of the Proposed FRC Background Area at ORNL/Y-12 Site

Figure 3-3 Photographs of the Proposed FRC Contaminated and Background Areas at ORNL/Y-12 Site

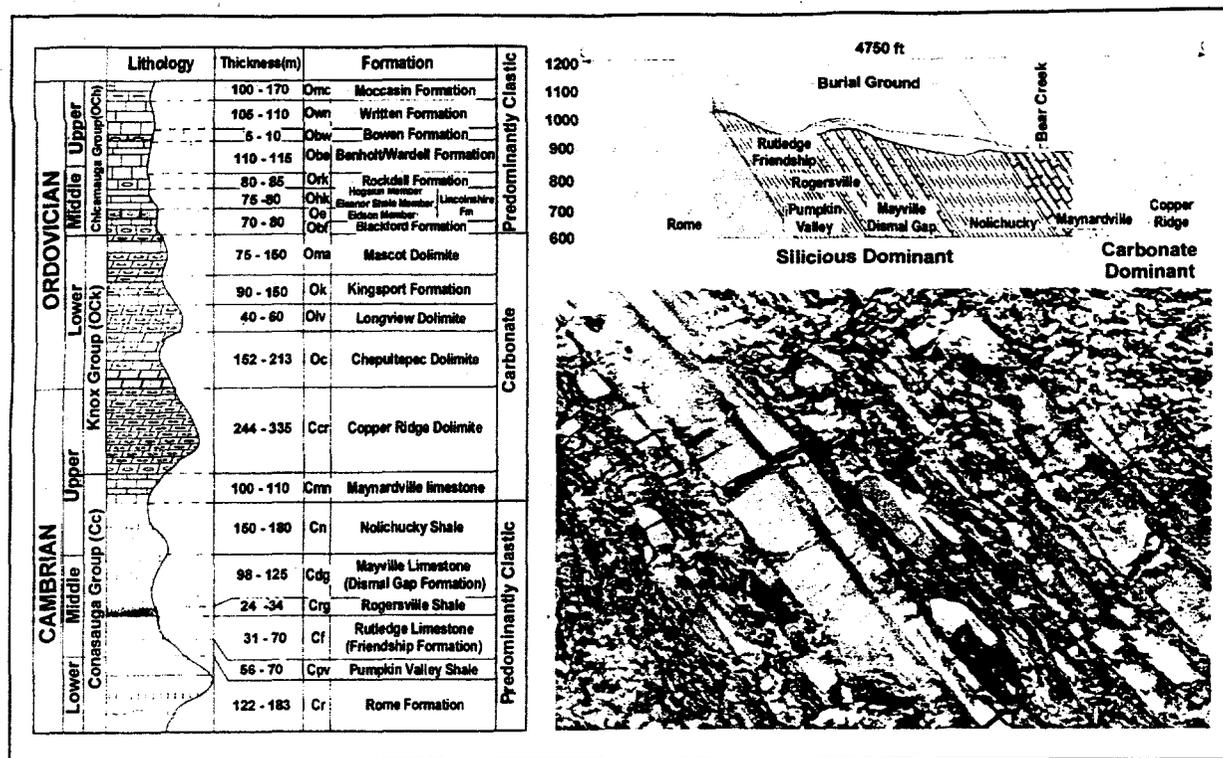


Figure 3-4 Geology of the proposed FRC

With the exception of the Maynardville Limestone, the Conasauga Group is a sequence of fractured shale, siltstone, and thin-bedded limestone. Some formations include laterally continuous limestone beds. High permeability zones parallel to bedding planes may exist, especially where karstification has enlarged fractures.

The Knox Group (i.e., Copper Ridge Dolomite) underlies and forms Chestnut Ridge, the southern boundary of BCV. It is composed of a series of medium- to thick-bedded, massive dolomite. Fracturing and karst formation in the Knox Group have resulted in locally high permeability (Shevenell and Beauchamp 1994). Sinkholes are common, and springs and seeps are common features at the upper and lower geologic contacts.

The primary geologic units that underlie the proposed contaminated area and background area are the Maynardville Limestone (carbonate) and Nolichucky Shale. The Maynardville Limestone, which forms the BCV floor, is a massively bedded limestone and dolomite (carbonate) with fracturing and karstification. The Nolichucky Shale is located just up slope and stratigraphically lower than the Maynardville Limestone.

There may be some geologic hazard associated with rare occurrence of sinkhole development in carbonate rock units in BCV. Hazards related to seismic activity along the faults located in the East Tennessee Valley and Ridge geologic province are relatively minor. There has been no known recent fault activity, although numerous small earthquakes (Richter magnitude of less than 4) occur yearly.

3.1.1.3 Soils and Waste Areas

Overlying the bedrock on the ORR is unconsolidated material that consists of weathered bedrock (referred to as residuum), man-made fill, alluvium, and colluvium. Silty and clayey residuum comprises a majority of the unconsolidated material in this area. The depths to unweathered bedrock differ throughout the ORR because of the different thicknesses of fill and alluvium and the particular weathering characteristics of the bedrock units. The total thickness of these materials typically ranges from 10 to 50 feet (3 to 15 m) (Hoos and Bailey 1986).

The principal waste areas and contaminant sources in BCV—the S-3 Ponds Site, the Oil Landfarm and Boneyard/Burnyard (BY/BY) area, and the Bear Creek Burial Grounds (BCBG)—are located in the upper 2.2 miles (3.5 km) of the valley on the outcrop of the Nolichucky Shale. Solid and liquid waste disposal has caused shallow soil and groundwater contamination. Where dense liquids were disposed of at the S-3 Ponds Site and BCBG, contamination of shallow and deep groundwater in the Nolichucky Shale has occurred.

The following volumes of waste and contaminated soils are estimated to be present in BCV (note that volume estimates for soils and wastes do not include the volumes of the caps themselves):

Location	Volumes of Waste, Contaminated Soils
S-3 Ponds Site—capped under RCRA in 1988	1.3 acre feet (1,600 m ³) waste and contaminated soils
Oil Landfarm—capped under RCRA in 1988	20 acre feet (25,000 m ³) waste and contaminated soils
BY/BY—This area has not been capped	73 acre feet (90,000 m ³) waste and contaminated soils
Sanitary Landfill 1—Capped under TDEC requirements in 1983	89 acre feet (110,000 m ³) waste and contaminated soils
BCBG—Capped under RCRA in 1989	150 acre feet (190,000 m ³) waste and contaminated soils

In addition, it is estimated that less than 0.82 acre feet (1,000 cubic meters [m³]) of soils and waste materials on the BCV floodplain contain low levels of contamination. Contaminants of the soil include uranium, technetium-99 (Tc⁹⁹), strontium, nitrate, barium, cadmium, boron, volatile organic contaminants (VOCs), and other inorganics and radionuclides. Although the proposed contaminated area is adjacent to most of these waste areas, it actually includes the former S-3 Ponds Site disposal area and portions of the BCV floodplain.

What is a RCRA Cap?

A RCRA Cap is a multi-layered barrier placed on top of a disposal site to control deep percolation of soil moisture in accordance with the requirements of the Resources Conservation and Recovery Act.

However, proposed FRC activities would not include drilling through the S-3 Ponds Site.

3.1.2 Climate and Air Quality

The climate of the region surrounding the Oak Ridge area is broadly classified as humid continental. The Cumberland Mountains to the northwest have a moderating influence on the climate of the area by shielding the region from cold air masses that frequently extend far south over the plains and prairies of the central United States during the winter months. In the summer months, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms; however, anticyclonic circulation around high-pressure systems centered in the western Gulf of Mexico can bring dry air from the southwestern United States into the region, which causes occasional periods of drought.

The annual mean air temperature for the Oak Ridge area is 57.1°F (13.9°C) (1963 through 1992 base period). The coldest month is usually January, with temperatures averaging about 35.6°F (2.0°C), but occasionally falling as low as -17°F (-27°C). July is typically the hottest month of the year, with average temperatures of 76.5°F (24.7°C), but occasionally rising to 105°F (41°C). Diurnal temperature changes are relatively consistent from month to month having a range of 18 to 27°F (10 to 15°C).

Average precipitation in the Oak Ridge area varies from place to place by as much as 30 percent depending on the location relative to local terrain. The 40-year annual average precipitation is 53.75 inches (137 centimeters [cm]), including about 10.4 inches (26 cm) of snowfall. Precipitation in the region is greatest in the winter and spring months (January through April) and least during the fall months (September through November), when high-pressure systems are most frequent.

The Oak Ridge area has relatively light winds compared to other parts of the United States. The Cumberland Mountains and Plateau to the northwest and west, and the local valley-and-ridge topography divert severe storms and minimize air movement and local wind impact. Ridge-top and valley sites in the Oak Ridge area (excluding the Cumberland Plateau) experience wind speeds less than 11.2 miles per hour (5 meters per second [m/s]) over 90 percent of the time, and many valley-bottom sites experience winds less than 4.5 miles per hour (2 m/s) over 70 percent of the time. Prevailing wind directions in the Oak Ridge area are primarily oriented parallel to the direction of the local ridge and valley terrain. Prevailing winds are either up-valley (northeasterly) day-time winds, or down-valley (southwesterly) night-time winds.

Existing air quality at ORR is in attainment with National Ambient Air Quality Standards (NAAQS) for all criteria pollutants (i.e., sulfur dioxide, nitrogen dioxide, inhalable particulate matter, carbon monoxide, ozone, and lead).

The Y-12 Site has permits for radiological and non-radiological air emissions. Radioactive emissions are registered by EPA under NESHAP regulations (40 *CFR* 61, Subpart H). Non-radiological emissions are regulated under the rules of Tennessee Department of Air Pollution Control (ORNL 1998).

3.1.3 Water Resources

3.1.3.1 Surface Water

Bear Creek is the predominant surface water feature of the proposed FRC in BCV. The creek is one of the surface water features of the ORR, which is characterized by a network of small streams that are tributary to the Clinch River. Water levels in the Clinch River are regulated by the Tennessee Valley Authority (TVA), and fluctuations in the river have a localized effect on tributary creeks and streams draining the ORR. Drainage from Y-12 enters both Bear Creek and East Fork Poplar Creek (EFPC); the headwaters of both originate within the Y-12 Area. Bear Creek and EFPC have total drainage areas of 7.4 and 30 square miles (1,900 and 7,700 ha), respectively.

Bear Creek is a relatively small (third-order) spring-fed stream that flows out of the Y-12 Plant and ultimately into the EFPC. Its watershed divide with EFPC crosses the western portion of the plant site near the S-3 Ponds Site, and most of the drainage from the Y-12 facilities flows to the EFPC. In addition to EFPC and Bear Creek, there are numerous streams, springs, and quarries/ponds within the Y-12 Area.

Bear Creek flows west down BCV and then flows north where it empties into EFPC. Little high-density development has occurred within the Bear Creek watershed, but a great deal of clearing and waste control activity has taken place. The drainage pattern of Bear Creek is a good example of trellis (i.e., lattice-like) drainage patterns typical of the Valley and Ridge Province. About 65 percent of the drainage basin is wooded. Although Bear Creek does not drain the main Y-12 site, it does drain the areas used for waste storage and closed waste disposal areas. As mentioned in Section 3.1.1.3, contaminants originating from the waste disposal units, and potentially present in surface water to some extent, include uranium, Tc⁹⁹, strontium, nitrate, barium, cadmium, boron, VOCs, and other inorganics and radionuclides.

Surface water and spring samples collected during 1997 show that spring discharges and water in upper reaches of Bear Creek contain many of the contaminants found in the groundwater; however, the concentrations in the creek and spring discharges decrease rapidly with distance downstream of the waste disposal sites (ORNL 1998).

3.1.3.2 Floodplain and Wetlands

Bear Creek completely traverses the length of both the proposed contaminated area and the background area, and thus includes the associated section of 100-year floodplain. Neither the FRC field office nor laboratory structures would be located in the floodplain.

Numerous wetlands have been identified in BCV. Most of these are small—from a few square yards up to about 2 acres (0.8 ha)—and are classified as palustrine forested, scrub-shrub, and emergent wetlands (Cowardin et al. 1979). Within the proposed contaminated area, wetlands have been identified at three separate surface springs. These are south of Bear Creek Road and outside the floodplain. Wetlands have also been identified on the seven tributaries that join Bear Creek along its reach within the proposed FRC. Five of these are outside the floodplain, and two of the wetlands lie both within and beyond the Bear Creek floodplain. Downstream of the proposed FRC, including the section of Bear Creek through the background area, wetlands occur within numerous floodplain locations and at higher elevations in several tributaries. Species normally found in these wetlands are

described in the ecological risk assessment in Appendix G of the BCV Remedial Investigation Report (DOE 1997a).

3.1.3.3 Groundwater

The proposed FRC contaminated and background areas are located in the BCV watershed. However, the eastern edge of the FRC boundary is located near a groundwater divide. Groundwater to the east of this divide flows to the east and into the Upper East Fork Poplar Creek (UEFPC) watershed; groundwater to the west of this divide flows to the west and into the BCV watershed. All FRC activities will be conducted west of this divide in the BCV watershed.

Groundwater flow through rocks underlying the proposed FRC in BCV is primarily through fractures and dissolution features (i.e., karst features) in the bedrock. The orientations of well-connected fractures or solution conduits are predominantly parallel to bedding planes (i.e., geological strike.) This results in dominance of strike-parallel groundwater flow paths. Fracture aperture width generally decreases with depth in all formations; thus, active groundwater circulation decreases with depth. Active (or open) fractures occur at greater depths in the carbonate members of the Knox Group and the Maynardville Limestone than in the shale members of the Conasauga Group. Therefore, active groundwater circulation is deeper in these carbonate formations.

Figure 3-5 shows a conceptual model for the movement of groundwater, surface water and

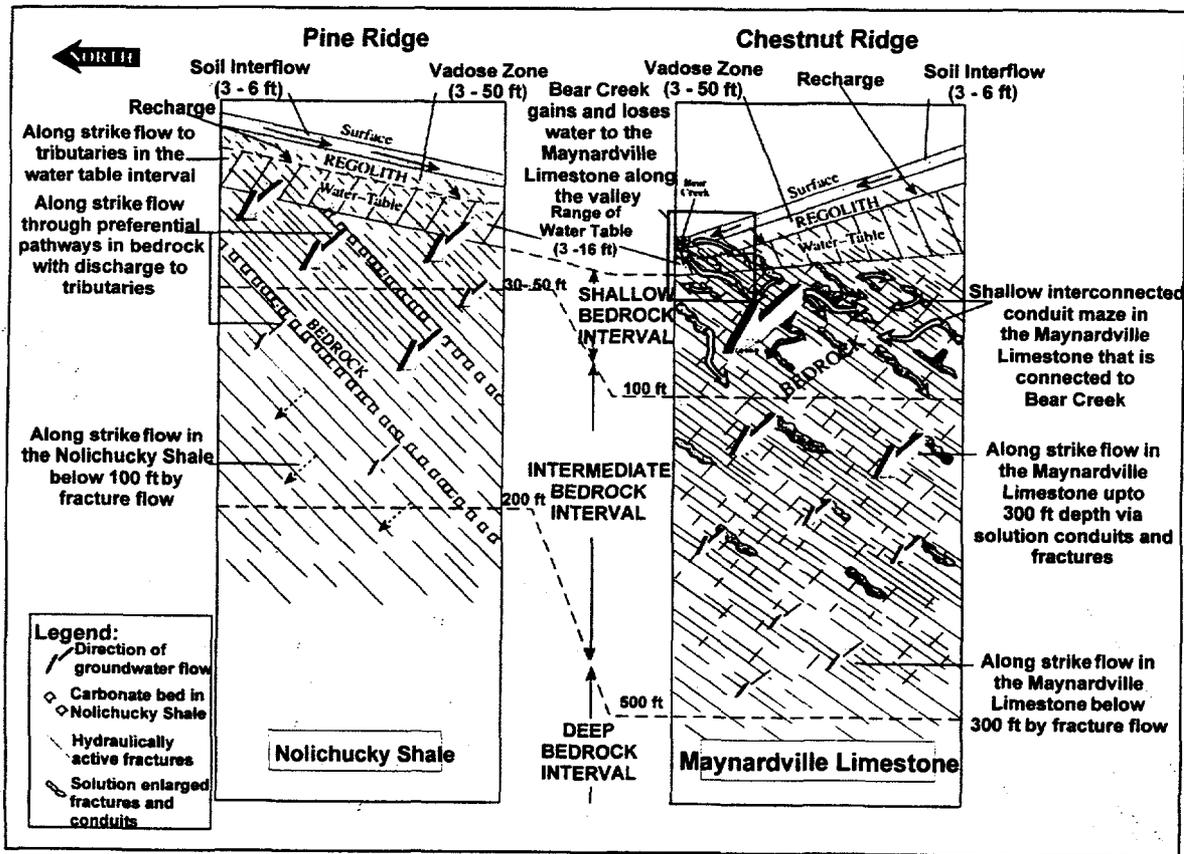


Figure 3-5 Conceptual model for movement of groundwater, surface water, and contaminants

contaminants in BCV (DOE 1997a). The hydrogeology differs significantly between the shale formations (e.g., Nolichucky Shale) and the carbonate formations (e.g., Maynardville Limestone). In BCV, the contact between the Maynardville Limestone and the Nolichucky Shale roughly corresponds to the axis of the valley and marks a major transition from predominantly low hydraulic conductivity shale formations to higher conductivity carbonate formations. Groundwater in the shale formations generally migrates in the direction of the geologic strike (generally from northeast to southeast) until eventually discharging to a tributary of Bear Creek. This surface water can enter the Maynardville groundwater system through losing sections of Bear Creek.

Key features of the shale and carbonate formations are discussed in the following paragraphs, followed by a discussion of groundwater quality in the area of the proposed FRC.

Flow in Predominantly Shale Formations (e.g., Nolichucky Shale)

Although there are no clearly defined abrupt hydrologic and geologic changes in the shale formations with depth, a general hydrologic and geologic stratigraphy can be defined that separates these formations into shallow, intermediate, and deep flow regimes (Figure 3-4). The boundary between shallow and intermediate intervals is defined by a consistent change in groundwater geochemistry at approximately 100-foot (30-m) depth that indicates flow is considerably slower below this depth (Haase 1991; Dreier, Early, and King 1993). The boundary between intermediate and deep intervals is poorly defined and is indicated by a change in groundwater geochemistry that has been observed between about 328- and 492-foot (100 and 150 m) depth (Solomon et al. 1992; Haase 1991; Dreier, Early, and King 1993).

Most flow in the shale formations occurs in the shallow interval. This interval includes the water table interval that usually occurs close to the soil-bedrock interface. Most flow in the shallow interval is probably through higher conductivity zones that may exist at the soil-bedrock interface (Solomon et al. 1992) or through other preferential flow pathways in the bedrock. Flow in the shallow interval is oriented predominantly along geological strike, with discharge occurring at the tributaries to Bear Creek.

In the intermediate interval, geochemistry data indicate greater groundwater residence times; thus, generally slower flow below 100 feet (30 m). However, the distribution of contaminant plumes in BCV indicates that more rapid flow than predicted by major ion geochemistry may in preferential pathways in this interval and may occur up to 200 feet (61 m) in depth. (Nitrate from the S-3 Site has migrated approximately 0.62 miles [1 km] or more since 1950.)

An upward hydraulic gradient occurs almost everywhere in the shale formations that crop out on the southern flank of Pine Ridge. Groundwater in deep formations is hydraulically connected along the bedding planes to recharge areas located up-dip at higher elevations on Pine Ridge. As a result, deeper formations tend to have recharge zones farther up-slope than shallow formations, creating the upward hydraulic gradient.

Flow in Carbonate Formations (e.g., Maynardville Limestone)

The Maynardville Limestone crops out along the southern side of the BCV floor. This formation and Copper Ridge Dolomite act as a hydraulic drain for the valley. Flow in these formations is predominantly along geologic strike and parallel to the maximum hydraulic gradient.

The hydrostratigraphy in the carbonate formations is less well defined than that in the shale formations (Solomon et al. 1992). The shallow interval includes groundwater to approximately 100-

foot (30-m) depth. Flow in this interval occurs through a system of interconnected fractures and solution conduits and cavities and is closely associated with flow in Bear Creek. The channel of Bear Creek is one of the main hydraulic conduits in this system. In this interval, groundwater flow is relatively rapid.

The intermediate interval occurs between approximately 100-foot and 328-foot (30-m and 100-m) depth. Solution cavities and solution-enlarged fractures exist in the Maynardville Limestone in this interval and are probably well connected by other fractures. Because of its depth, this zone is isolated from dilution effects seen in shallower zones. Thus, flow rates are probably slower than those in the shallow interval, but contaminant plumes are more persistent and extend farther along the valley. This zone constitutes an important contaminant transport pathway.

In the deep interval (greater than 328-foot [100-m] depth), flow through fractures dominates groundwater movement, and flow zones become less frequent as fracture density decreases with depth.

Groundwater Quality

The proposed contaminated site includes portions of the commingled plume of groundwater contamination in the Nolichucky Shale and Maynardville Limestone (490 acre feet [600,000 cubic meters] of contaminated groundwater) that originated predominantly from the S-3 Disposal Ponds and the BY/BY. The BCBG is also a source of groundwater contamination and dense nonaqueous phase liquid (DNAPL) in BCV, but the BCBG is not included in the FRC boundary. Contaminants in the commingled S-3 Disposal Ponds and BY/BY plume include uranium, Tc⁹⁹, strontium, nitrate, barium, cadmium, boron, mercury, chromium, VOCs and other inorganics and radionuclides. The S-3 Disposal Ponds site is a source of all of these contaminants. The BY/BY site has contributed primarily uranium and VOCs. There are 570 acre feet (700,000 m³) of contaminated groundwater from the S-3 site and 57 acre feet (70,000 m³) of contaminated groundwater from the BY/BY.

The S-3 Ponds Site and BY/BY are located on top of the Nolichucky Shale, and historical waste discharges have contaminated groundwater beneath the waste sites. Due to the high dissolved solids contents of the liquid wastes disposed at the S-3 Ponds Site, contamination has migrated to depths as great as 200 feet (60 m) in the Nolichucky Shale. The S-3 Ponds Site is located on a groundwater divide so contamination has migrated both to the west and east.

Contaminants migrate away from the waste disposal units through a number of pathways. Contaminated shallow groundwater at sources above the Nolichucky Shale migrates through fractures along geological strike and discharges to tributaries or directly to Bear Creek, causing the tributaries and Bear Creek to become contaminated. Contaminants in deep groundwater in the Nolichucky Shale also migrate through fractures along geologic strike and discharge to tributaries. However, contaminant pathways in the deep groundwater can underflow proximal tributaries and/or springs and be a source of contamination in neighboring tributary subwatersheds.

After entering tributaries, contaminants migrate in surface water directly to Bear Creek. Bear Creek intermittently loses and gains water from groundwater in the Maynardville Limestone throughout the length of the valley. Losing reaches of Bear Creek cause groundwater contamination in the Maynardville Limestone. Gaining reaches of Bear Creek are associated with large springs at the base of Chestnut Ridge, some of which have contaminated discharge.

Surface water in Bear Creek and shallow groundwater in the Maynardville Limestone constitute 96 percent of water flowing along the valley. Contaminants in these media pathways are quickly diluted by rapid recharge of rainwater and inputs from noncontaminated tributaries.

Deep groundwater in the Maynardville Limestone (100- to 300-foot [30 to 90 m] depth) constitutes less than 4 percent of water flowing along the valley. Concentrations of contaminants in this and in the deep groundwater pathway are not attenuated as rapidly as those in shallow groundwater. This pathway is an important source of long distance groundwater transport along the valley.

Contaminant concentrations in shallow groundwater in the Nolichucky Shale and the Maynardville Limestone and in surface water are diluted by recharge during storm events, and show seasonal trends of lower concentrations during periods of high rainfall.

3.1.4 Ecological Resources

The following section identifies and describes the terrestrial, and aquatic resources that occur in BCV and near the proposed contaminated area and background area.

3.1.4.1 Terrestrial Resources

The vegetation of the ORR is primarily second-growth hardwood oak-hickory forest that is mostly distributed on ridges and dry slopes. Virginia and shortleaf pines are also common, particularly in areas that were cleared and farmed before 1942. The ORR provides habitat for a large number of animal species, including about 60 reptilian and amphibian species, more than 152 species of birds (including 32 species of waterfowl, wading birds, and shorebirds), and about 40 mammalian species. Habitats supporting the greatest number of species are those dominated by hardwood forests and wetlands. Wetland areas within the ORR consist mostly of small swampy areas, generally less than 30 feet (9 m) wide, within and around major drainage basins (DOE 1997a).

Bear Creek Valley, the location of the proposed FRC, lies outside the main Y-12 Plant complex close to areas of potential ecological sensitivity. Before 1940, most of BCV was cleared and used for agriculture (Southworth et al. 1992). Currently, about 65 percent of the BCV watershed is wooded, with common vegetation being predominantly oak and oak-hickory associations on the upper slopes and ridgetops and planted pine along the creek and floodplain area (McMaster 1967). Old field and grassland habitat zones are also present. Thus elements of the majority of wildlife habitat types and the expected terrestrial fauna found on the ORR occur in BCV (Welch 1989). Hardwood and mixed hardwood/conifer habitats are the most abundant of the habitat types in the Bear Creek watershed, followed by pine plantation and grassland habitats, with considerable riparian habitat along the length of Bear Creek. Species commonly found in these habitats are described in the ecological risk assessment in Appendix G of the BCV Remedial Investigation Report (DOE 1997a).

According to the U.S. Fish and Wildlife Service, the gray bat (*Myotis grisescens*) and the Indiana bat (*Myotis sodalis*), which are on the federal endangered species list, may inhabit areas near the proposed FRC (Appendix E). Avian species that have been observed on the ORR and may be present in the BCV are the Cooper's hawk (*Accipiter cooperii*) and the sharp-shinned hawk (*A. striatus*), both listed by the State of Tennessee as threatened; and the red-shouldered hawk (*Buteo lineatus*), listed by the state as in need of management (Kroodsma 1987, Mitchell et al. 1996). The southeastern shrew (*Sorex longirostris*), which the state lists as in need of management, and the pine snake (*Pituophis melanoleuas*), which the state lists as threatened, have been documented in BCV (Mitchell et al.

1996). The Tennessee dace is listed by the State of Tennessee as in need of management, and occurs throughout most of Bear Creek. Its habitat is protected by the State of Tennessee (Starnes and Etnier 1980).

Rare plant species that occur in BCV include the Canada lily (*Lilium canadense*), which the state lists as threatened, and the southern rein orchid (*Platanthera flava*), which the state lists as a species of special concern. An uncommon aquatic plant, *Orontium aquaticum*, also occurs in BCV. In addition, the Chestnut Ridge Whorled Horse-Balm Forest, which overlaps the southeast border of the experimental project area, contains ginseng (*Panax quinquefolius*), which is listed as special concern in Tennessee due to commercial exploitation, and whorled horsebalm (*Collinsonia verticillata*), which is considered to be globally rare by the Nature Conservancy. Natural communities of concern within this tract include mesic hardwoods. Landscape elements of concern include mature forest, steep slopes, and moist ravines.

The Oak Ridge National Environmental Research Park (NERP) serves as an outdoor laboratory and encompasses approximately 22,500 acres (9100 ha) of the 34,516-acre (13,968-ha) ORR. It is one of seven DOE NERPs across the country. A portion of the Oak Ridge NERP overlays the Y-12 area of responsibility, and overlaps with the western and southern portions of the proposed contaminated area and all of the background area. The DOE NERP provide opportunities for environmental studies on protected lands that act as buffers around DOE facilities. They are used to evaluate the environmental consequences of energy use and development as well as the strategies to mitigate these effects. The research parks are also used to demonstrate possible environmental and land-use options.

DOE has made a commitment to preserve biological diversity through protection of special habitats on the ORR such as habitat of rare plants or animals, vegetational communities representative of the Southern Appalachians, and vegetational communities uncommon in the area. Special habitats on the ORR are protected through National Environmental Research Natural Area or Reference Area designations. The entire length of Bear Creek, from its beginning in the proposed FRC through the background area, is a designated Aquatic Natural Area. The Chestnut Ridge Whorled Horse-Balm Forest, described in the previous section, is also a designated National Environmental Research Natural Area, as is the Bear Creek Spring Area, which is just south of the western end of the proposed FRC.

Species of concern in the Bear Creek Spring Area include tubercled rein-orchid (*Platanthera flava* var. *herbiola*) listed as threatened in Tennessee, golden seal (*Hydrastis canadensis*) listed as special concern in Tennessee due to commercial exploitation, ginseng (*Panax quinquefolius*) listed as special concern in Tennessee due to commercial exploitation, and whorled horsebalm (*Collinsonia verticillata*) considered to be globally rare by the Nature Conservancy. Natural communities include mesic hardwoods, mixed pine and hardwoods, and meadows. Landscape elements of concern include wetlands, springs, seeps, ponds, mature forests, and forested rock outcrops.

The entire ORR, including the Y-12 Area, is designated as a Wildlife Management Area through a cooperative agreement between DOE Oak Ridge Operations and the Tennessee Wildlife Resources Agency. This agreement provides for management of game and non-game wildlife on the ORR.

Wildlife management includes game species management (particularly reduction of the white-tail deer herd); species richness management (ensuring reservation wildlife residents are maintained in viable numbers); featured species management (introduction/restoration of native species); threatened and endangered species management (identifying and protecting individuals, habitat, and factors that

create and maintain particular habitats); and pest management (evaluating current land uses and those under consideration for potential wildlife problems).

A portion of the Y-12 Area, including the western portion of the proposed contaminated area and all of the background area, is open to deer hunting for six days each year. The hunt is conducted to control the deer population and to help minimize the number of deer/vehicle collisions. Turkey hunting began on the ORR in April 1996. The hunt consists of one scouting Saturday followed by two hunting weekends. The turkey hunting area is the same as the deer hunting area on the ORR.

3.1.4.2 Aquatic Resources

Nineteen species of fish have been found in quantitative monitoring efforts conducted at seven sites along almost the entire length of Bear Creek; some fish communities have shown evidence of degraded conditions (Southworth et al. 1992; Hinzman et al. 1995). Minnows are the predominant fish found in the upstream reaches of the creek. Downstream of the location of the proposed background area, northern hogsucker (*Hypentelium nigricans*), white sucker (*Catostomus commersoni*), and rock bass (*Ambloplites rupestris*) are more common. The Tennessee dace (*Phoxinus tennesseensis*), listed by Tennessee Wildlife Resources Agency as in need of management, was found at all sites except near the confluence of Bear Creek and EFPC. Studies have shown that, not only did the number of fish species increase from 1988 to 1993, but the frequency of occurrence also increased between 1984 and 1987. Recent studies conclude that, while much of Bear Creek still has limited fish fauna (low species richness), it is characterized by robust population parameters (high densities and biomass).

The benthic invertebrate fauna, which is rich and diverse at the downstream sections of Bear Creek, shows considerable impact near the headwaters. Quantitative sampling of benthic invertebrates showed a pattern of increasing density, biomass, and taxonomic diversity and richness with increasing distance downstream from the uppermost sampling site (Southworth et al. 1992).

3.1.5 Archaeological, Cultural, and Historic Resources

Under the National Historic Preservation Act, the National Register of Historic Places (NRHP) was established to protect important cultural resources. A listing in the NRHP provides recognition that a property is of significance to the national, state, or community, and requires consideration in the planning of federal or federally assisted projects.

Cultural resources within the Y-12 area of responsibility include seven cemeteries; one prehistoric site, which is not eligible for inclusion in the NRHP and which has an undetermined cultural affiliation; and 22 pre-World War II structures, four of which are eligible for inclusion in the NRHP. A cultural resources evaluation of previously recorded and inventoried sites within portions of the Y-12 area of responsibility has been prepared but has not been published.

One of the seven cemeteries, the Currier Cemetery, is located near the western boundary of the proposed background area in BCV. The Cox-Copeland Cemetery and the Douglas Chapel Cemetery are near but outside of the western and northern boundaries of the proposed FRC, respectively. These cemeteries are protected by law, managed by the Y-12 Environmental Management Department, and open to related families.

One pre-World War II structure site (852A) is close to the northwestern edge of the proposed contaminated area. No details are available for this site, but it is designated as not being eligible for inclusion in the NRHP.

According to the Tennessee Historical Commission, there are no NRHP-listed or NRHP-eligible properties affected by the proposed FRC (Appendix E).

3.1.6 Land Use, Recreation, and Aesthetic Resources

As discussed in Section 3.1.1, the proposed contaminated area and background area lie within the BCV, which is located on the DOE ORR in Anderson and Roane counties. The residential section of Oak Ridge forms the northern boundary of the ORR. The TVA's Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee rivers form the eastern, southern, and western boundaries. Oak Ridge and the ORR are about 23 miles (37 km) west of the center of Knoxville, 12 miles (19 km) southwest of Clinton, and 7 miles (11 km) northeast of Kingston.

The area is linked by Interstates 40 and 75, which intersect in Knoxville.

BCV, bordered by Pine Ridge on the northwest and by Chestnut Ridge on the southeast, is approximately 10 miles (16 km) long, spanning the distance from the eastern end of the Y-12 Plant to the Clinch River on the west. The eastern portion of the valley is on ORR land and the western portion (i.e., the Grassy Creek watershed) includes TVA and private land. The proposed contaminated area and background area lie solely within the Bear Creek watershed.

Recreational uses of the surrounding area include fishing, boating, hunting, and camping. Melton Hill Lake, which delineates the southern boundary of the ORR, is the closest major water body for recreational uses. Major lake recreational areas within a 5-mile (8-km) radius of BCV include Clark Center Park, Melton Hill Park, Solway Public Use Area, Haw Ridge Park, Oak Ridge Marina, and Guinn Road Park. Additional recreational areas include neighborhood parks and civic centers managed by the city of Oak Ridge. Controlled deer and turkey hunts are held annually on the ORR but are not allowed in areas immediately adjacent to the Y-12 Plant or its disposal areas in BCV. Within the footprint of the proposed FRC, there are no recreational uses of Bear Creek.

Much of the region in which the proposed contaminated area and background area are located, between the west end of the Y-12 plant and the junction of Bear Creek Road and State Route 95, has second-growth hardwood forest. Near the Y-12 plant, developed areas associated with the S-3 Ponds Site and waste control areas are open and highly visible. Mowed grassy areas surround these more developed portions. Thus, visual resources range from relatively closed forests to developed areas that include waste control areas and storage yards for scrap metal and other materials.

3.1.7 Socioeconomic Conditions

Over 80 percent of ORR employees live in five counties surrounding the ORR; i.e., Anderson, Knox, Loudon, Morgan, and Roane counties). The total population of this five-county area was 517,158 in 1992.

The total 1997 labor force in the four-county area, excluding Morgan County, evaluated by DOE in 1998 was 280,190. In 1995, the average per capita income for the four-county area was \$20,771, while the Tennessee state average was \$21,060. Per capita income in the area ranged from \$23,107 in

Knox County to \$18,749 in Roane County. Per capita income in Knox County and Anderson County (\$21,621) were higher than the state average, while both Roane County and Loudon County (\$19,606) fell below the average income for the state. Per capita income is typically higher in the city of Oak Ridge than in surrounding counties, reflecting the higher level of education in Oak Ridge and the concentration of residents employed by DOE and its contractors (DOE 1992). Recent downsizing at the DOE facilities in Oak Ridge is a concern of local communities, and significant efforts are underway to attract new industries and businesses. (DOE 1999a, DOE 1997b).

3.1.8 Human Health

A baseline human health risk assessment has been conducted as part of the BCV Remedial Investigation (DOE 1997a). The data for the entire valley were divided into four functional areas (FAs) for analysis based on location and/or contaminant source. The proposed FRC lies within the Maynardville Limestone and Bear Creek FA and S-3 Ponds Site FA. The contaminants in these FAs are those to which workers at the proposed contaminated area could be exposed.

The primary contaminants in the Maynardville Limestone and Bear Creek FA are: nitrate, boron, uranium, strontium, barium, cadmium, manganese, PCE, TCE, 1,2-DCE, and Tc⁹⁹.

The primary contaminants in the S-3 Ponds Site FA are: uranium, Tc⁹⁹, strontium, cadmium, barium, boron, mercury, chromium, VOCs and nitrates, copper, lead, mercury, nickel, vanadium, and zinc.

Persons currently visiting or working in BCV include maintenance or sampling workers. They have limited contact with these contaminants, and are protected from exposure to contamination via adherence to Health and Safety Plans, the use of personal protective equipment when necessary, and Occupational Safety and Health Administration (OSHA)/Superfund Amendments and Reauthorization Act (SARA) training. Administrative controls are in place to limit exposure to radionuclides. These include Radiological Control Organization (RADCON) policies, standards, and procedures.

Noise

Background data on noise levels at the proposed contaminated area and background area are not available. Noise levels 200 feet (60 m) from main thoroughfares such as State Route 95 have been estimated from traffic counts during rush hour to be between 55 and 60 decibels (dB/A). Noise levels at relatively isolated sites within the plant area may be lower than 55 dB/A (DOE 1997b). Potential activities at the proposed contaminated area and background area are listed in Section 2.2.3. Noise associated with potential FRC activities would be produced by well-drilling equipment, compressors, trucks, and generators. Typical noise levels of familiar noise sources are provided in Figure 3-6.

3.1.9 Waste Control

Wastes generated at the proposed contaminated area and background area could include small quantities of contaminated groundwater from drilling wells and sampling in contaminated zones; small quantities of excess soil from coring; field laboratory wastes, some of which would be considered RCRA waste; biological wastes; domestic wastes from the offices and laboratories; and sanitary wastes.

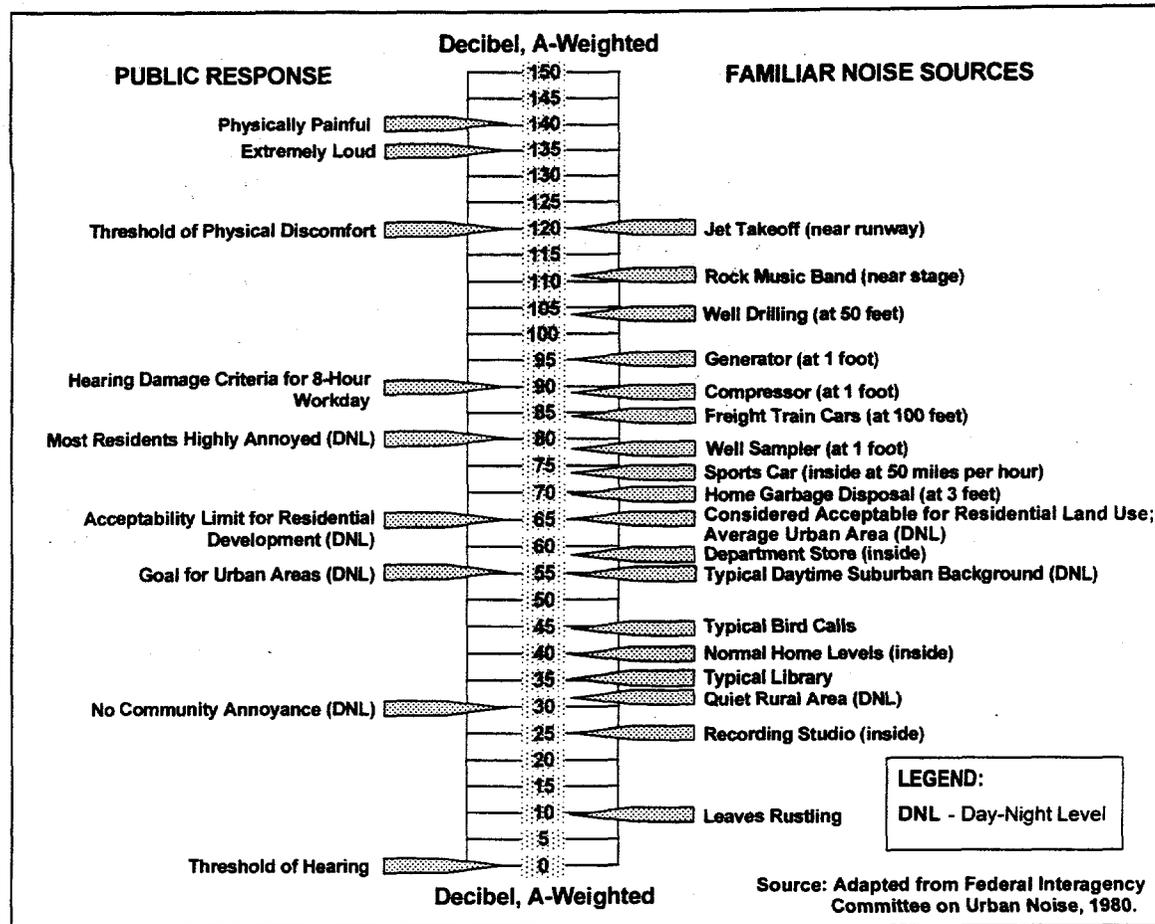


Figure 3-6 Typical noise level of familiar noise sources and public responses

There are existing waste disposal facilities at both ORNL and at Y-12 for the disposal of radioactive, hazardous, chemical, biological, and domestic wastes.

The waste generator (e.g., FRC Manager), would work with the ORNL "generator interface" to prepare and submit data packages to BJC to classify the waste stream under the BJC Master Waste Stream Profile. The data package would be reviewed by BJC to ensure that waste acceptance criteria were met. Once the waste certification became official, the waste would be accepted by BJC for final disposition. Waste accepted by BJC would be owned by BJC; they would decide how the waste would be handled, stored, treated and disposed of. Based on current practices, liquid wastes would be treated at the Y-12 West End Treatment Facility (WETF) but ORNL treatment facilities could also be used. Treated water from the WETF is generally discharged to Upper East Fork Poplar Creek. Low level solid wastes are generally disposed of at an appropriate waste disposal facility, such as Envirocare in Clive, Utah. Nonhazardous waste is disposed of at onsite landfills. Any RCRA waste generated by the proposed FRC would be stored in an onsite satellite accumulation area or taken to a 90-day area.

3.1.10 Transportation

Much of the proposed contaminated area and parts of the background area are adjacent to Bear Creek Road, which has considerable employee traffic during shift changes at the plant and intermittent

traffic during most of the workday. The western boundary of the background area is adjacent to State Route 95, which had existing peak travel volumes of 970 vehicles per hour in 1997 (Table 3.7-2 in DOE 1997b).

The Environmental Sciences Division at ORNL currently conducts research at a variety of field sites on the ORR, including groundwater sampling in BCV. Therefore, collection and transport of samples for the proposed FRC would follow existing procedures and meet all environmental, safety, and health (ES&H) requirements. For each new research project that would be conducted at the FRC, the principal investigator would be required to fill out an Environmental, Safety, Health, and Quality Evaluation and complete a Transportation Checklist. Among the items that are detailed in the ES&H evaluation are the movement of soil samples and the transport of samples on public roads. The Transportation Checklist includes questions about the specific activity of the material, its flashpoint, whether or not it is preserved, if samples contain hazardous materials, if the sample is a RCRA waste, and whether there is any question about the hazardous nature or radioactivity of the shipment. Completion of the checklist gives the researcher guidance on the need to contact ES&H specialists in transportation to assist with compliance with appropriate shipping requirements. Transport of samples off the ORR must meet all applicable Department of Transportation requirements for packaging and shipping.

3.1.11 Utilities and Services

Electricity for the ORR is provided by the Tennessee Valley Authority. Power is brought onsite via transmission lines currently owned by DOE.

DOE withdraws water from the Clinch River at a point south of the eastern end of the Y-12 Plant. The water is filtered and chlorinated at a water treatment plant located north of the Y-12 Plant and distributed to the City of Oak Ridge, the Y-12 Plant and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gallons (26.5 million liters [L]).

ORNL operates and maintains an individual sanitary waste treatment plant (SWTP), while the Y-12 Plant uses sewage treatment services at the City of Oak Ridge. The SWTP at ORNL has a current capacity of 300,000 gallons per day (1.1 million liters per day [Lpd]), while the average daily flow to the SWTP is less than 200,000 gallons per day (757,080 Lpd). Ancillary facilities would be used to support the proposed FRC. FRC staff and researchers would use existing facilities at ORNL, including offices and research laboratories in Building 1505, drilling and field equipment storage and shop in Building 0855, core barn sample storage in Building 7042, and field equipment storage in Building 7874. At Y-12, there is an existing office trailer near the S-3 Ponds Site that could be used for some FRC purposes. (See Figure 3-7 for locations.)

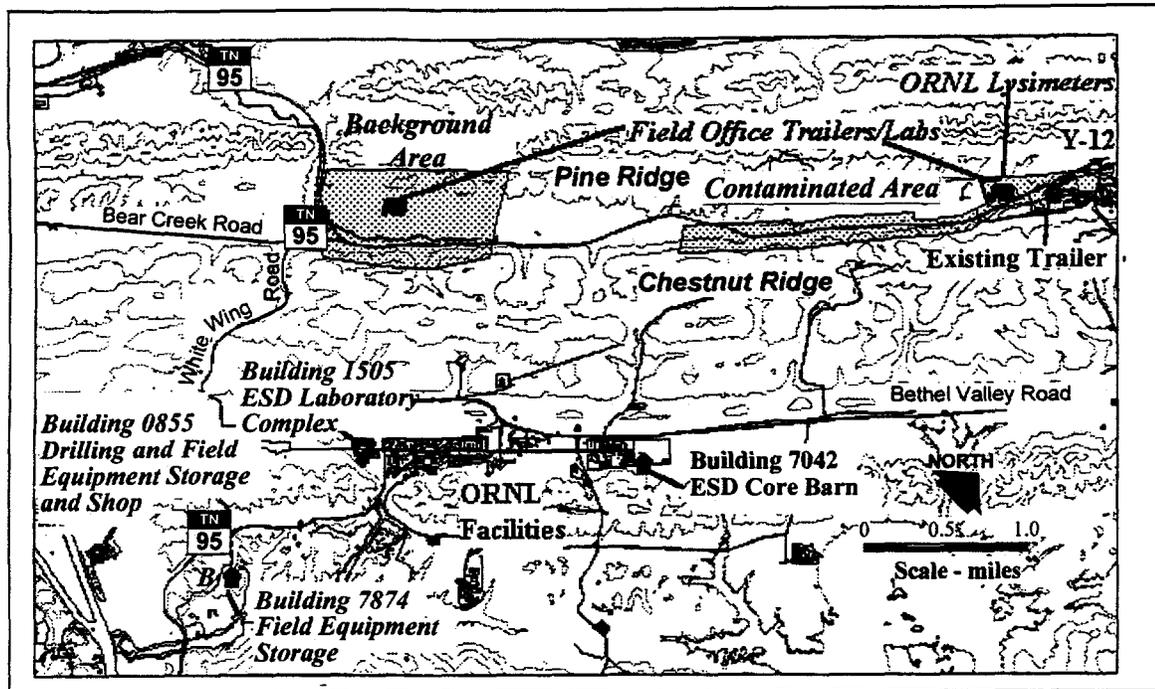


Figure 3-7 Proposed FRC ancillary facilities

3.1.12 Environmental Justice

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The Executive Order mandates that each federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Approximately 880,000 people live within a 50-mile (80-km) radius of the ORR. Based on 1990 census data, minorities compose about 6 percent of this population, compared to about 24 percent for the nation and 17 percent for the State of Tennessee. No federally recognized Native American groups are present within the 50-mile (80-km) radius (DOE 1999a).

The distribution of minority populations and low-income housing data surrounding the ORR is summarized in Table 3-1. The data are provided by census tract in the City of Oak Ridge, the nearest population center to the ORR and the proposed FRC. The minority population data is composed of any census tract within the 50-mile radius with a minority population proportion greater than the national average of 24.4 percent. The low-income household data is composed of any census tract within the 50-mile radius with a low-income population proportion greater than the national average of 13.1 percent.

Table 3-1. Description of the Populations Surrounding ORNL (1990)

Environmental Justice Parameter	ORNL
Population and Minority Population Statistics	
Population within 50 mi (80 km) of center of Site	880,000
Minority population within 50 mi (80 km) of center of Site	6%
Native American, Eskimo, or Aluet populations	0
Asian or Pacific Islander population and other race categories	733
African American population	2,148
Hispanic origin population	437
Low-Income Households surrounding the site*	
Households surrounding the Site	7,092
Low-income households surrounding the Site	568
Percent of low-income households surrounding the Site	8%

*Data calculated by City of Oak Ridge census tracts

3.2 Pacific Northwest National Laboratory/Hanford Site 100-H Area

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The Hanford Site occupies an area of about 560 square miles (1,450 km²) north of the confluence of the Yakima River with the Columbia River. The Columbia River flows through the northern part of the site and turning south, forms part of the Hanford Site's eastern boundary. Rattlesnake Mountain forms the southwestern boundary and the Saddle Mountains form the northern boundary. Adjoining lands to the west, north, and east are principally agricultural and range land. The cities of Richland, Kennewick, and Pasco (also referred to as the Tri-Cities) constitute the nearest population center and are located immediately to the southeast of the Hanford Site (Figure 3-8).

In the late 1980s, portions of the Hanford Site were listed on the National Priorities List because of extensive contamination from past activities. In 1989, the DOE entered into an enforceable agreement with the U.S. Environmental Protection Agency and the State of Washington Department of Ecology for achieving environmental compliance. The *Hanford Federal Facility Agreement and Consent Order*, or Tri-Party Agreement, establishes enforceable milestones for achieving remediation and regulatory compliance.

The Hanford Site encompasses more than 1,500 waste control units and four groundwater contamination plumes that have been grouped into 79 operable units. Each unit has complementary

characteristics of such parameters as geography, waste content, type of facility, and relationship of contaminant plumes. The 79 operable units have been aggregated into four areas: 22 in the 100 Area, 43 in the 200 Area, five in the 300 Area, and four in the 1100 Area.

The proposed FRC would be located in the 100-H Area. The 100-H Area was the site of one of nine plutonium production reactors, the H Reactor, which operated from 1949 to 1965. Following shutdown of reactor operations in the mid-1960s, most of the facility was demolished.

The 100-H Area contains several CERCLA operable units that fall under the Tri-Party Agreement. The R-3 Operable Unit in the 100-H Area contains the contaminated groundwater underlying the 100-H Area. This designation is beneficial because although remediation-related activities within the operable unit must meet all of the substantive requirements of applicable permits, they do not need to obtain the permit itself. This operable unit is currently undergoing an interim remedial action (pump and treat system) for chromium contamination in accordance with a CERCLA Interim Record of Decision (ROD).

The irregular boundaries of the proposed FRC site were chosen to avoid other construction and waste-remediation activities there, planned or ongoing. The contaminated area would encompass an area approximately 2,950 feet long by 2,300 feet wide (900 m by 700 m) (Figures 3-9 and 3-10). Two smaller background areas would be located just southeast and southwest of the contaminated area. As with the proposed ORNL background and contaminated areas, the proposed background and contaminated areas at the 100-H Area would have test plots of several areas (Figure 3-9). Groundwater extraction wells would be placed at the border of each test plot to capture groundwater that flows through the test plot area. In addition, monitoring wells would be placed outside the boundary of the FRC, particularly along the Columbia River, so that groundwater chemistry could be monitored.

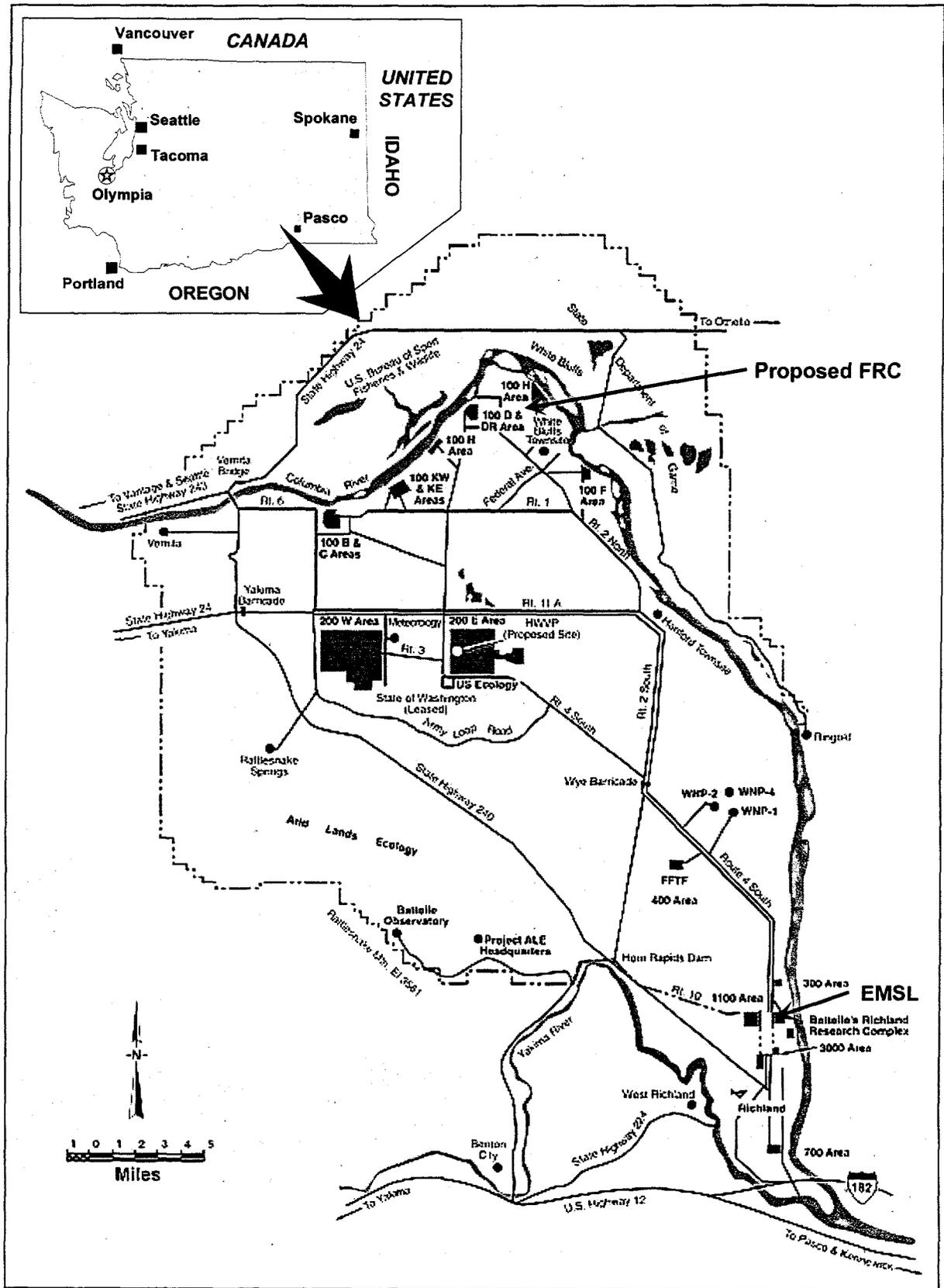


Figure 3-8 Location of proposed FRC in Hanford, Washington

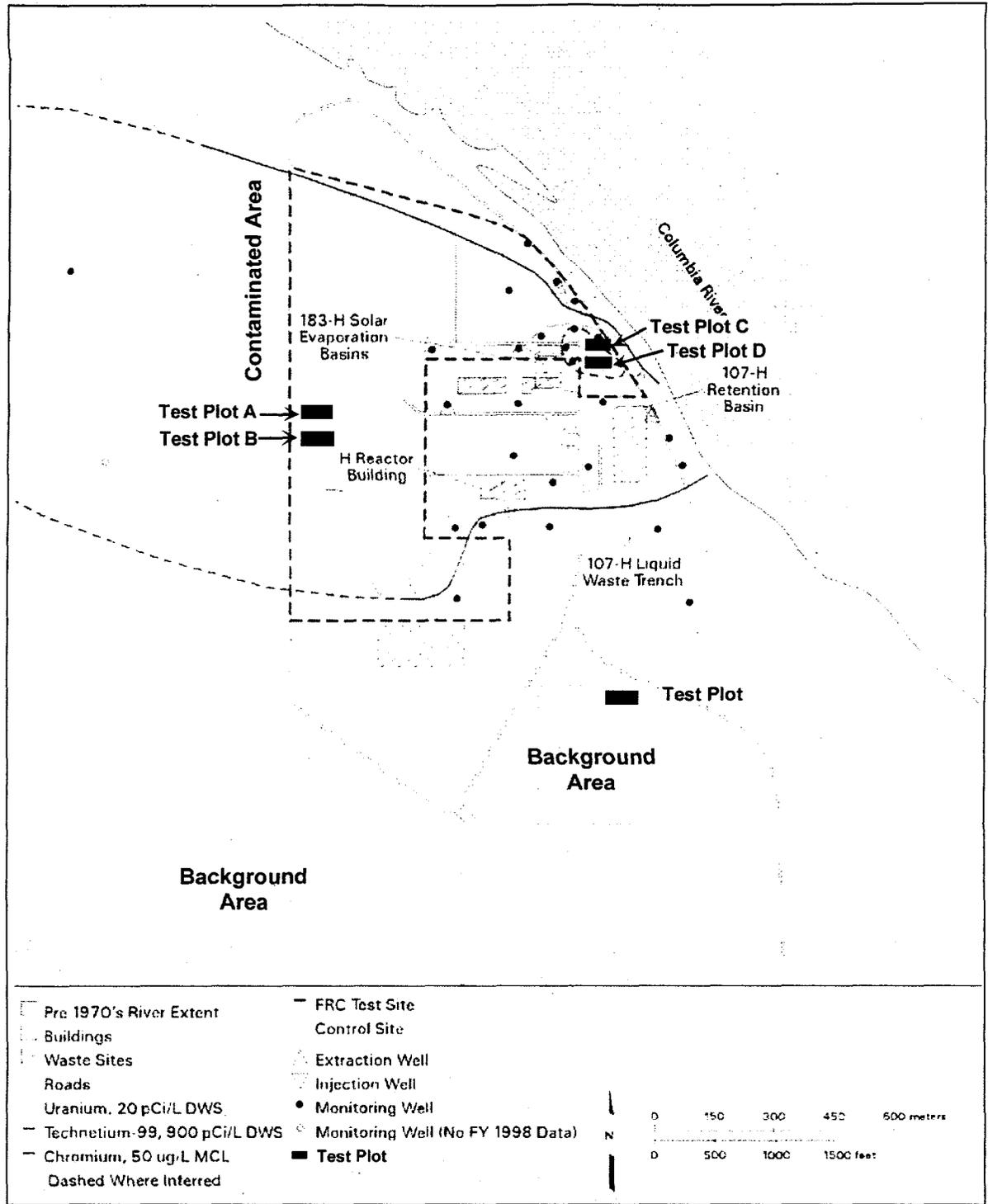
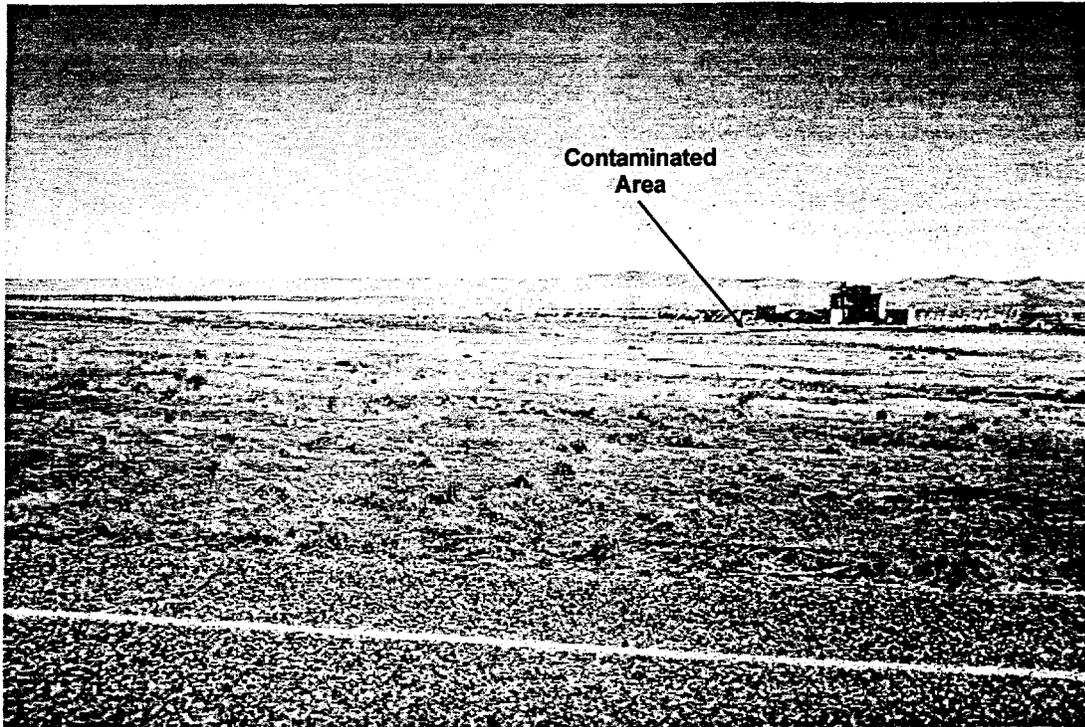


Figure 3-9 Proposed FRC in the 100-H Area of the Hanford site



A portion of the Proposed FRC Contaminated Area at PNNL/Hanford



A portion of the Proposed FRC Background Area at PNNL/Hanford

Figure 3-10 Photographs of the Proposed FRC Contaminated and Background Areas at PNNL/Hanford

3.2.1 Earth Resources

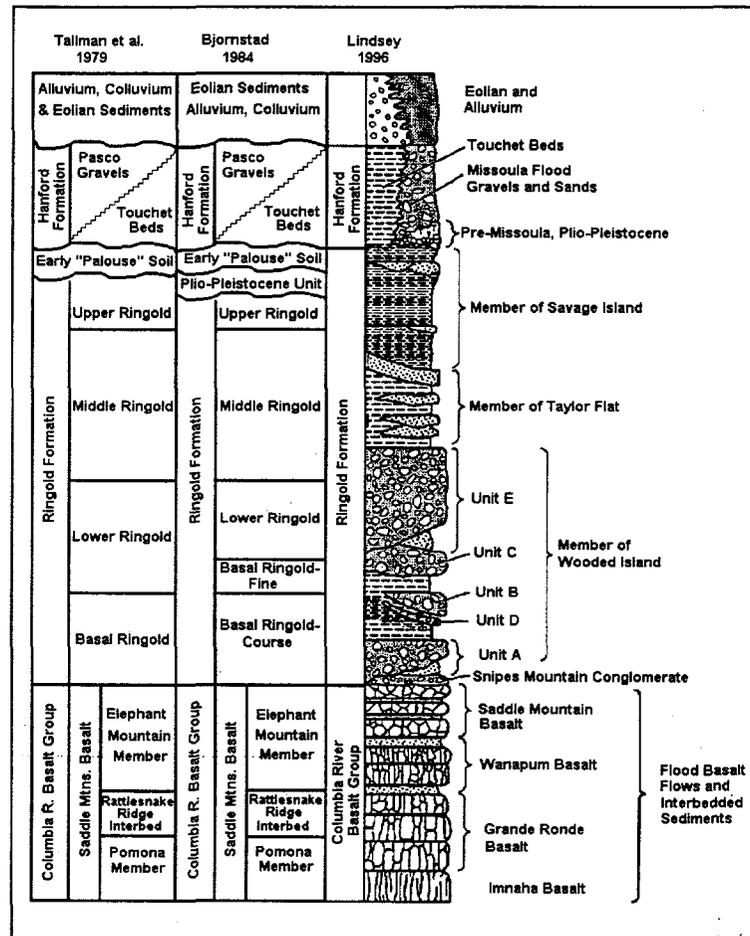
3.2.1.1 Topography

The 100-H Area lies on an essentially low-relief, semiarid bench south of the Columbia River. The elevation of the area ranges from river level (~380 feet) to 425 feet above mean sea level. The land surface slopes gradually toward the river, with a bank up to 30 feet at the edge of the river. The surface topography of the 100-H Area reflects the impacts of river erosion (i.e., channeling) of the area during unregulated floods prior to construction of Priest Rapids Dam up-river. To the east, beyond the 100-H Area, lie the high-relief cliffs of eroded Ringold Formation, referred to as the White Bluffs.

3.2.1.2 Geology

The Hanford Site is located near the junction of the Yakima Fold Belt and the Palouse structural subprovinces (DOE 1988a). The Palouse subprovince is primarily a regional paleoslope that dips gently toward the central Columbia Basin and exhibits only relatively mild structural deformation. The principal characteristics of the Yakima Fold Belt are a series of segmented, narrow, asymmetric anticlines. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of sediments (i.e., Ringold and Hanford formations). Thrust or high-angle reverse faults are principally found along the limbs of the anticlines.

The 100-H Area lies within the Wahluke syncline, the east-west trending structural depression lying between Saddle Mountains to the north and the Umtanum Ridge-Gable Mountain uplift to the south. The Wahluke syncline is asymmetric and relatively flat-bottomed. The Umtanum Ridge-Gable Mountain uplift is a segmented, asymmetrical anticlinal ridge that extends onto the Hanford Site from the west. Gable Mountain and Gable Butte consist of two topographically isolated, anticlinal ridges



composed of a series of northwest-trending, doubly plunging, en echelon anticlines, synclines, and associated faults. The potential for present-day faulting has been identified on Gable Mountain.

Bedrock beneath the Hanford Site consists of the Miocene Columbia River Basalt Group (volcanic origin) interbedded with sedimentary deposits of the Ellensburg Formation. Overlying bedrock are suprabasalt sediments belonging to the Miocene-Pliocene Ringold Formation and Pleistocene Hanford formation. Other stratigraphic units of local extent include the early "Palouse" soil, the Plio-Pleistocene unit, and pre-Missoula gravels. The Hanford Site stratigraphy (Figure 3-11) is described in more detail in Neitzel et al. 1999.

The Columbia River Basalt Group consists of continental flood basalts that erupted from linear vents within northeastern Oregon, eastern Washington, and western Idaho between 6 to 17 million years ago. The Saddle Mountains Basalt forms the uppermost basalt unit in the Pasco Basin, except along some of the bounding ridges where Wanapum and Grande Ronde Basalt flows are exposed.

The fluvial-lacustrine Ringold Formation was deposited in generally east-west trending valleys by the ancestral Columbia River and its tributaries in response to development of the Yakima Fold Belt.

Cataclysmic flooding, originating in western Montana and northern Idaho, spilled across eastern and central Washington, forming the channeled scablands and depositing sediments in the Pasco Basin. The last major flood occurred about 13,000 years ago. Cataclysmic floods inundated the Pasco Basin a number of times during the last ice age. The flood deposits, informally called the Hanford formation, blanket low-lying areas over most of the central Pasco Basin.

Alluvium is present as a surficial deposit along the Columbia and Yakima Rivers; and in the subsurface, interbedded with cataclysmic flood deposits. Colluvium (talus and slopewash) is a common Holocene deposit in moderate- to high-relief areas. Varying thicknesses of loess or sand mantle much of the Columbia Plateau. Active and stabilized sand dunes are widespread over the Pasco Basin. Landslide deposits in the Pasco Basin occur within the basalt outcrops along the ridges or steep river embankments (e.g., the north side of Rattlesnake Mountain and White Bluffs, respectively).

Approximately 300 feet (91.5 m) of suprabasalt sediments overlie the proposed FRC and the 100-H Area. Sediments overlying Columbia River basalt include the Ringold Formation, the Hanford formation, as well as localized Holocene alluvium and backfill (Lindsey and Jaeger 1993). The Ringold Formation and Hanford formation are continuous across the 100-H Area.

The Hanford formation consists primarily of gravel-dominated facies, with local occurrences of sand-dominated or silt-dominated facies. The Hanford formation generally thickens from north to south, ranging from 30 to 65 feet (9 to 20 m), and overlies fine-grained facies of the Ringold Formation.

Ringold Formation sediments—with total thickness of 250 to 270 feet (76 to 82 m) near the proposed FRC—are dominated by lacustrine, overbank deposits and associated paleosols. All are represented within the 100-H Area. Fine-grained, overbank-paleosol facies (Ringold upper mud) (Auten and Myers 1996), comprises the upper 100 to 125 feet (30 to 38 m) of the Ringold Formation. The upper mud unit is described as a moderately consolidated, light brownish gray to light yellowish brown to reddish brown, sandy clayey silt to clayey silt (Fruchter et al. 1996). This unit averages 19.7 percent sand, 54.7 percent silt, and 25.5 percent clay.

Two other Ringold units are present within the 100-H Area. A sandier facies (Unit B/D [Auten and Myers 1996]) separates the upper mud sequence from the Ringold lower mud unit. Unit B/D is

composed of a fluvial sand facies. The Ringold lower mud unit (90- to 100-foot total thickness) is interpreted to be lacustrine (Lindsey and Jaeger 1993).

In the 100-H Area, an erosional unconformity exists between the Ringold and Hanford formations, which slopes gently toward the east. The upper contact with the Ringold Formation was scoured out during Pleistocene cataclysmic flooding, and subsequently deposited the Hanford formation during the waning stages of flooding (Baker et al. 1991).

Seismicity of the Columbia Plateau is relatively low when compared with other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho. The largest known earthquake in the Columbia Plateau occurred in 1936 near Milton-Freewater, Oregon. This earthquake had a Richter magnitude of 5.75. In the central portion of the Columbia Plateau, the largest recorded earthquake near the Hanford Site occurred in 1973. This event registered a magnitude of 4.4 and was located north of the Hanford Site near Othello.

Earthquakes commonly occur in spatial and temporal clusters in the central Columbia Plateau and are termed "earthquake swarms." The region north and east of the Hanford Site is a region of concentrated earthquake swarm activity, but earthquake swarms have also occurred in several locations within the Hanford Site. The frequency of earthquakes in a swarm tends to gradually increase and decline without a large event in the sequence. Roughly 90 percent of the earthquakes in swarms have Richter magnitudes of 2 or less. These earthquake swarms generally occur at shallow depths, with 75 percent of the events located at depths of less than 2.5 miles (<4 km).

3.2.1.3 Soils

Hajek 1966 describes 15 different soil types on the Hanford Site, varying from sand to silty and sandy loam. In the 100-H Area, soils are classified as either Burbank loamy sand or Riverwash, with Riverwash occurring closer to the river. Burbank loamy soil is a course-textured soil underlain by gravel. The surface soil is usually about 16 inches (40 cm) thick, but can be 30 inches (75 cm) thick. This soil type is highly permeable. Soils beneath 100-H Area waste disposal sites have been found to contain uranium, technetium-99 (Tc^{99}), strontium, and chromium, among other constituents.

3.2.2 Climate and Air Quality

Climate at the Hanford Site is classified as mid-latitude semiarid or mid-latitude desert, depending on the climatological classification scheme used. Summers are warm and dry with abundant sunshine. Large diurnal temperature variations result from intense solar heating during the day and radiational cooling at night. Daytime temperatures in June, July, and August periodically exceed 100°F (38°C). Winters are cool with occasional precipitation. Outbreaks of cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below 0°F (-18°C). Overcast skies and fog occur periodically.

Air quality in the Hanford region is well within the state and federal standards for criteria pollutants, except that short-term particulate concentrations occasionally exceed the 24-hour "particulate matter nominally 10 microns or less" (PM_{10}) standard. Benton County is in an "unclassified" area for PM_{10} (Neitzel et al. 1999).

3.2.3 Water Resources

3.2.3.1 Surface Water

The primary surface water feature in the vicinity of the proposed FRC is the Columbia River. The primary uses of the Columbia River include the production of hydroelectric power and extensive irrigation in the Mid-Columbia Basin. Several communities located on the Columbia River rely on the river as their source of drinking water. The river is also used as a source of drinking water at several Hanford facilities and for onsite industrial uses (Neitzel et al. 1999).

The Comprehensive Land Use Plan designates 43.1 miles (111.6 km) of the Columbia River adjacent to the Hanford Site as the Columbia River Corridor. Along the southern shoreline of the corridor, the 100 Areas occupy approximately 26 miles (68 km). RCRA closure permit restrictions have been placed in the vicinity of the 100-H Area, which is associated with the 183-H Solar Evaporation Basins. Additional deed restrictions or covenants for activities that potentially extend more than 15 feet (4.6 m) below ground surface are expected for CERCLA remediation areas.

The Columbia River borders the 100-H Area on the northeast. The Hanford Reach is the only stretch of the Columbia River within the United States that is not impounded by a dam, though the flow is controlled by the Priest Rapids Dam located several miles upstream of the Hanford Site.

The existence of the Hanford Site has precluded development of this section of the river for irrigation and power and the Hanford Reach is now currently under consideration for Wild and Scenic River status by the National Park Service. In 1988, Congress passed Public Law 100-605. The law requires the Secretary of Interior to prepare a study in consultation with the Secretary of Energy to evaluate the outstanding features of the Hanford Reach and its immediate environment and to institute interim protection measures. An Environmental Impact Statement (EIS) was prepared to evaluate the unique natural features of the Hanford Reach. Based on the evaluation in the EIS, the Secretary of Interior signed a Record of Decision on July 16, 1996 (DOI 1996), recommending Congress designate the Hanford Reach and public land within one-quarter mile of the river on the south shore (as well as a larger area on the north shore) as a Wild and Scenic River. To date, despite the introduction of bills concerning this issue, Congress has not acted to designate the Hanford Reach as a Wild and Scenic River.

Water samples are collected quarterly from the Columbia River along established points on the Hanford Site as well as immediately upstream and downstream. The current major source of heat to the Hanford Reach is solar radiation. The average pH values ranged from 7.7 to 8.1. Mean specific conductance values ranged from 128 to 165 microSiemens/cm. Radionuclides consistently detected in the river during 1998 included tritium, Sr-90, I-129, U-234,238, and Pu-239,240. Total alpha and beta measurements (useful indicators of the general radiological quality that provide an early indication of changes in radioactive contamination levels) were approximately 5 percent or less of the applicable drinking water standards of 15 and 50 pCi/L, respectively (Neitzel et al. 1999, PNNL 1998).

3.2.3.2 Floodplain and Wetlands

There are no Federal Emergency Management Agency (FEMA) floodplain maps of the Hanford Reach of the Columbia River. Prior to 1933, when the Columbia River was free-flowing, periodic

large floods occurred that affected the 100-H Area. This is indicated by a series of fluvial channels that dissect older cataclysmic-flood and older fluvial deposits in the vicinity of 100-H Area. These channels were probably last occupied during the largest known unregulated historical flood, which occurred in 1894 and is estimated to have a discharge of 742,000 cubic feet per second (21,000 cubic meters per second [m^3/s]) (Neitzel et al. 1999). The Columbia River flow is now controlled by a series of dams located both upstream and downstream of the Hanford Area.

The largest recent flood at the Hanford Area took place in 1948 with an observed peak discharge of 700,000 cubic feet per second (20,000 m^3/s). The 1948 flood did not inundate the 100-H Area. An estimate of the 100-year dam-regulated flood is 440,000 cubic feet per second (12,400 m^3/s) (Neitzel et al. 1999). The 100-year regulated flood would not affect the 100-H Area.

The 100-H Area does not include any wetlands other than the narrow ribbon of wetlands along the shoreline of the Columbia River; these wetlands are not located within the proposed FRC (Neitzel et al. 1999).

3.2.3.3 Groundwater

Groundwater beneath the Hanford Site is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers (Neitzel et al. 1999). Portions of the upper aquifer system are in locally confined or semiconfined. Confined aquifers within the Columbia River Basalt Group are formed by relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows. The horizontal hydraulic conductivities of most of these aquifers fall in the range of 3×10^{-10} to 3×10^{-4} feet per second (10^{-10} to 10^{-4} m/s). The dense interior sections of the basalt flows have horizontal hydraulic conductivities ranging from 3×10^{-15} to 3×10^{-9} feet per second (10^{-15} to 10^{-9} m/s), about five orders of magnitude lower than those of the confined aquifers. Groundwater in the basalt confined aquifers generally flows toward the Columbia River and, in some places, toward areas of enhanced vertical communication with the unconfined aquifer system.

Groundwater in the unconfined aquifer at Hanford generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries (the 100-H Area). The Columbia River is the primary discharge area for the unconfined aquifer. Along the Columbia River shoreline, daily river level fluctuations may result in water table elevation changes of up to 10 feet (3 m). During the high river stage periods of 1996 and 1997 some wells near the Columbia River showed water level changes of more than 10 feet). As the river stage rises, a pressure wave is transmitted inland through the groundwater. The longer the duration of the higher river stage, the farther inland the effect is propagated. The pressure wave is observed farther inland than the water actually moves. For the river water to flow inland, the river level must be higher than the groundwater surface and must remain high long enough for the water to flow through the sediments. Typically, this inland flow of river water is restricted to within several hundred feet of the shoreline.

Groundwater recharge from precipitation across the entire Hanford Site is thought to range from approximately 0 to 4 inches per year (0 to 10 cm/yr) but is probably less than 1 inch per year (<2.5 cm/yr) over most of the Site. Since 1944, the artificial recharge from Hanford wastewater disposal in the 200 Areas has been significantly greater than the natural recharge. An estimated 4.44×10^{11} gallons (1.68×10^{12} L) of liquid was discharged to disposal ponds, trenches, and cribs from 1944 to the present. Horizontal hydraulic conductivities of sand and gravel facies within the Ringold Formation generally range from about 0.9 to 9 feet per day (0.3 to 3 meters per day [m/d]) compared to 1,000 to 10,000 feet per day (300 to 3,000 m/d) for the Hanford formation. Because the Ringold

sediments are more consolidated and partially cemented, they are approximately 10 to 100 times less permeable than the sediments of the overlying Hanford formation. Before wastewater disposal operations at the Hanford Site, the uppermost aquifer was mainly within the Ringold Formation and the water table extended into the Hanford formation at only a few locations. However, wastewater discharges raised the water table elevation across the Site, especially within the 200 Areas. Because of the general increase in groundwater elevation, the unconfined aquifer now extends upward into the Hanford formation. This change has resulted in an increase in groundwater velocity not only because of the greater volume of groundwater but also because the newly saturated Hanford sediments are highly permeable. More recently, water levels have declined over most of the Hanford Site because of decreased wastewater discharges (Neitzel 1999).

The hydrology of the 100 Areas is notable because of the location adjacent to the Columbia River. A map showing the water table elevations in the vicinity of the 100-H Area is shown in Figure 3-12. The water table ranges in depth from near 0 feet at the river edge to 107 feet (30 m). The groundwater flow direction is generally toward the river. During high-river stage, however, the flow direction may reverse immediately adjacent to the river.

The groundwater gradient varies depending on the distance from the river and the time of year. Groundwater flow near the river is strongly influenced by fluctuations in Columbia River stage, which is controlled by dams. River stage can vary 6 to 8 feet daily and 8 to 10 feet seasonally. The hydraulic gradient is greatly increased near the river during periods of low flow. As the river stage increases the gradient flattens, as the groundwater responds to a higher discharge elevation. Normal peak discharge occurs during June while normal low flow occurs in October and November. River stage can influence wells up to 2,000 feet (600 m) inland from the river. Confined aquifer layers have potentiometric surfaces that are generally above those of the unconfined aquifer.

Groundwater Quality

Groundwater quality has been negatively impacted by past practices at the 100-H Area, and because of its proximity to the Columbia River, the 100-H Area has received high priority for the remediation of hazardous and radioactive wastes at Hanford. Contaminants of concern include chromium, nitrate, Tc⁹⁹, and uranium, all of which occur above drinking water standards within the 100-H Area. A pump and treat system is presently in operation to contain these contaminants and prevent them from entering the river. The proposed FRC is located hydraulically upgradient of the pump and treat system. The system is presently pumping contaminated groundwater from five wells immediately adjacent to the river, passing the water through an ion-exchange filter and injecting the treated water into several wells located 1,970 to 2,300 feet (600 to 700 m) upgradient of the river. Through the CERCLA Interim Record of Decision, the EPA and DOE are scheduled to review the status and success of this pump and treat effort in 2002. At that time, changes might be made to the pump and treat system.

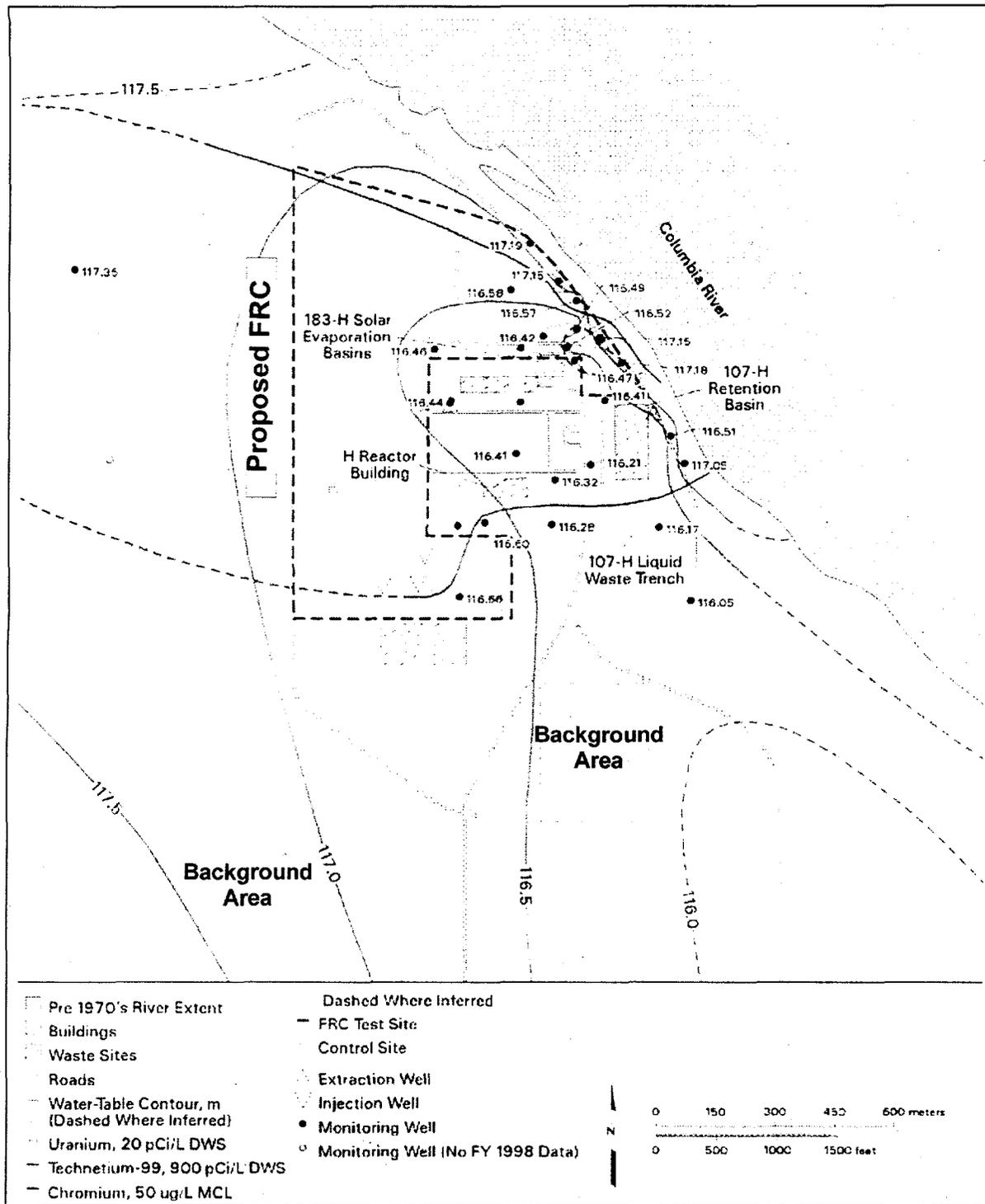


Figure 3-12 Groundwater table in the vicinity of the 100-H Area

3.2.4 Ecological Resources

The following section identifies and describes the terrestrial, and aquatic resources that occur on the Hanford Site and in the 100-H Area

3.2.4.1 Terrestrial Resources

The Hanford Site is located within what has been botanically characterized as a shrub-steppe ecosystem, with various shrub and bunchgrass associations playing dominant roles. The region is often referred to as high desert, northern desert shrub, or desert scrub (Franklin and Dyrness 1973). The Hanford Site is a relatively large, undisturbed area of shrub-steppe habitat that contains numerous plant and animal species adapted to the semi-arid environment in the region. The major DOE facilities and infrastructure occupy only a small part of the site and their impact on the surrounding ecosystems is minimal. Most of the Hanford Site has not experienced tillage or livestock grazing since the early 1940s.

A pedestrian and visual reconnaissance of the proposed contaminated area and the background area near the southeast corner of 100-H Area was performed by staff from the Hanford Biological Resources Laboratory on April 23, 1998. An additional background area, which is proposed to be to the south/ southwest of the original 100-H perimeter, has not been recently surveyed. However, information on the habitat of the region was obtained from the habitat classification database of the Ecosystems Monitoring Project (Neitzel et al. 1999). The Braun-Blanquet cover-abundance scale (Bonham 1989) was used to determine percent cover of dominant vegetation.

The northern portion of the proposed contaminated area is characterized as a Rabbitbrush (*Crysothamnus nauseosus*)/cheatgrass (*Bromus tectorum*) community, with a significant amount of bulbous bluegrass (*Poa bulbosa*). Other portions of the proposed contaminated area are primarily characterized as cheatgrass communities. All proposed contaminated areas have been previously disturbed. The proposed background area in the southeast corner of 100-H Area is characterized as a cheatgrass community.

In 1999, the U.S. Fish and Wildlife Service provided a list of threatened and endangered species, candidate species and species of concern, which may be present in the Benton County portion of the Hanford Area (Appendix E). However, no plant or animal species protected under the Endangered Species Act, candidates for such protection, or species listed by the Washington State government as threatened or endangered were observed within the proposed FRC boundaries. Bald eagles use the river area adjacent to the proposed area during the winter. Bald eagles are currently on the Federal Endangered Species list; however, a proposal to delist the bald eagle was published in the Federal Register, July 6, 1999. A final decision is expected in July 2000.

3.2.4.2 Aquatic Resources

The Columbia River is the dominant aquatic ecosystem on the Hanford Area and flows to the northeast of the 100-H area. The river supports a large and diverse community of fish, benthic invertebrates, and other communities.

Neitzel 1999 lists 43 species of fish in the Hanford Reach of the Columbia River. The brown bullhead (*Ictalurus nebulosus*) has been collected since 1977, bringing the total number of fish

species identified in the Hanford Reach to 44. Of these species, chinook salmon, sockeye salmon coho salmon, and steelhead trout use the river as a migration route to and from upstream spawning areas and are of the greatest economic importance. The Upper Columbia River steelhead, Upper Columbia River spring-run chinook salmon, and the bull trout are known to occur in the Columbia River immediately adjacent to the proposed project areas. All three species are federally listed as endangered

Benthic organisms are found either attached to or closely associated with the substratum. All major freshwater benthic taxa are represented in the Columbia River. Insect larvae such as caddisflies (*Trichoptera*), midge flies (*Chironomidae*), and black flies (*Simuliidae*) are dominant. Other benthic organisms include limpets, snails, sponges, and crayfish. Peak larval insect densities are found in late fall and winter, and the major emergence is in spring and summer (Neitzel 1999).

3.2.5 Archaeological, Cultural, and Historic Resources

Management of the Hanford Area cultural resources follows the *Hanford Cultural Resources Management Plan* (PNL 1989), which was approved by the State Historic Preservation Office in 1989. The Management Plan was developed to establish guidance for the identification, evaluation, recordation, curation, and management of archaeological, historic, and traditional cultural resources as individual entities or as contributing properties within a district. The plan specifies methods of consultation with affected tribes, government agencies, and interested parties, and includes strategies for the preservation and/or curation of representative properties, archives, and objects.

The proposed contaminated area was reviewed by staff from the Hanford Cultural Resources Laboratory (Appendix E). There are no known historic properties within the proposed contaminated area. A records review indicated that approximately half of the proposed contaminated area has been intensively surveyed for cultural resources. No archaeological sites or isolated artifacts were identified in the survey area. The proposed contaminated area is primarily within areas where the ground surface has been disturbed by prior Hanford Site construction activities. All but a very small part of the remainder of the proposed contaminated area not intensively surveyed is identified as original ground surface. Part of the proposed contaminated area is within 1,310 feet (400 m) of the Columbia River, which is considered culturally sensitive. A cultural resource expert is required to be present during excavation in this area.

The proposed southwest and southeast background areas have also been previously surveyed for cultural resources. No archaeological sites or isolated artifacts were located within the background areas. Review of 1941 aerial photographs indicates that, prior to Hanford Site development, the southwest background area was undeveloped range land, while the southeast background area was a combination of undeveloped and agricultural land. There are no known historic properties within either of the background areas.

3.2.6 Land Use, Recreation, and Aesthetic Resources

The Hanford Site encompasses 560 square miles (1,450 km²) and includes several DOE operational areas. Land use categories at the Hanford Site include reactor operations, waste operations, administrative support, operations support, sensitive areas, and undeveloped areas. Remedial activities are currently focused within or near the disturbed areas, such as the 100 Areas. Much of the Hanford Site is undeveloped, providing a safety and security buffer for the smaller areas used for

operations. The entire Hanford Site has been designated a National Environmental Research Park. Public access to most facility areas is restricted.

DOE, in partnership with several cooperating agencies, has issued a Record of Decision based on the Hanford Comprehensive Land-Use Plan Environmental Impact Statement (EIS) (DOE/RL 1999b) to address proposed land uses at the Hanford Site over the next 50 years. The comprehensive land use plan provides a comprehensive and long-term approach to planning and development for the Hanford Site and recognizes the multiple uses that must be coordinated, including research and development activities. The 100 Areas are the site of eight retired plutonium production reactors and the N Reactor. The facilities in the 100 Areas are being placed in a stabilized state for ultimate decommissioning. Remedial activities are currently focused within or near the disturbed areas.

Access to the Hanford Site is restricted, so recreation does not occur on the site. However, access to the Hanford Reach of the Columbia River, which flows adjacent to the 100-H Area, is unrestricted. The river is used extensively for fishing, hunting, boating, windsurfing, water-skiing, diving, and swimming.

The Hanford Reach of the Columbia River is designated as Class A, Excellent. Class A waters are suitable for all uses, including raw drinking water, recreation, and wildlife habitat. Water quality is routinely monitored from locations upstream and downstream of the Hanford Site. State and federal drinking water standards apply to the Columbia River and are currently being met.

The land in the vicinity of the Hanford Site is generally flat with little relief. Rattlesnake Mountain, rising to 3,480 feet (1,060 m) above mean sea level, forms the southeastern boundary of the Hanford Site. Gable Mountain and Gable Butte are the highest landforms within the Hanford Site. Large rolling hills are located to the west and north of the Site. The Columbia River, flowing across the northern part of the Site and forming the eastern boundary, is generally considered scenic, with its contrasting blue against a background of dark basaltic rocks and desert sagebrush. The White Bluffs' steep, whitish-brown bluffs adjacent to the Columbia River (located across the river from the 100-H Area) are a striking natural feature of the landscape.

3.2.7 Socioeconomic Conditions

The Tri-Cities constitute the nearest population center and are located southeast of the Hanford Site. The 1997 estimates distributed the Tri-Cities population as follows: Richland 36,860, Pasco 26,000, and Kennewick 50,390. Activity on the Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities and surrounding counties. In addition to providing direct employment, the Hanford payroll has a widespread impact on the Tri-Cities and state economies (Neitzel et al. 1999).

Three major employment sectors have been the principal driving forces of the economy of the Tri-Cities since the early 1970s: 1) DOE and its contractors operating the Hanford Site; 2) Energy Northwest and its operation of a commercial nuclear power plant located on the Hanford Site; and 3) the agricultural community, including a substantial food processing component. In 1997, nearly 20 percent of the nonagricultural jobs in Benton and Franklin counties were composed of DOE and its contractors at the Hanford Site (Neitzel et al. 1999).

Land in the surrounding environs is used for urban and industrial development, irrigated and dry-land farming, and grazing. Major industrial facilities within a 50-mile (80-km) radius include a meat-packing plant, food-processing facilities, fertilizer plants, a pulp and paper mill, chemical plant, hydroelectric dams, and small manufacturing firms. Within a 50-mile radius of the 100-H Area, but

outside the Hanford boundary, agriculture is the predominant land use. Government facilities located on the Hanford Site include retired chemical processing plants, radioactive waste control units, decontamination facilities, nuclear materials storage facilities, research laboratories, and a retired reactor at the 100-H Area. Commercial use of the Hanford Site includes a nuclear power plant (Energy Northwest Nuclear Plant 2) and a low-level radioactive waste burial area administered by Washington State and operated by U.S. Ecology Inc.

3.2.8 Human Health

Radioactive emissions from many onsite facilities are approaching levels practically indistinguishable from the naturally occurring radioactivity present everywhere. (PNNL 1998). This translates to a very small offsite radiation dose attributable to site activities. Using thermoluminescent dosimeters, radiological dose rates were measured at both onsite and offsite locations during 1997. Radioactive substances contributing to the measured dose rates were of either natural or man-made origin. The dose rates did not change significantly from the dose rates measured in previous years. The 1997 annual average background dose rate measured in communities distant from the Hanford Site was 67 ± 1 millirem per year (mrem/yr). The 1997 annual average perimeter dose rate was 89 ± 10 mrem/yr. All onsite thermoluminescent dosimeters averaged 85 ± 5 mrem/year (PNNL 1998).

The Hanford Environmental Health Foundation (HEHF) provides occupational health services to Hanford personnel through health risk management and occupational health monitoring. The HEHF's health risk management program identifies and analyzes the hazards Hanford personnel face in the work environment and brings an awareness to worker health and safety issues at Hanford. HEHF's occupational health services provide occupational medicine and nursing, including medical monitoring and surveillance; ergonomics assessment; psychology and counseling; fitness for duty evaluation; infection control; immediate health care; industrial hygiene; and health, safety, and risk assessments.

Noise

Background noise levels were evaluated in the 1980s at five Hanford Site locations. Noise levels were expressed as equivalent sound levels for 24 hours (Leq-24). The average noise level for these five sites was 38.8 dB/A on the dates tested. The wind was identified as the primary contributor to background noise levels, with winds exceeding 12 miles per hour (19 km/hr) significantly affecting noise levels. This study concluded that background noise levels in undeveloped areas at the Hanford Site are generally in the range of 24 to 36 dB/A. Periods of high wind, which normally occur in the spring, would elevate background noise levels (Neitzel et al. 1999).

Noise levels at the 100-H Area are expected to be similar to the levels identified in the Hanford study. There might occasionally be higher noise levels associated with ongoing remediation work at 100-H. Potential activities at the contaminated area and background area are listed in Section 2.2.3. Noise associated with potential FRC activities would be produced by well-drilling equipment, compressors, trucks, and generators. Noise from FRC activities would be temporary and likely to disturb wildlife or other sensitive receptors for only short periods during daylight hours.

3.2.9 Waste Control

Wastes generated at the proposed contaminated area and background area could include small quantities of contaminated groundwater from drilling wells and sampling in contaminated zones;

small quantities of excess soil from coring; field laboratory wastes, some of which would be considered RCRA waste; biological wastes; domestic wastes from the offices and laboratories; and sanitary wastes.

There are existing waste disposal facilities on the Hanford Site for the disposal of radioactive, hazardous, chemical, biological, and domestic wastes.

3.2.10 Transportation

U.S. Department of Transportation (DOT) Hazardous Materials Regulations (Title 49, *CFR*, Parts 171-180) establishes requirements governing packaging and shipping hazardous materials on public highways. The standards are applicable to any necessary shipments of hazardous materials to or from the proposed FRC. The PNNL Shipping and Transportation Program ensures compliance with the DOT Hazardous Materials Regulations and DOE requirements specific to packaging and transportation safety. The PNNL Hazardous Materials Transportation Officer would be consulted to assure safe packaging and transportation of regulated samples, hazardous materials, or wastes.

The 100-H Area is restricted to use only by DOE and its contractors. In the vicinity of the proposed FRC, the majority of roads are being used for the decommissioning of the H Reactor Building, and for remediation activities at the 183-H Solar Evaporation Basins and 107-H Liquid Waste Trench. Large trucks are frequently on the roads.

3.2.11 Utilities and Infrastructure

The Hanford Site has a potable and raw water system, supplying the developed areas of the Site, including the 100-H Area. Electrical power is provided to the 100 Areas from the Bonneville Power Administration. Additional support services include sewers, fire protection, waste disposal, and safeguards, and security.

Key elements of site infrastructure include facilities and roads (DOE/RL 1994a). Onsite programmatic and general purpose facilities provide 6.5 million square feet (600,000 m²) of space. General purpose facilities include offices, laboratories, shops, warehouses, and other facilities. Programmatic space supports a liquid waste evaporator, waste recovery, treatment, storage facilities, and research and development laboratories. The road network is well developed at Hanford with approximately 290 miles (460 km) of roads. Upgrades are planned or underway to support remediation efforts including in the 100 Areas, as hauling wastes and waste site cover material is integral to many of the remediation efforts. Ancillary facilities would be used to support the proposed FRC.

FRC staff and researchers would use existing facilities at PNNL, including offices/laboratories in the Life Science Building (331 Building), the Environmental Molecular Sciences Laboratory, Sigma V Building, the Research Technology Laboratory, the Chemical Engineering Laboratory, and the Plant Growth Facilities.

3.2.12 Environmental Justice

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*.

The Executive Order mandates that each federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Approximately 383,934 people live within a 50-mile (80-km) radius of the Hanford Site. Based on 1990 census data, minorities compose nearly 25 percent of the population.

The distribution of minority populations residing in areas surrounding the Hanford Site is shown in Table 3-2. The table shows minority populations and the racial and ethnic compositions within a 50-mi (80-km) radius of the Site. At the time of 1990 census, Hispanics composed nearly 81 percent of the minority population surrounding the Hanford Site. The Site is also surrounded by a relatively large percentage (about 8 percent) of Native Americans because of the presence of the Yakama Indian Reservation in the vicinity (Neitzel et al. 1999).

Table 3-2. Description of the Populations Surrounding the Hanford Site (1990)

Environmental Justice Parameter	PNNL
Population and Minority Population Statistics	
Population within 50 mi (80 km) of center of Site	383,934
Minority population within 50 mi (80 km) of center of Site	25%
Native American and other race categories	7,913
Asian or Pacific Islander population	5,864
African American population	4,331
Hispanic origin population	76,933
Distribution of Low-Income Households in 50 mi Radius of Site	
Households in counties surrounding the Site	204,501
Low-income households in counties surrounding the Site	86,693
Percent of low-income households in counties surrounding the Site	42%

3.3 No Action

There would be no affected environment under the No Action alternative. No DOE sites would be used for operation of an FRC to conduct basic fundamental bioremediation research.

4.0 ENVIRONMENTAL CONSEQUENCES

This section describes the environmental consequences of the alternatives—the ORNL/Y-12 Site (the preferred alternative), the PNNL/Hanford Site 100-H Area, and No Action. The analyses are based on the type of work and research activities that would be expected to occur on the FRC.

4.1 Oak Ridge National Laboratory/Y-12 Site

4.1.1 Earth Resources

4.1.1.1 Topography

FRC research activities would not change the landscape (e.g., large-area bulldozing, large-scale clearing, and excavation.) Activities to support site characterization, to obtain research-quality samples, and *in situ* research would not impact the general topography of the proposed FRC because of the small-scale nature (less than one acre) of the proposed activities.

4.1.1.2 Geology

The geology of Bear Creek Valley provides a unique opportunity to investigate the physiographic influence of geologic units affecting the movement and containment of contaminants. FRC research activities should provide researchers insight into how the stratigraphy of Bear Creek Valley affects vadose zone contaminants. Because of the small scale of investigations (less than one acre and to a depth of up to 75 feet), no impacts to the large geologic units are anticipated as a result of proposed FRC activities.

When drilling deep boreholes within the FRC, there would be a small potential for downhole migration of shallow contaminants to deeper zones through the borehole annular space. Procedures for preventing this migration, such as installing conductor casing across the unconsolidated zone and sealing with low permeability grout or bentonite prior to drilling to deeper bedrock zones, would be developed and described in the FRC management documents.

4.1.1.3 Soils

Soils within the FRC are previously disturbed and composed of man-made fill, alluvium and colluvium. Proposed FRC activities would disturb these soil types only in areas where drilling, boring, or well installation would occur. Uncontaminated soils would be redistributed around the test plot. Contaminated soils would be disposed of in accordance with site-specific management plans. Soils obtained as research-quality samples would be characterized for potential hazardous contaminants prior to laboratory experimentation. It is estimated that the quantity of soil removed as a result of research activities at a test plot would be small (1.2 cubic feet per bore hole; 10 to 15 bore holes per test plot); therefore, impacts to soils would be minimal.

4.1.2 Climate and Air Quality

ORR/Y-12 emissions are within standards set by the NAAQS for priority pollutants. Additional criteria pollutants generated as a result of small-scale temporary drilling, clearing, or other site development activities would be small and would not cause NAAQS violations. Because ORR/Y-12 is in an attainment area for all criteria pollutants, a conformity determination is not needed.

Drilling and associated sampling actions would not produce significant amounts of fugitive dust. It is expected that these activities would generate much less dust than normal farming practices in the surrounding Oak Ridge area. Because of the large number of existing wells and existing NABIR research support infrastructure at ORNL, it is anticipated that minimal land disturbance would be required.

Operation of the FRC would use standard, construction best management practices to mitigate any airborne releases. Common measures include application of water for dust suppression and to control fugitive emissions during drilling and other activities. It is anticipated that these and other construction/drilling management practices should adequately control fugitive emissions of radionuclides and any other air pollutants.

The release of radiological contaminants into the atmosphere at ORR/Y-12 occurs almost exclusively as a result of Y-12 plant production, maintenance, and waste control activities. In 1997, 46 of the Y-12 Plant's 58 stacks were considered major sources of radionuclide emissions (ORNL 1998). A major source, as defined under National Emissions Standard for Hazardous Air Pollutants (NESHAP) in 40 *CFR* 61, Subpart H, is a stack/vent that contributes more than 0.1 mrem per year to an offsite individual. It is not anticipated that FRC activities would result in additional radiological contaminants being released into the atmosphere. Final project plans would be evaluated for applicability of these best management practices and the requirements of any permits would be complied with if required.

Other substances, which could be released into the air at the FRC, include oxygen, hydrogen, nitrogen, and methane. None of these are regulated under state or federal air regulations. Groundwater collected during the research activities would not be expected to contain pollutants that would volatilize into the air.

No adverse impacts to air quality would be expected from FRC activities.

4.1.3 Water Resources

4.1.3.1 Surface Water

The primary surface water feature of the FRC in BCV is Bear Creek. Bear Creek is supplemented by other small tributaries and springs emanating primarily from the base of Chestnut and Pine Ridges. Surface water and spring samples collected during 1997 show that spring discharges and water in the upper reaches of Bear Creek contain many of the contaminants found in the groundwater.

FRC activities to support site characterizations, obtain research-quality samples, and perform *in situ* research would occur away from all surface waters including Bear Creek. Research generally would take place approximately 100 feet or more from Bear Creek. Research activities would be temporary

and small in scale. Any potential runoff occurring as a result of ground-disturbing activities, coupled with rain events, would be reduced by implementing best management practices such as silt fencing at site-specific research areas within the FRC.

The potential exists that groundwater additives injected as part of *in situ* research at either the background or contaminated areas might pass through groundwater to the surface waters of Bear Creek. As described in Appendix A, small quantities of nontoxic tracers, nutrients, electron donors or acceptors, microorganisms, or other substances might be injected either in the background or contaminated areas of the FRC in accordance with state and federal regulations, best management practices and close monitoring of environmental conditions. While *in situ* research at the background and contaminated areas would provide additional information on groundwater flow paths and the movement of injected materials, sufficient information currently exists to permit estimates of potential impacts from the injection of these materials.

4.1.3.1.1 Tracers

To better understand groundwater flow paths and speed, nontoxic and nonpersistent tracers could be injected in concentrations ranging from less than 500 parts per million (ppm) to 10,000 ppm at both the background and contaminated areas of the proposed FRC. Examples of tracers that might be used include bromide, sodium chloride (NaCl), dyes such as fluorescein or rhodamine WT, noble gases (e.g., neon or helium), sulfur hexafluoride, microspheres, or bacteriophages (i.e., a virus that attacks bacteria.) In some cases, more than one tracer might be injected during the course of a field study. Injections at the background area would not occur in close proximity to Bear Creek (greater than 300 feet); however, because injections at the contaminated area could be as close as 100 feet to Bear Creek, the potential exists for tracers to reach the surface waters of Bear Creek.

At least two different types of tracers have been injected within 100 feet of Bear Creek in the proposed contaminated area within the past few years. In one test, approximately 9 gallons (40 L) of a magnesium bromide tracer was injected into a well that is about 100 feet from Bear Creek at a concentration of 10,000 ppm bromide (Watson and Gu 1998). The maximum concentration of bromide detected in a groundwater seep adjacent to Bear Creek was 0.57 ppm, for a dilution factor of 17,500. In Bear Creek, the dilution factor under dry base flow conditions was 70,000. In addition, the concentration of bromide in the seep returned to background levels within 15 days after the tracer was injected. In a second test, 500 grams of fluorescein dye was added to a 3 grams per liter solution of NaCl. Approximately 2,320 gallons (10,220 L) of the solution was injected into a dry part of the Bear Creek stream bed in an attempt to better understand the groundwater flow paths (Geraghty and Miller 1989). At downstream points in Bear Creek where the dye emerged, no adverse effects on aquatic life were detected. Finally, in a third test, 5 gallons of a 5,000 ppm bromide solution was injected less than 100 feet from the creek. Bromide was not detected above background levels in seeps or in Bear Creek (Watson 1999a). Based on these studies, tracers injected in the contaminated area appear to be greatly diluted, and in at least one case were not detectable in Bear Creek.

Different tracers move and diffuse into the groundwater at different rates. Therefore, the use of more than one tracer at the same time provides additional information about the subsurface than would be possible with only one tracer. The use of multiple tracers at one time would not be expected to result in an increased possibility that any of the tracers would reach Bear Creek. Multiple tracers have been used at another field site on the Oak Ridge Reservation. The results of this study suggest not only that the movement of one tracer is not affected by another, but that all of the tracers become diluted very quickly (Jardine et al. 1999a). Similarly, the use of multiple tracers at the contaminated area would be

expected to result in movement and diffusion profiles for each tracer consistent with their individual movement and diffusion profiles.

Tracer concentrations would not be expected to exceed 10,000 ppm. This, coupled with the apparent high degree of dilution (matrix diffusion) of tracers in the groundwater of the contaminated area, and the lack of adverse environmental impacts to aquatic resources from much higher levels of a tracer, suggests that no environmental impacts would be expected from the injection of tracers. Further information on the proposed use of groundwater tracers at the FRC is available in Appendix A.

4.1.3.1.2 Electron Donors and Acceptors and Other Nutrients

To stimulate the activity and growth of microorganisms, electron donors or acceptors or other nutrients could be injected in concentrations ranging from 100 ppm to 1,000 ppm (i.e., 100 mg/L to 1,000 mg/L) at both the background and contaminated areas of the proposed FRC. Examples of electron donors that might be used include acetate, glucose, lactate, pyruvate, molasses, or biomass remnants (e.g., yeasts). Examples of electron acceptors that might be used include oxygen, nitrate, methane or sulfate. Other nutrients might include nitrogen and phosphorus. Injections at the background area would not occur in close proximity (within 300 feet) to Bear Creek. However, because injections at the contaminated area could be as close as 100 feet to Bear Creek, the potential exists for electron donors, electron acceptors, and nutrients to reach the surface waters of Bear Creek. Should they reach Bear Creek in sufficient concentration, they could stimulate microbial populations in the vicinity of the point of entry.

While there have been no direct injections of electron donors or acceptors, or nutrients at either the background or contaminated areas, there has been an addition of an electron donor (specifically a carbon source) to the subsurface in the contaminated area. During construction of one of the two permeable reactive barriers in the contaminated area, approximately 80,000 gallons of a guar gum biopolymer slurry was pumped into the trench to keep the side walls from collapsing. Once the construction effort was completed, an enzyme was added to the subsurface to break down the guar gum. This resulted in an extremely large source of carbon for the subsurface microbial community and a source that also moved with the groundwater and seeped into Bear Creek (Watson and Gu 1999). Guar gum entering the creek formed a sheen that extended less than 100 feet downstream. In addition, there was a strong sulfur smell (due to the growth of sulfate-reducing bacteria) that lasted for several months. However, no long-term ecological impacts were observed in Bear Creek from this discharge (Watson 1999b). While this situation suggests that at sufficient concentration electron donors could reach Bear Creek, the amount of electron donors that might be added at the contaminated area would be thousands of times less than the amounts that were added in this situation (Watson 1999b).

More typical of the amount of electron donors that might be added to the contaminated area would be the amounts used in a recent field study at a contaminated site in Schoolcraft, Michigan (Dybas et al. 1997). In the Schoolcraft study, both acetate and microorganisms were added to a sandy aquifer to degrade carbon tetrachloride. Initial acetate concentrations were 100 ppm, but subsequent analyses indicated that only 50 ppm was sufficient to degrade the carbon tetrachloride. Based on data collected from downstream monitoring wells, acetate concentrations were at background within about three feet (three meters) of the injection well. Therefore, it appears that the bacteria used the acetate as a carbon source while degrading the carbon tetrachloride, and that the acetate was completely used up within about three feet of the injection point (Criddle 1999a).

There was a possibility that the microbial community (the mix of species of microorganisms in a given volume of the sediment) might be permanently altered, or that the effect of the additions might extend some great distance from the injection point. To study this, the scientists involved in the Schoolcraft study have been monitoring conditions in downstream wells for almost two years. While changes have been detected in microbial communities downstream from the injection well, these changes appeared only up to a distance of about three feet from the injection well and they have been stable for almost two years (Criddle 1999b). In addition, it appears that as the concentration of the acetate decreases with distance from the injection point, the microbial community appears to return to the original community. The phenomena of localized changes to the microbial community apparently is not that unusual. Two recent studies at two different field sites likewise discuss shifts in the mix of species present in contaminated soils and groundwater from that present in nearby uncontaminated areas (Konopka et al. 1999, Rooney-Varga et al. 1999). In both studies, changes in the microbial community were again attributable only to the presence of contamination (i.e., the contaminant or nutrient addition had to be present to result in changes in the microbial community). Taken together, these studies suggest that when nutrients or contaminants are "added" to the subsurface, the microbial community structure changes, but the changes are localized and occur only in the presence of the addition (i.e., a carbon source, a contaminant, etc.)

Injection of electron donors or acceptors or nutrients into the contaminated area would be at levels more consistent with those used at the Schoolcraft site rather than the levels encountered during the guar gum situation. For example, as part of another program, ORNL scientists are planning to inject less than 700 ppm of lactate (an electron donor) to stimulate the microbial community in another field site on the Oak Ridge Reservation to examine whether cobalt contamination can be mitigated (Jardine 1999b; Brooks et al. 1999). Another reason for injecting only low levels of electron donors or acceptors or nutrients is that at high concentrations, the injection of electron donors or acceptors or nutrients could overstimulate microbial reproduction and result in well clogging. Consistent with the findings from the Schoolcraft study, electron donors or acceptors or nutrients injected into the contaminated area would not be expected to migrate the minimum 100 feet to Bear Creek. Rather, they would be used by native microorganisms and would be undetectable within 25 feet of the injection point. Further information on the proposed use of electron donors and acceptors and nutrients at the FRC is available in Appendix A.

4.1.3.1.3 Microorganisms

To determine whether it might be feasible to add microorganisms to a contaminated subsurface environment, a small quantity (2×10^7 colony forming units per ml [cfu/ml]) of native or non-native microorganisms could be injected into the background and contaminated areas of the proposed FRC. Native microorganisms would be isolated from the contaminated area and then reinjected. Reinjection of native microorganisms would not be expected to be of concern either at the background or contaminated area. Non-native (but not genetically engineered) microorganisms might be obtained from some other field site, but then injected at both the contaminated and background areas. For the non-native microorganisms, a possible consequence of injecting these microorganisms would be the possible movement of the non-native bacteria through the groundwater to Bear Creek.

Because no injections of bacteria have been undertaken either at the background or contaminated areas of the proposed FRC, or on the Oak Ridge Reservation, it is difficult to speculate how far non-native microorganisms might move either in the background or contaminated areas. However, there have been a number of recent field site remediation studies involving the injection of non-native microorganisms into a variety of geologically different, and contaminant-specific, subsurface

environments (Bourquin et al. 1997, Dybas et al. 1997, Stefan et al 1999). Results from these studies could be extrapolated to the background and contaminated areas of the proposed FRC.

Non-native bacteria (10^9 cells/mL) were injected into a sandy groundwater aquifer at a contaminated site in Wichita, Kansas on two separate occasions (Bourquin et al. 1997). In the first instance, bacteria only were injected. Just 0.005% of the injected bacteria were recovered in an extraction well that was less than one foot (30 centimeters) away. Even though this was a sandy aquifer, the bacteria hardly moved. In the second instance, glucose and other nutrients were added along with the bacteria in a pulsed mode. The bacteria moved only slightly farther than in the first test. Overall, the results suggest that 98% of the bacteria injected moved less than one inch (two centimeters) from the point of injection (Reardon 1999). A second study involving the injection of a non-native strain into a sandy aquifer at Schoolcraft, Michigan, has already been described in section 4.1.3.1.2 (Dybas et al. 1997). The results suggest that non-native bacteria do not move great distances, most likely because the carbon source (acetate) concentrations decrease to background within a few yards. Both of these studies suggest very limited movement of microorganisms in sandy aquifers.

In contrast, a third study involved the injection of a non-native strain of bacteria (at 1×10^{11} cfu/ml) along with oxygen into a contaminated silty sand aquifer in Pennsauken, New Jersey. The bacteria were found to move as much as 65 feet in 20 days (Stefan et al. 1999). For this site, movement was needed to get dispersal of the bacteria to large parts of the contaminated area; in fact, the strain of bacteria used was specifically selected because it did not adhere to aquifer solids. Yet, in spite of the adhesion-deficient character of this strain of bacteria, most of the bacteria remained concentrated near the injection well.

The studies cited suggest that non-native microorganisms that would be used at the contaminated area would not move any great distance from the point of injection unless they were adhesion-deficient. Even so, the highest concentrations of microorganisms would be expected to remain near the injection well. Finally, the concentrations of microorganisms used in all of these studies and the amounts injected were used in attempts to achieve site remediation. Because site-remediation experiments at the contaminated area are not part of this action, the concentrations and amounts of microorganisms that would be injected would be much less than in these studies. Taken together, non-native microorganisms would not be expected to reach Bear Creek. Further information on the proposed use of microorganisms at the FRC is available in Appendix A.

4.1.3.1.4 Other Substances

Two classes of other substances that could be injected at the background or contaminated areas are biosurfactants and chelators. To examine the influence of surfactants produced by certain microorganisms (biosurfactants) on contaminant characteristics and on the microbial community, biosurfactants could be injected. Biosurfactants would include rhamnolipids, polysulfonates, and polyalcohols.

The injection of a biosurfactant either into the background or the contaminated areas might be conducted to examine the influence of the biosurfactant on native microorganisms, on the interactions between native microorganisms and the contaminants, or for other reasons. Because biosurfactants are biodegradable, they would not be expected to be persistent if injected, and they would be degraded within a short distance of the injection point.

To investigate the mobilization and immobilization of metals and radionuclides, chelators could be injected in the background and contaminated areas. Typical chelators would include

ethylenediaminetetracetic acid (EDTA), nitrilotriacetic acid (NTA), Natural Organic Matter such as humics, or quinones. Injection concentrations would be expected to range from 100 ppm to 1,000 ppm, although most injections would be at the lower concentrations. Movement of these substances through the aquifer to Bear Creek should be considered.

Metals and radionuclides would be expected to complex more readily with chelators than with aquifer solids, and the resulting metal or radionuclide/chelate complexes would therefore become more mobile in the groundwater. However, results from an on-going study at another field site on the Oak Ridge Reservation suggest that at least for some radionuclide/chelate complexes, sediment minerals outcompete the chelator and complex with the radionuclide (Jardine et al. 1999b). The study was conducted at a field site with geologic and chemical characteristics that are similar to those at the contaminated area. In this study, injected radionuclide/chelate complexes were dissociated within 60 feet of the injection point and the radionuclides were attenuated by the sediments. The results suggest that radionuclide/chelate complexes that might be injected at the contaminated area might not remain as complexes (and thereby promote mobilization), but that they might be broken apart such that the radionuclide would be immobilized after a short distance and would not reach Bear Creek.

4.1.3.2 Floodplain and Wetlands

Bear Creek traverses the length of the proposed FRC. Thus, it includes associated sections of the 100-year floodplain. In 1993, DOE published a "Notice of Floodplain/Wetlands Involvement for Environmental Restoration and Waste Management Activities at the DOE's Oak Ridge Reservation; Oak Ridge, TN, (58 FR 51624)." In 1996, the "Floodplain Assessment for Site Investigation Activities at the Oak Ridge Y-12 Area of Responsibility" (DOE 1993) was published. The assessment addressed general construction, sample collection, and environmental monitoring. In addition, the assessment considered both intrusive and nonintrusive activities. On March 3, 1997, DOE issued a "Floodplain Statement of Findings for Site Investigation Activities at the Oak Ridge Y-12 Plant Area of Responsibility." The Statement of Findings states, "Most of the activities addressed by the floodplain assessment will result in no measurable impact of floodplain cross-sections or flood stage, and thus do not increase the risk of flooding." The activities proposed for the FRC fall within the terms of the Notice of Floodplain and Wetlands Involvement. The Notice of Involvement, a summary of the Floodplain Assessment, and the Statement of Findings are included in Appendix D.

The only FRC activities expected to occur within floodplain areas would be well drilling and monitoring (e.g., installation of piezometers). Typical installations of wells or piezometers, using for example, 2 foot by 6 inch (0.41 meter by 15.24 centimeter) diameter protective casing and 4 foot by 3 inch (0.82 meter by 7.62 centimeter) diameter bollards with a concrete pad 3 inches high and 2 feet long (7.62 centimeters by .41 meters) may reduce the cross-sectional area of the floodplain by 1.64 square feet (.5 square meters). This reduction in volume of even several wells would be negligible within the total cross-sectional area of the floodplain. Well and piezometer construction therefore, would have a negligible impact on the floodplain. The well pads would minimize the erosion potential of the wells and bollards.

Procedures for preventing migration of contaminants down boreholes would be developed and described in the FRC management documents. These procedures would include sealing the upper few feet of shallow boreholes with low permeability bentonite or grout and installing conductor casing across the unconsolidated zone and sealing with grout or bentonite prior to drilling to deeper bedrock zones.

At the appropriate time, wells would be plugged (backfilled with clean soils) and abandoned. Well plugging and abandonment would result in the removal of surface structures (e.g. wellheads) and restoration of the former grade. This activity would have little impact on floodstage or floodplain cross-sectional area, nor would there be an increase in erosional potential since the wellhead and other surface equipment would be removed and the site restored to the original grade.

No structures or facilities would be constructed in the floodplain. Movement of heavy equipment through the floodplain would be a temporary occurrence and would not impact the capacity of the floodplain to store or carry water. The impacts from the movement of heavy equipment alone is expected to be negligible. To the extent practicable, staging areas and access roads would be temporary, construction would be limited to periods of low precipitation, and stabilization and restoration of the affected areas would be initiated promptly.

Wetlands are interspersed throughout the proposed FRC. Many are often small and are classified as palustrine forested, shrub-scrub, or emergent wetland types (Cowardin et al. 1979). Because FRC research would take place on small test plots (less than one acre), it is anticipated that any wetlands found in proposed selected research areas could be avoided. In addition, the limited ground-disturbing activities associated with FRC research should preclude damage to adjacent wetlands that might be in proximity to selected research areas. The U.S. Army Corps of Engineers (USACOE) and TDEC have regulatory responsibility for wetland management and for mitigation of impacted resources. FRC management would consult with USACOE and TDEC if the potential for impacts to wetlands would occur.

4.1.3.3 Groundwater

The primary geologic units of interest in the proposed FRC are the Nolichucky Shale (low permeability) and Maynardville Limestone (high permeability). The flow of shallow interval groundwater (up to 100 feet) in the limestone occurs through a system of interconnected fractures and solution conduits and cavities. Most groundwater flow in the shale formation occurs in the shallow interval and is oriented along geological strike and is very predictable. The shallow interval groundwater in both geologic units discharges to Bear Creek or its tributaries. Any additives to the groundwater introduced as a result of FRC research activities (e.g., nontoxic chemical tracers, nutrients, or microbes) might also reach surface water including Bear Creek. It is estimated that groundwater flow rates are as much as seven feet in 24 hours. Fate-and-effect information would be determined prior to initiation of FRC applications that include groundwater additives. Permeable reactive barriers have been constructed and installed by DOE EM-40 parallel and adjacent to Bear Creek. For some FRC studies in the vicinity of these barriers it might be possible to use the barriers to contain FRC groundwater additives.

The primary sources of groundwater contamination within the proposed FRC are the S-3 Disposal Ponds and the Boneyard/Burnyard (BY/BY). Both source areas are underlain by Nolichucky Shale. Contaminants within the proposed contaminated area include heavy metals, radionuclides, VOCs, and inorganics. The primary purpose of FRC activities would be to investigate these contaminants *in situ*, thus attempting to prevent the migration of contaminants offsite. Consequently, a possible net positive impact to groundwater is anticipated.

When drilling boreholes for the FRC, there would be a small potential for downhole migration of shallow contaminants to deeper zones. Procedures for minimizing migration of contaminants during drilling and abandonment of boreholes and wells would be developed and described in the FRC management documents. These procedures would include sealing the upper few feet of

shallow boreholes with low permeability bentonite or grout and installing conductor casing across the unconsolidated zone and sealing with grout or bentonite prior to drilling to deeper bedrock zones.

Groundwater pumping activities at an FRC test plot (e.g., pump/slug and other pumping tests, and tracer experiments) would not collect more than 20,000 gallons (76,000 L) of groundwater per year. In years when long-term pumping tests were not performed, less than 2,000 gallons (7,600 L) of groundwater would be collected. Similar volumes would be collected at the background site. Contaminated groundwater would be collected in 55-gallon drums or other suitable containers. Tanker trucks with 10,000- to 20,000-gallon (38,000- to 76,000-L) capacity could also be used during long-term pumping tests with contaminated groundwater being transported to the nearby Y-12 West End Treatment Facility (WETF). The state also might allow discharge of contaminated water to infiltration basins as long as there would be no direct discharge to Bear Creek. In this case, treatment would be deferred to final cleanup under CERCLA. Clean groundwater collected from the background site would be released to the ground.

As described in Section 4.1.3.1, the introduction of nontoxic tracers, nutrients, electron donors and acceptors, microorganisms and other substances might have a local effect (several meters) on groundwater characteristics, but the overall groundwater quality and flow within Bear Creek Valley would not be affected. Any purged groundwater from drilling operations or well clean-out would be collected and disposed of as previously described.

Injection of small quantities of tracers, electron donors and acceptors and nutrients, microorganisms and other substances into the groundwater is part of the proposed action. Sufficient information already exists to permit estimates of the potential impacts of the injection of these materials into the groundwater.

4.1.3.3.1 Tracers

As described in Section 4.1.3.1.1, to better understand groundwater flow paths and speed, nontoxic and non-persistent tracers could be injected in concentrations ranging from 500 parts per million (ppm) to 10,000 ppm at both the background and contaminated areas of the proposed FRC. Worth considering would be potential alterations in the groundwater chemistry from the injection of tracers in both the background and contaminated areas.

For most studies at both the background and contaminated areas, the tracers that would be used would be non-reactive. That is, the chemical structure of the tracer that would be injected would be the same structure as the chemical that would be extracted in downstream wells. It is possible that reactive tracers such as bacteriophages or microspheres might be injected into both the background and contaminated areas. While these reactive tracers would be non-toxic, they could stick to mineral particles, colloids suspended in the groundwater, bacteria, and possibly even contaminants if injected into the contaminated area. However, because of the low-concentrations and limited amounts that would be injected, changes to the groundwater chemistry would be expected to be localized to 30 or 40 feet from the injection point. Due to the apparent dilution processes operating in the subsurface at the background and contaminated areas, as described in Section 4.1.3.1.1, greater degrees of change to the groundwater chemistry would be expected close to the injection point, but these changes would drop off with distance from the injection point.

4.1.3.3.2 Electron Donors and Acceptors and Nutrients

As discussed in Section 4.1.3.1.2, to stimulate the activity and growth of microorganisms, electron donors or acceptors or other nutrients might be injected in concentrations ranging from 100 ppm to 1,000 ppm (i.e., 100 mg/L to 1,000 mg/L) at both the background and contaminated areas. Because of the addition of electron donors and acceptors or nutrients, it is possible that the groundwater chemistry might be directly or persistently changed, or that certain species of microorganisms might be stimulated to cause changes to the groundwater chemistry.

It is possible that there may be some localized changes in the groundwater chemistry of the background and contaminated areas due to the addition of electron donors or acceptors or nutrients. However, in light of the small quantities that might be added, and in light of the expectation that native microorganisms would use these electron donors or acceptors or nutrients fairly quickly, there should not be any sustained impact to the groundwater chemistry. Worth considering would be the impact from the injection of electron donors or acceptors or nutrients into the contaminated area. In this case, a change in groundwater chemistry could conceivably lead to a permanent change in the microbial community, or to the unwanted mobilization of a contaminant.

Again, there have been no direct injections of electron donors or acceptors, or nutrients at the contaminated area. However, the addition of an electron donor (guar gum) during the construction of the two permeable reactive barriers serves as a good example of what consequences might be expected (Watson and Gu 1999). As described in Section 4.1.3.1.2, the degradation of guar gum by subsurface microorganisms resulted in a strong sulfur smell along Bear Creek. Because the sulfur smell lessened and disappeared within a few months, it is most likely that the microbial populations involved in degrading the guar gum died out because they no longer had a food source. The reduction in smell thereby suggests that the microbial populations returned to their pre-exposure community structure. As for the possible mobilization of a contaminant in that area, contaminant concentrations were lower in wells downstream from the guar gum "plume" (Watson and Gu 1999).

4.1.3.3.3 Microorganisms

To determine whether adding microorganisms to a contaminated subsurface environment would impact contaminant mobility, a small quantity (2×10^7 cfu/ml) of native or non-native microorganisms might be injected into the background and contaminated areas of the proposed FRC. Native microorganisms would most likely be strains that would be isolated from the contaminated area and reinjected. Non-native (but not genetically engineered) microorganisms might be obtained from some other field site, but then injected at one or both the contaminated and background areas. For the non-native microorganisms, a possible consequence of injecting these microorganisms would be a possible, very localized permanent shift in the microbial community to one dominated by the non-native microorganism, or a possible permanent change in the groundwater chemistry. These possible changes would be limited to a few feet from the injection point.

As discussed in section 4.1.3.1.3, at the low injection concentrations that would be used, the microorganisms would not be expected to be present in a large area of the groundwater, and therefore they would be unlikely to change the groundwater chemistry of large areas.

4.1.3.3.4 Other Substances

As discussed in Section 4.1.3.1.3, two classes of other substances that might be injected at the background or contaminated areas are biosurfactants and chelators. Again, injection concentrations

would be expected to range from 100 ppm to 1,000 ppm, although most injections would be at the lower concentrations.

Based on the discussion of the results from work at another Oak Ridge Reservation field site, as presented in Section 4.1.3.1.3, it does not appear that injection of chelators would significantly affect the groundwater characteristics of the contaminated area (Jardine et al. 1999). Chelators would not be added to the background area.

Also, as discussed in Section 4.1.3.1.3, the injection of biosurfactants in the background and contaminated areas would not be expected to affect a large area of the subsurface or be persistent. For these reasons, no large effect on groundwater would be anticipated.

4.1.4 Ecological Resources

Ecological resources evaluated for impacts include sensitive terrestrial and aquatic species, protected natural areas, and managed wildlife resources. These resources are discussed in the following paragraphs.

4.1.4.1 Terrestrial Resources

As described in Section 3.0, the proposed contaminated area and background area would be located within 200 acres of the BCV. However, because of the type of research preferred, only small portions of the FRC would be utilized. It is estimated that most research actions would have a footprint of less than one acre and likely would be situated in areas in which site clearing has occurred or past construction activities have already changed the predominant landscape. As a result, it is anticipated that few terrestrial resources would be impacted by FRC-related activities. In the event that previously unknown sensitive resources were discovered during FRC planning activities (e.g., site plan evaluations or site design construction), efforts to avoid impacts would be conducted and specific research sites would be moved away from sensitive resources.

As described in Appendix E, the U.S. Fish and Wildlife Service has indicated two federally listed endangered species, the gray bat (*Myotis grisescens*) and the Indiana bat (*Myotis sodalis*), may inhabit an area near the proposed FRC. Mistnetting has been conducted specifically for bats in the East Fork Poplar Creek basin (ORR personal communication). According to information provided by ORNL and Dr. Michael J. Harvey of Tennessee Technological University in Cookeville, Tennessee, significant mistnetting efforts were conducted in the East Fork Poplar Creek watershed, including Bear Creek, in 1992 and 1997. The 1997 efforts resulted in the collection of 14 bats representing six species. No Indiana bats or gray bats were captured in the 1997 efforts. The 1992 efforts were not as extensive as those in 1997, and four bats representing two species were collected. It was noted in both surveys that significant potential habitat for the Indiana bat existed in the East Fork Poplar Creek watershed. An Indiana bat was collected on the ORR in the 1950s, and survey efforts on the ORR have not been extensive enough to definitely establish or refute current use by this species.

In 1994, a moribund gray bat was found in the Beta-3 building of the Y-12 complex, near areas proposed for siting of the FRC. The specimen was identified by researchers at the University of Tennessee and submitted to the U.S. Fish and Wildlife Service. The condition of this juvenile specimen indicated it may have utilized the building as roosting habitat. Other suitable buildings on the ORR may also serve as roosting habitat for a variety of bat species. Little Turtle Cave, located on the ORR near the Y-12 plant, was surveyed by the Tennessee Department of Environment and

Conservation in 1996. Ten male gray bats were found in the cave and it was determined that the cave could serve as a hibernaculum for a bachelor colony.

In February 2000, Oak Ridge National Laboratory completed an Assessment and Evaluation of Potential Roosting and Foraging Habitats for the gray and Indiana bats (Appendix G.). The assessment was conducted in the BCV watershed, the location of the proposed FRC. The assessment did not include the EFPC watershed because the FRC would not be located or have an impact on the EFPC watershed. The assessment concluded that the proposed FRC would not adversely affect either bat species. Also, since no proposed or designated critical habitats are present on the site, none would be affected. The Fish and Wildlife Service concurred with this conclusion in a letter dated February 10, 2000 (Appendix E).

Within the contaminated area and background area, no other threatened or endangered species or critical habitat listed, or proposed to be listed, by the Fish and Wildlife Service is known to be present. In the event that a rare or sensitive species were identified during FRC planning activities, every effort to adjust specific research sites out of any area of concern would be made. NABIR would have the flexibility of adjusting field activities to new locations to allow for the protection of potentially sensitive habitats.

The entire length of Bear Creek, from its beginning within the proposed contaminated area through the background area, is designated an Aquatic Natural Area. In addition, much of the land adjacent to the proposed contaminated area and background area has been designated part of the Oak Ridge National Environmental Research Park (NERP). A portion of the proposed contaminated area (the Y-12 area) and the entire background area is contained within the NERP. Activities needed to support site characterizations, to obtain research-quality samples, and *in situ* research would not impact or interfere with these designated areas. Any ongoing research projects in areas considered part of the National Environmental Research Area or Reference Area would be avoided.

ORNL manages much of its land for game species including land within the proposed contaminated area and background area. As such, portions of these areas are utilized during hunting seasons. Efforts would be made to limit FRC activities during seasonal hunting periods. In addition, specific FRC field research areas would not be placed in areas popular with hunters. As a result, no impacts to managed wildlife resources would be anticipated.

4.1.4.2 Aquatic Resources

Much of the proposed contaminated area and background area are situated either within the riparian zone of Bear Creek or adjacent to it. Bear Creek has been quantitatively monitored and has been designated as having a degraded fish community especially in headwater locations. Most of the proposed contaminated area and background area are located at the headwaters of Bear Creek. Several minnow species were determined to be the predominant fish species in these upstream portions of Bear Creek and are indicative of a low species diversity (Southworth et al. 1992, Hinzman et al. 1995). Benthic invertebrate fauna collections show a similar pattern with a diverse benthic fauna well established at downstream locations (outside the proposed FRC) and a depauperate benthic community within the proposed contaminated area and background area adjacent to Bear Creek.

Recent research has indicated an improvement in species diversity within the upper reaches of Bear Creek; however, the fish population is still considered impaired. The Tennessee dace, a minnow, is listed by the Tennessee Wildlife Resource Agency as a sensitive species in need of management, and is the only sensitive species likely to be encountered in the proposed FRC study area. The dace was

found at all sites including those at the headwaters of Bear Creek. As described in Section 4.1.3.1, the small scale of disturbance required to conduct FRC research within the contaminated area and background area, and the limited quantities of materials that would be injected should preclude any potential for impact. In addition, permeable reactive barriers have been constructed and installed by DOE Environmental Management parallel and adjacent to Bear Creek in the proposed contaminated area. For some FRC studies in the vicinity of these barriers it might be possible to use the barriers to contain FRC groundwater additives.

While it is not anticipated that FRC-related activities would have any impact on aquatic resources, the sensitive status of the Tennessee dace in Bear Creek makes it likely that additional measures to protect the species might be required if a specific research plot is chosen in proximity to Bear Creek. Any such additional measures would be determined and documented during the project's environmental review process. Other evaluation could include conducting monitoring activities to determine the pre-existing condition of specific reaches of Bear Creek in proximity to selected research plots. Periodic monitoring by ORNL of aquatic and benthic resources within adjacent reaches might be conducted to determine if FRC activities would result in impact to the Tennessee dace or its forage base.

4.1.5 Archaeological, Cultural, and Historic Resources

According to the Tennessee State Historic Preservation Officer, no cultural resources have been identified within the proposed contaminated area and background area (Appendix E). Several historic sites exist in proximity to the proposed FRC but none are located within its boundaries. Because the scale of potential disturbance would be small (less than one acre) and research would take place in previously disturbed areas, it is unlikely that previously unknown historic resources would be discovered during activities needed to support site characterizations, to obtain research-quality samples, or *in situ* research. If in the course of conducting FRC activities, archaeological, cultural, or prehistoric resources were discovered, the state historic preservation office would be notified and measures would be initiated to eliminate impact.

4.1.6 Land Use, Recreation, and Aesthetic Resources

The proposed contaminated area and background area lie entirely within the Bear Creek Valley at ORNL. Land uses within the BCV include developed areas such as those near the Y-12 plant, the S-3 Ponds Site, waste control areas that are open and highly visible, and closed forested areas that are part of the Y-12 reservation. While there may be hunting activities in these areas several times during the year, access is restricted.

New facilities that would be needed include two field office/laboratory trailers—one to be located at the contaminated area and one at the background area. The only intrusion expected to impact existing land uses would be the placement of the trailers to support activities near the location of discrete research areas within the FRC. In all cases, the trailer would be part of an already developed area and would be compatible with the immediate surroundings. In the background area, some clearing would need to be done to place a trailer in proximity to the research areas. However, every effort would be made to locate the trailer in an area that has been previously disturbed (e.g., powerline right of way or past area of research). Activities undertaken to support site characterizations, obtain research-quality samples, and conduct *in situ* research might result in short-term impacts to visual aesthetic resources, especially during the site characterization phase of research. Drill rigs, an increase in site personnel, and support vehicles might be needed.

Recreational uses in the area surrounding the ORR include fishing, boating, hunting, hiking, and camping. Access to the ORR is controlled, and recreational uses within ORR are limited to controlled hunts during certain seasons. Within the proposed contaminated area and background area, deer and turkey hunts are held annually except in areas immediately adjacent to the Y-12 plant and its disposal areas in Bear Creek Valley. Because these seasonal activities are scheduled well in advance, FRC management would plan to minimize activities during hunting seasons to avoid the potential for impact.

Visual/aesthetic resources range from relatively closed forests to developed areas that include waste control areas and storage yards for scrap metal and other materials. The only visual intrusions anticipated as a result of implementation of FRC research would be the placement of two support trailers and the temporary placement of drilling rigs and other equipment near specific research sites in the proposed contaminated area and background area. Efforts would be made to locate trailers and equipment in areas previously disturbed to limit the potential for visual intrusion. No impacts are expected from FRC activities.

4.1.7 Socioeconomic Impacts

As stated in Section 3.1.7, the labor force in the four county area in 1998 was 280,190. The work force for the proposed FRC is anticipated to be small: possibly a staff of up to six individuals, some of whom would be part-time employees of the FRC. Researchers from ORNL, other national laboratories, universities, and other research institutions would visit the proposed FRC to conduct experiments and collect samples. The numbers of visitors at any one time would be small, but could be as many as 24 on occasion. Visiting staff and scientists would contribute in a beneficial manner to the local economy by staying in local hotels and using local services. There would be no negative impact to the socioeconomics of the Oak Ridge area as a result of FRC activities.

4.1.8 Human Health

As described in Appendix C, ORNL would develop an overall Management Plan for the FRC that would explain the goals and objectives of the FRC, roles and responsibilities of FRC staff, procedures for investigators to follow, and procedures for storage of material and waste disposal. To address potential ES&H issues associated with human health and environmental protection, ORNL would also develop the following plans:

- an action-specific health and safety plan detailing potential pathways of exposure and best management practices to reduce those hazards;
- a characterization and waste control plan;
- a contingency plan to address offsite migration of any nutrients or other chemicals used in conjunction with NABIR research activities; and
- a site closure plan.

Although important for operating the proposed FRC, this EA seeks to evaluate potential impacts to human health and the environment prior to selecting the FRC. For purposes of this evaluation, health and safety issues to be evaluated include:

- exposure to contaminated soils and groundwater,
- occupational hazards associated with a drilling/construction site, and
- hazards associated with accidental releases of stored liquid chemicals or materials.

4.1.8.1 Exposure to Contaminated Soils and Groundwater

There are two primary human health issues associated with exposure to contaminated soils and groundwater from the contaminated area at ORNL. The first issue is potential radiation exposure from groundwater and soils/sediments with radioactive contaminants. The second issue is potential chemical toxicity of the contaminants that may be in groundwater and soils/sediments from the contaminated area.

Because of the proposed nature of operation, potential exposures could occur during drilling and sampling operations in the contaminated area and/or in the processing and analysis of samples obtained from the contaminated area. Such exposures could be to FRC staff or to scientists. To mitigate these potential exposures, a combination of personal protective equipment, personnel training, physical design features, and other controls (e.g., limiting exposure times) would be required to ensure that worker and visitor protection would be maintained for all proposed FRC-related activities. In addition, OSHA regulations that pertain to construction and well installation would be adhered to in all situations.

For the majority of scientists, potential exposures would be from samples obtained from the contaminated area and would occur while they performed sample processing or analyses. For scientists and FRC staff, who would be involved with drilling and sampling operations, potential exposures would be from accidents associated with drilling and sampling operations in the contaminated area.

Title 10, *CFR*, Part 835, "Occupational Radiation Protection," establishes radiation protection standards, limits, and program requirements for protecting workers and the general public from ionizing radiation resulting from the conduct of DOE activities. For workers, 10 *CFR* 835 requires a 5-rem per year dose limit. For the general public, 10 *CFR* 835 requires a 100 millirem (mrem) per year dose limit. In addition, it requires that measures be taken to maintain radiation exposure as low as reasonably achievable. The 5-rem dose limit would be applicable to FRC staff and those involved in drilling and sampling operations in the contaminated area. The 100 mrem dose limit would be applicable to scientists who process or analyze both soil/sediment and groundwater samples from the contaminated area.

For purposes of this EA, the maximum allowable exposure to FRC staff was assumed to be 100 mrem per year. In addition, because potential exposures most likely would be during drilling and sampling operations, the following analysis of potential doses was assumed to be for hypothetical workers involved in drilling and sampling operations.

Doses to workers were bounded by evaluating a "bounding analysis" scenario, in the absence of any existing data on worker doses for this kind of work in the field. Workers were assumed to spill small amounts of soil/sediment (1 gram of contaminated soil/sediment five times per year for a total of 5 grams) or groundwater (1 milliliter of contaminated groundwater five times per year for a total of 5 milliliters) on themselves during the course of sample extraction and processing. To maximize the

potential dose, it was further assumed that the workers did not wash off the contamination, but actually ingested it.

Radionuclide ingestion was calculated from the average measured activity values for U-233, U-235, U-238, Pu-238 and Pu-239 in soil and groundwater (see Table 4-1). The measured data in Table 4.1 were obtained from the Remedial Investigation report for Bear Creek Valley (DOE 1997a). Totals were based on a yearly consumption of 5 grams of soil/sediment and 5 milliliters of groundwater. Dose factors for the Committed Effective Dose Equivalent were taken from the EPA report, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion, Federal Guidance Report No. 11" (EPA-5201/1-88-020), published in September 1988.

For the soil/sediment ingestion pathway, the total dose (for all radionuclides) came to less than 0.01 mrem/year, which is 10,000 times less than the limit of 100 mrem/year allowed for members of the public under 10 *CFR* 835, Section 208. The groundwater ingestion pathway is three times smaller, with a total dose of approximately 0.003 mrem/year.

To estimate the total potential risk to workers from this "bounding analysis" exposure scenario, it was further assumed that the workers were exposed during the entire life of the project, which is ten years. The combined annual dose from both the soil and groundwater ingestion pathways was 1.26E-02 mrem per year (9.47E-03 + 3.09E-03). Over the ten-year lifetime of the project, the total dose was ten times that amount, or 1.26E-01 mrem. The lifetime fatal cancer risk is calculated by multiplying this ten-year dose by the dose-to-risk conversion factor of 4E-04 deaths per person-rem (NRC 1991). This calculation yields a lifetime risk of 6.28E-08, or roughly six in 100 million.

Table 4-1 Human Health Exposure Rates

Soil Ingestion (5 g/y)					Groundwater Ingestion (5 ml/y)			
Radionuclide	mrem/ pCi	pCi/g (avg)	Total pCi	mrem/y		pCi/l (avg)	Total pCi	mrem/y
U-233	2.89E-04	2.1	10.5	3.03E-03		660	3.3	9.54E-04
U-235	2.66E-04	0.12	0.6	1.60E-04		68.8	0.344	9.15E-05
U-238	2.55E-04	4.6	23	5.87E-03		1601	8.005	2.04E-03
Pu-238	3.20E-03	0.02	0.1	3.20E-04		0	0	0.00E+00
Pu-239	3.54E-03	0.005	0.025	8.85E-05		0	0	0.00E+00
			TOTAL:	9.47E-03			TOTAL:	3.09E-03

Although radioactive exposure would not be a problem, the potential chemical toxicity of the contaminants in the soils/sediments and groundwater from the proposed contaminated area also needs to be considered. Because the proposed contaminated area would be within a CERCLA site, contaminant concentrations are evaluated according to CERCLA standards. Based on the recent Remedial Investigation (RI) of Bear Creek Valley, the concentrations of a variety of radioactive and organic contaminants and other groundwater constituents within the contaminated area are of regulatory concern (DOE 1997a). Examples include lead, strontium, uranium, nitrate, acetone, and trichloroethylene.

Not all of these contaminants of concern are present in all existing wells within the contaminated area. However, they are found often enough to warrant caution and protection from exposure. For example, lead has been detected in 61 out of 82 wells within the Bear Creek Valley, and trichloroethylene (TCE) has been detected in 57 out of 83 wells within the Bear Creek Valley (DOE 1997a). Also, although these wells are in Bear Creek Valley, they are not necessarily within the proposed contaminated area. Finally, the concentration of these contaminants varies from one well to another. For lead, the maximum concentration detected was 0.23 mg/L, but the mean of the medians concentration was 0.0046 mg/L. For TCE, the maximum concentration detected was 460 mg/L, but the mean of the medians concentration was 21.9 mg/L. The specific contaminants of concern are identified in the RI report.

Most of the contaminants of concern would have an impact on human health only if ingested (i.e., by drinking contaminated groundwater or by swallowing contaminated soils/sediments). A few contaminants could have an impact if they contact skin. To guard against skin contact, personal protective equipment would be employed. Because groundwater from the contaminated area would not be used for drinking water, and because scientists would not consider drinking any groundwater collected either from the background or contaminated area, there should not be any potential for human exposure. Ingestion of contaminated soils/sediments likewise would not be considered by scientists and therefore would not result in human exposure.

Based on the information published in the RI, knowledge of the contaminated area and experienced drilling and field operations staff would be essential for guiding the drilling and sampling activities in the contaminated area. In addition, the staff of the proposed FRC would advise scientists on training and personal protective equipment and provide oversight of operations to ensure that worker and visitor protection would be maintained.

4.1.8.2 Site Specific Hazards and Accidents

Reasonably foreseeable accidents associated with the proposed FRC could involve: construction accidents associated with well-drilling and sampling; striking a subsurface structure during drilling; spilling a tank of stored liquid chemical, such as glucose or acetate; and leaks of contaminated purgewater from fittings and valves.

Very few accidents associated with well-drilling/sampling or striking a subsurface structure have occurred on the ORR. According to Oak Ridge National Laboratory (<http://www.tis/eh/doe.gov/web/oeaf/orps/orps.html>) only two accidents have occurred during the course of remedial investigations in the Bear Creek Valley. Both accidents involved the use of a drill rig and failure by the operators to follow operating procedures.

For accidents involving injuries to workers (e.g., during drilling operations at the background or contaminated areas), emergency services at Y-12 would be contacted to provide treatment and

transport to the plant medical facility or a hospital, as needed. For accidents at ORNL facilities, assistance from the ORNL Laboratory shift superintendent would be obtained.

Although spills of chemicals used at the background or contaminated area would be possible, the quantities of materials stored or transported onsite would be small (i.e., a few gallons of concentrated material or at most 55 to several hundred gallons of a one percent solution). For experiments where long-term injections of nutrients, tracers or other materials would take place, the rate of injection is likely to be less than ten gallons per day. Therefore, 200 to 300 gallons of diluted material would last at least two weeks.

A direct spill to Bear Creek could cause a temporary localized decrease in oxygen due to increased microbial activity; however, the spill would be rapidly diluted, even during low-flow periods. Quantities that might be spilled would be small (less than 200 gallons) and dilute (equal to or less than one percent).

As identified in Section 4.1.3, there would be no impacts to groundwater or surface water as a result of injection of the materials.

In the event of a spill of a contaminated sample or chemical reagent at the contaminated area or background area, the research team would immediately contact the Y-12 Plant shift superintendent who would mobilize an emergency management team responsible for spill containment and cleanup. Accidents involving injuries to workers (e.g., during drilling operations) would involve contacting emergency services at Y-12 to provide treatment and transport to the plant medical facility or a hospital, as needed. Similarly, any laboratory spills or accidents at ORNL facilities would involve obtaining assistance from the ORNL Laboratory shift superintendent. In addition, a Health and Safety Plan would be developed for the FRC that would identify all appropriate requirements, such as training, monitoring, spill prevention and control measures, and emergency response procedures.

Overall, a spill directly into Bear Creek or to the ground would be expected to have little to no impact on environmental quality or human health.

Noise

Background data on noise levels at the proposed contaminated area and background area are not available. Much of the proposed contaminated area and parts of the background area are adjacent to Bear Creek Road, which has considerable employee traffic during shift changes at the plant and intermittent traffic during most of the workday. The western boundary of the background area would be adjacent to State Route 95, which had existing peak travel volumes of 970 vehicles per hour in 1997 (Table 3.7-2 in DOE 1997b). Noise levels 200 feet (60 m) from main thoroughfares such as State Route 95 have been estimated from traffic counts during rush hour to be between 55 and 60 dB/A. Noise levels at relatively isolated sites within the plant area may be lower than 55 dB/A (DOE 1997b).

Activities to be undertaken at the proposed contaminated area and background area are listed in Section 2.2.3. Noise associated with drilling would be temporary and would potentially disturb wildlife or other sensitive receptors for only short periods during daylight hours. Drilling operators would be required to meet all OSHA requirements.

Representative activities and average noise levels are presented below:

- The average noise level of a compressor at a point 1 foot (0.3 m) distant is 88-90 decibels (dB/A).
- The average noise level of well sampling is 75-78 dB/A for the sampler.
- The average noise level of a generator at a point 1 foot (0.3 m) distant is 93-95 dB/A.
- The average noise level of well drilling at a point 49 feet (15 m) distant is 89-111 dB/A.

Noise levels would not exceed noises heard during routine daily activities. Decibel levels are below that considered to be harmful (see Figure 3-6). Noise from FRC activities would be temporary and likely to disturb wildlife or other sensitive receptors for only short periods during daylight hours. Expected hours of operation would be from 8:00 a.m. to 6:00 p.m.

4.1.9 Waste Control

Wastes generated as a result of NABIR activities are estimated to be up to 12,000 gallons (about 46,000 L) of groundwater and 20 cubic feet (0.56 cubic meters) of soil per year. Similar volumes would be generated at the uncontaminated site but would be discharged to the ground. All wastes would be evaluated and managed in compliance with the appropriate requirements. The regulatory standards would be met through use of appropriate waste packaging and labeling; placement in designated waste storage areas, and routine inspections and maintenance. Best management practices would be instituted wherever applicable. The majority of non-hazardous solid waste material generated during drilling would be in the form of subsurface drill cuttings (soil materials). This soil material and bentonite clay would be used to backfill the test holes at the completion of field work. If there is any soil material remaining after backfilling, it would be distributed around each test plot.

Contaminated wastes (i.e., radioactive, chemical, and mixed wastes) would be handled under existing procedures for dealing with such wastes at Y-12 and ORNL, as appropriate (see Section 9.0, Applicable Environmental Regulations, Permits and DOE Orders). Purge water from drilling operations in the contaminated area likely would fill several 55-gallon drums. Other than pumping tests, which could generate up to 12,000 gallons of wastewater that would be collected in 20,000-gallon tanker trucks, groundwater extracted due to research activities would be collected in 55-gallon drums. All contaminated groundwater would be transported to the Y-12 West End Treatment Facility. Contaminated sediments and soils would be transferred to Bechtel Jacobs Corporation, the ORR waste control contractor, for disposal. All wastes generated from normal everyday activities by workers, including biological wastes, garbage, and similar materials, would be kept in containment and exported from the work sites to proper disposal facilities, to preclude leaving any wastes behind during and at the termination of this activity.

Trailers for the FRC would be equipped with portable chemical toilets, which would be serviced periodically. The Y-12 Environmental Management Division would be asked to help handle field investigation-derived wastes generated at the contaminated and background areas. ORNL laboratory wastes would be handled as part of the ongoing waste control program at ORNL.

4.1.10 Transportation

FRC staff and researchers would be required to travel roads between the contaminated area, background area and ancillary facilities located within ORNL. Public roads that would be traveled include Bear Creek Road, State Highway 95, and Bethel Valley Road. These roads are open-access

public roads. Some use of limited access roads on the ORR would occur to access storage sites and other facilities. Due to the small number of staff and researchers involved, there would be minimal increases in traffic due to FRC activities. Some interruption of normal traffic flow might occur as a result of drilling rigs and on-site field trailer transport. This activity would be of short duration and would not result in long term impacts.

Miscellaneous chemicals, acids (e.g., sulfuric, nitric and hydrochloric), bases (sodium hydroxide), reagents (e.g., Hach Kit), formaldehyde, or other chemicals used onsite for conducting chemical analyses and sample preparation might be infrequently transported. Generally, less than 0.26 gallons (one liter) of these chemicals would be used on a yearly basis. U.S. Department of Transportation (DOT) Hazardous Materials Regulations (Title 49, *CFR*, Parts 171-180) establishes the requirements governing packaging and shipping hazardous materials. These standards would be applicable to any necessary shipments of hazardous materials to or from an FRC and would be followed, thus minimizing risks.

Collection and transport of samples from the contaminated area and background area would follow existing procedures and meet all environmental, safety, and health (ES&H) requirements as stipulated by ORNL. FRC research projects would be required to fill out an Environmental, Safety, and Health Quality Evaluation and transportation checklist prior to initiating any transportation action. Completion of this checklist would provide guidance to FRC researchers and minimize the potential for transportation impacts. If it were determined that transport of samples from ORNL were required, an ES&H transportation specialist would be contacted to assist with compliance with appropriate DOT and DOE shipping requirements. Use of these risk management procedures would result in minimal impacts.

4.1.11 Utilities and Infrastructure

Impacts to infrastructure features such as housing, education, health care, police and fire protection, and water and sewage are not anticipated as a result of implementation of proposed FRC research at ORNL. There would be no living facilities provided for workers at the work site. It is estimated that a staff as small as six individuals would be needed to conduct FRC-related research. Initiation of FRC-related activities supporting site characterizations, obtaining research-quality samples, and *in situ* research would not require an increase in staff as the majority of the activities would be implemented with existing personnel. Any additional personnel (e.g. visiting researchers) involved in FRC activities would be small in number (possibly up to 24 individuals) and would not impact existing infrastructure.

The existing facilities to be used, as mentioned in Section 3.0, would have ample office/laboratory space to allow for the addition of the small FRC staff and researchers.

ORNL proposes to locate a new office/laboratory trailer at the contaminated area, adjacent to the S-3 Ponds Site. Ample space is available. Electrical service to the office/laboratory trailer could be provided by existing power lines. Other trailers have been located in this area in the past (it is previously disturbed) and electrical lines are present. Trailers have not been located in the proposed background area in the past, but nearby power lines should enable a connection to be made easily. Hooking up water and sewer lines to the trailers would be avoided, but portable toilets and containers of drinking and distilled water would be provided.

A small area (50 feet by 50 feet) would be needed to park the drill rig, support truck and mobile decontamination trailer. This equipment is mobile and could be moved to where the work is to be conducted.

Staging areas would be used for material and equipment laydown and as temporary satellite accumulation areas for wastes (in drums, tanks, or other containers) generated by characterization actions (e.g., drill cuttings and decontamination wastes). Staging areas would be operated and maintained in compliance with site waste control procedures for the duration of their operation and during setup of decontamination trailers/change houses. Staging areas would be established in previously disturbed areas (or in areas that would require minimal grading) and would be covered with gravel or gravel and geotextile material. Temporary access roadways (or temporary extensions of existing roadways) might also be constructed, as necessary. Clearing of low brush or removal of trees and shrubs with the goal of minimization of clearing might also occur.

4.1.12 Environmental Justice

No potential impacts have been identified that would affect other ORNL/Y-12 employees or the offsite public, including low-income or minority populations. Socioeconomic analysis recently has been conducted on the potential for impacts to low-income and minority populations in association with the Spallation Neutron Source (SNS) EIS (DOE 1999a).

That analysis determined that radiological doses and normal air emissions are negligible and would not result in adverse human health or environmental effects on the offsite public. Furthermore, it was determined that prevailing winds follow the general topography of the ridges; up-valley winds come from the southwest during the daytime, and down-valley winds come from the northeast during the nighttime. The only concentration of minority and low-income population and non-minority higher income population is located to the northeast—in the path of the daytime prevailing winds. No populations are located to the southwest—the nighttime prevailing wind direction. However, because it was determined that there would not be high and/or adverse impacts to any of the population, there would be no disproportionate risk of significantly high and adverse impacts to minority and low income populations. The same analysis and findings would also hold true for FRC-related activities that would occur within BCV.

DOE is unaware of any subsistence populations residing in BCV nor are there any recognized Native American tribes within 50 miles of the proposed FRC (DOE 1999a). No discharges of contaminated water to surface waters would occur because any contaminated groundwater would be trucked to existing waste processing facilities at ORNL. As discussed in Section 4.1.3.1, there are no anticipated impacts to the surface waters (Bear Creek). All activities associated with this action that involved releases would be regulated and in compliance with federal and state regulations. As such, there would be no disproportionate and adverse impacts to low-income or minority populations.

4.2 Pacific Northwest National Laboratory/Hanford 100-H Area

4.2.1 Earth Resources

4.2.1.1 Topography

FRC research activities would not change the landscape (e.g., large-area bulldozing, large-scale clearing, and excavation.) Activities to support site characterization, to obtain research-quality samples, and *in situ* research would not impact the general topography of the proposed FRC because of the small-scale nature (less than one acre) of the proposed activities.

4.2.1.2 Geology

The 100-H area in which the proposed contaminated area and background area are located is dominated by the Hanford and Ringold formations, which contain primarily sand and gravel dominated facies. Because of the small-scale nature of investigations (less than one acre and to a depth of up to 75 feet), minimal impacts to these large geologic units are anticipated as a result of proposed FRC activities.

4.2.1.3 Soils

Within the 100-H Area, soils are classified as either Burbank loamy sand or Riverwash, with Riverwash occurring closer to the river. Proposed FRC activities would disturb these soil types only in areas where drilling, boring, or well installation would occur. Uncontaminated soils would be redistributed around the test plot. Contaminated soils would be disposed of in accordance with site-specific management plans. Soils obtained as research-quality samples would be characterized for potential hazardous contaminants prior to laboratory experimentation. It is estimated that the quantity of soil removed as a result of research activities at a test plot would be small (75 kilograms of soil per well or 825 kilograms of soil from 11 wells in a test bed); therefore, impacts to soils would be minimal.

4.2.2 Climate and Air Quality

The proposed contaminated area and background area lie entirely within Benton County of Washington State. Benton County is in "attainment" for all NAAQS except particulate matter (PM). For PM, the county is "unclassified." PM is managed under the EPA Natural Events Policy of 1996, since high PM events are associated with natural blowing dust. In the past, EPA has exempted the rural fugitive dust component of background concentrations when considering permit application and the enforcement of air quality standards. EPA is working with the state of Washington to characterize and document the sources of PM emissions and develop appropriate control techniques. It is anticipated that activities supporting proposed FRC research would produce minor amounts of dust (particulate matter) as a result of site clearing, construction activities (e.g., access improvement, trailer placement), and associated construction traffic. Emissions resulting from equipment typically associated with well-drilling operations (e.g., gas powered generators) would be below NAAQS. Any particulate matter generated from these activities would be limited in amount and would occur over a

short period of time. The "conformity rule" (40 *CFR* 51 Subpart T) applies only to areas classified as "nonattainment" or "maintenance" (40 *CFR* 51.394[b]). The conformity rule does not apply to "unclassified" areas.

Other airborne pollutants regulated by NAAQS that might be generated as a result of proposed FRC research could include vehicle exhaust and generators, and potentially point source air emissions of radionuclides resulting from drilling activities. Under Title 40, *CFR*, Part 61, Subpart H, and Washington Administrative Code (WAC) 246-247, radionuclide airborne emissions from all combined operations at the Hanford Site may not exceed 10 mrem/yr effective dose equivalent to the hypothetical off-site maximally exposed individual. WAC 246-247 requires verification of compliance, typically through periodic confirmatory air sampling. These radionuclide emissions standards would apply to any fugitive, diffuse, and point source air emissions of radionuclides generated during research operations at the proposed contaminated area. It is anticipated that any well installation activities that might occur in areas of known radionuclide contamination would incorporate appropriate safeguards into operations in order to limit the potential for airborne contamination.

It is anticipated that operations at the proposed FRC would use standard, construction best management practices to control any airborne releases. Common best management practices include application of water for dust suppression and to control fugitive emissions during drilling and other activities. It is anticipated that these and other construction/drilling BMPs should adequately control fugitive emissions of radionuclides and any other air pollutants. Final project plans would be evaluated for applicability of these best management practices and the substantive requirements of permits would be complied with if required. Any proposed activities at the FRC would not have any adverse impact on the current CERCLA remediation activities in the 100-H Area.

Other substances, which might be used at the proposed FRC, include oxygen, hydrogen, nitrogen, and methane. None of these is regulated under state or federal air regulations. Groundwater collected during the research activities would not be expected to contain pollutants that would volatilize into the air.

No impacts to air quality would be expected from proposed FRC activities.

4.2.3 Water Resources

4.2.3.1 Surface Water

Surface waters within the 100-H Area are dominated by the Columbia River, which flows alongside the contaminated area of the proposed FRC (see Figure 3-9). The two background areas are located approximately one-half mile from the Columbia River. FRC activities to support site characterization, obtain research-quality samples, and perform *in situ* research would not occur any closer than 200 feet (60 meters) from all surface waters, including the Columbia River. Any potential runoff occurring as a result of ground-disturbing activities, coupled with rain events, would be reduced by implementing best management practices (e.g., silt fences).

The closest point where injection of materials might occur would be in the contaminated area 200 feet from the Columbia River. While it is conceivable that injected materials could reach the Columbia River if an injection well were installed at this point, PNNL anticipated the need to recover injected substances. PNNL proposed that they would install a series of groundwater extraction wells within

each test plot to capture any substances injected into upstream injection wells. These extraction wells would be positioned to intercept groundwater flow moving toward the Columbia River. In addition, PNNL could make use of a secondary containment system of five existing extraction wells located within 150 feet of the Columbia River to ensure that substances injected as part of *in situ* research by investigators do not reach the Columbia River. The existing five extraction wells are part of an ongoing CERCLA Interim Remedial Action that involves pumping and treating for chromium-contaminated groundwater. Filters to extract tracers, electron donors and acceptors, nutrients, microorganisms and other substances would be added to the extraction well systems. The pump and treat extraction wells have been operating constantly and will continue to do so (DOE/RL 1999c).

All contaminated water extracted from the proposed wells and existing pump and treat extraction wells would be collected in large truck-mounted tanks and transported to the Effluent Treatment Facility (ETF). Contaminated water extracted from the existing pump and treat extraction wells goes through a filtration system and is reinjected into the ground upstream from the pump and treat area. (See Section 4.2.10 for waste control information.) In the unlikely event that all of the existing and proposed extraction wells failed, the potential exists that groundwater additives injected as part of *in situ* research at either the background or contaminated areas could pass through groundwater channels in the highly porous loamy sand soils of the 100-H Area to the Columbia River.

As described in Appendix A, small quantities of nontoxic tracers, nutrients, electron donors or acceptors, microorganisms, or other substances might be injected as part of the *in situ* research activities. These substances might be injected either into the background or contaminated areas of the proposed FRC in accordance with state and federal regulations, best management practices and close monitoring of environmental conditions. While *in situ* research at the background and contaminated areas would provide additional information on groundwater flow paths and the movement of injected materials, sufficient information currently exists to permit estimates of potential impacts from the injection of these materials on surface waters.

4.2.3.1.1 Tracers

To better understand groundwater flow paths and speed, nontoxic and nonpersistent tracers could be injected in concentrations ranging from 500 parts per million (ppm) to 10,000 ppm at both the background and contaminated areas of the proposed FRC. Examples of tracers that might be used include bromide, chlorofluorocarbons, latex microspheres, alcohols, and non-radioactive strontium. Tracer injections at the two proposed background areas would be more than 1,500 feet from the Columbia River and concentrations would be expected to be unmeasurable by the time the tracer had traveled only half that distance. In part, this would be due to a slow groundwater flow rate of six inches per day and to the diffusion of the tracer into the subsurface matrix. In contrast, tracer injections into the contaminated area, particularly into test plots C and D, which are close to the Columbia River, could conceivably reach the surface waters if they were not captured by proposed NABIR extraction wells or existing pump and treat extraction wells.

As with tracers proposed for use at the ORNL FRC, tracers proposed for use at the background and contaminated areas of 100-H would also be greatly diluted by diffusion into the matrix of the 100-H Area subsurface. Assuming that no NABIR extraction wells were installed, injected tracers would be recovered in the continuously operating pump and treat extraction well systems.

Different tracers move and diffuse into the groundwater at different rates. Therefore, the use of more than one tracer at the same time provides additional information about the subsurface than would be possible with only one tracer. Injection of multiple tracers at one time in the contaminated area in an

injection well 200 feet from the Columbia River would not be expected to result in an increased possibility that any of the tracers would reach the Columbia River. Again, both the proposed NABIR extraction well system and the existing pump and treat system would be employed to ensure that these tracers would not reach the Columbia River.

Tracer concentrations would not be expected to exceed 10,000 ppm. The use of nontoxic and non-persistent tracers coupled with the proposed and existing extraction well systems would ensure that tracers would not reach the Columbia River. Further information on the proposed use of groundwater tracers at the FRC is available in Appendix A.

4.2.3.1.2 Electron Donors and Acceptors and Other Nutrients

To stimulate the activity and growth of microorganisms, electron donors or acceptors or other nutrients could be injected in concentrations ranging from 100 ppm to 300 ppm (i.e., 100 mg/L to 300 mg/L) at both the background and contaminated areas of the proposed FRC. At maximum, these concentrations would be lower than those that would be considered at the ORNL FRC. Examples of electron donors that might be used include acetate, glucose, lactate, hydrogen, or molasses. Examples of electron acceptors that might be used include oxygen, nitrate, methane or sulfate. Other nutrients might include nitrogen and phosphorus. Injections at the background area would not occur in close proximity to the Columbia River (i.e., they would be more than 1,500 feet from the Columbia River).

Although injections at the contaminated area could be as close as 200 feet to the Columbia River, the likely approach for such injections would be a push-pull approach. In a push-pull experiment, electron donors, acceptors or nutrients would be "pushed" into a single injection well, and then "pulled" out of the same well after a short time of up to several hours (Schroth et al. 1998). Using this type of injection/extraction procedure in a single well, PNNL estimates that approximately 95 percent of the injected materials could be recovered through the injection well (Long 1999a).

In some cases, electron donors, electron acceptors, or nutrients could be injected into one well and extracted from another. In such a situation, the proposed series of NABIR extraction wells and the existing pump and treat extraction wells would mitigate any potential for electron donors, electron acceptors, or nutrients to reach the surface waters of the Columbia River. In addition, the proposed NABIR extraction wells and the existing pump and treat system would capture any contaminants that might be mobilized as a result of the addition of electron donors, electron acceptors, or nutrients in the contaminated area.

Another point to consider would be a shift in the existing microbial population due to the addition of electron donors, electron acceptors, or nutrients. Based on two other recent studies, even though the species that constitute the existing microbial populations might shift, the shift would only be detectable as long as the electron donor, electron acceptor or nutrient was present in the groundwater (Konopka et al. 1999, Rooney-Varga et al. 1999). Once the electron donor, acceptor or nutrient was removed from the groundwater through the extraction well systems, the microbial populations would return to their previous state, and there would be no change to inputs to the Columbia River.

Further information on the proposed use of electron donors and acceptors and nutrients at the FRC is available in Appendix A.

4.2.3.1.3 Microorganisms

To determine whether it might be feasible to add microorganisms to a contaminated subsurface environment, a small quantity (2×10^7 colony forming units per ml [cfu/ml]) of native microorganisms could be injected into the background and contaminated areas of the proposed FRC. Native microorganisms would most likely be strains that would be isolated from the contaminated area and reinjected. Reinjection of native microorganisms would not be expected to be of concern either at the background or contaminated area. Although they would not be expected to move through the groundwater (Dybas et al. 1997), it is conceivable that they could proliferate. In some cases, the push-pull technique might be used; in other cases, one injection and one or more different extraction wells might be used. In either situation, the microorganisms would be captured in the proposed NABIR extraction wells or in the existing pump and treat extraction wells.

PNNL has stated that non-native microorganisms would be those from a non-Hanford field site (Long 1999b). Non-native microorganisms would not be injected either at the background or contaminated areas. Similarly, genetically engineered microorganisms would not be used either at the background or contaminated areas. Further information on the proposed use of microorganisms at the FRC is available in Appendix A.

4.2.3.1.4 Other Substances

As discussed in section 4.1.3.1.4, the two primary classes of other substances that might be injected would be biosurfactants and chelators. However, unlike the proposed ORNL FRC, PNNL would not consider using these two classes of substances either at the background or the contaminated areas. Because they would not be used, there would be no impacts to the surface waters of the Columbia River.

4.2.3.2 Floodplain and Wetlands

The only proposed FRC activities expected to occur within floodplain areas would be well drilling and monitoring (e.g., installation of piezometers). Typical installations of wells or piezometers, using for example, 2 foot by 6 inch (0.41 meter by 15.24 centimeter) diameter protective casing and 4 foot by 3 inch (0.82 meter by 7.62 centimeter) diameter bollards with a concrete pad 3 inches high and 2 feet long (7.62 centimeters by .41 meters) may reduce the cross-sectional area of the floodplain by 1.64 square feet (.5 square meters). This reduction in volume of even several wells would be negligible within the total cross-sectional area of the floodplain. Well and piezometer construction therefore, would have negligible impact on the floodplain. The well pads would minimize the erosion potential of the wells and bollards.

At the appropriate time, wells would be plugged (backfilled with clean soils) and abandoned. Well plugging and abandonment would result in the removal of surface structures (e.g. wellheads) and restoration of the former grade. This activity would have little impact on floodstage or floodplain cross-sectional area, nor would there be an increase in erosional potential since the wellhead and other surface equipment would be removed and the site restored to the original grade.

No structures or facilities would be constructed in the floodplain. Movement of heavy equipment through the floodplain would be a temporary occurrence and would not impact the capacity of the floodplain to store or carry water. The impacts from the movement of heavy equipment alone is expected to be negligible. To the extent practicable, staging areas and access roads would be temporary, construction would be limited to periods of low precipitation, and stabilization and restoration of the affected areas would be initiated promptly.

Wetlands in association with the Columbia River occur on the banks of the Columbia in proximity to the proposed contaminated area and background area. These wetlands are small in scale and are generally associated with the immediate bank of the Columbia River. Proposed FRC research would not occur in proximity to the wetlands and would not impact them.

4.2.3.3 Groundwater

The Ringold and Hanford Formations are continuous across the 100-H Area. Approximately 300 feet of suprabasalt sediment overlie the proposed FRC. The water table ranges from 0 feet at the Columbia River to 107 feet in depth. The direction of the groundwater flow is toward the river. Under high river flows, the direction of groundwater flow may be reversed for several hundred feet inland.

The contaminated groundwater underlying the 100-H Area is contained within a CERCLA operable unit (100-HR-3). Contaminants of concern within 100-HR-3 include chromium, nitrate, technetium-99, and uranium. This operable unit is currently undergoing interim remediation by a pump and treat system. There are extraction wells located along the river to intercept and remove contaminated groundwater, thereby protecting the quality of surface water (i.e., the Columbia River). Both the background and the contaminated area would be located hydraulically upgradient of the pump and treat system.

Because of the somewhat limited field site information available for both the background and contaminated areas, one of the first field activities that could be expected at both the background and contaminated areas would be a groundwater gradient test. As with most groundwater gradient tests, modification of the groundwater gradient due to pump/slug tests would be expected to alter the groundwater gradient over an area of several hundred feet and over a time frame of weeks. However, groundwater pumping and monitoring activities would not generate more than 14,000 gallons per year of purge water.² These tests would not affect the existing direction of overall groundwater flow. The groundwater gradient would be expected to return to its pre-test level and the overall groundwater gradient would not be significantly altered.

As described in Appendix A, small quantities of nontoxic tracers, electron donors and acceptors, nutrients, microorganisms, or other substances might be injected as part of the *in situ* research activities. These substances might be injected either into the background or contaminated areas of the proposed FRC in accordance with best management practices and close monitoring of environmental conditions. Because the proposed contaminated area would be located in a CERCLA operable unit, permitting of discharges resulting from FRC activities would not be required. PNNL has obtained and currently holds several Categorical State Waste Discharge Permits that cover various categories of discharges, including experimental discharges from research activities. FRC work would be done within the bounds of these permits.

² In accordance with the Hanford purge water strategy, if groundwater were uncontaminated, it could be released onsite but not discharged directly to the Columbia River. If it were contaminated, it would be collected in tanker trucks until it could be transported to the ETF.

4.2.3.3.1 Tracers

As described in Section 4.2.3.1.1, to better understand groundwater flow paths and speed, nontoxic and non-persistent tracers in concentrations ranging from 500 ppm to 10,000 ppm might be injected at both the background and contaminated areas of the proposed FRC. As with the tracers proposed for use at the ORNL FRC, the tracers proposed for use at the background and contaminated areas of 100-H would also be greatly diluted by diffusion into the matrix of the 100-H Area subsurface.

Nonreactive tracers proposed for use at the background and contaminated areas would not be expected to alter the groundwater chemistry if used. Reactive tracers could conceivably alter the groundwater chemistry, but their use would be tested in the laboratory prior to use in the field. Based on the laboratory studies, reactive tracers that would alter the groundwater chemistry would not be used at the background or contaminated areas.

4.2.3.3.2 Electron Donors and Acceptors and Nutrients

To stimulate the activity and growth of microorganisms, electron donors or acceptors or other nutrients might be injected in concentrations ranging from 100 ppm to 300 ppm (i.e., 100 mg/L to 300 mg/L) at both the background and contaminated areas of the proposed FRC. At maximum, these concentrations would be lower than those that would be considered at the ORNL FRC. Injections at the background area would not occur in close proximity to the Columbia River (i.e., they would be more than 1,500 feet from the Columbia River).

As described in Section 4.2.3.1.2, injections at the contaminated area could be as close as 200 feet to the Columbia River and the most likely approach would be to use a push-pull approach. Again, approximately 95% of the injected materials could be recovered using the push-pull approach. With injection concentrations of up to 300 ppm, it is not likely that groundwater chemistry would be changed in a large area of the subsurface.

In some cases, electron donors, electron acceptors, or nutrients might be injected into one well and extracted from another. In such a situation, the proposed series of NABIR extraction wells and the existing pump and treat extraction wells would mitigate any potential for electron donors, electron acceptors, or nutrients to change the groundwater chemistry of large areas. For areas that would be changed such that a contaminant would become more mobile, the proposed NABIR extraction wells and existing pump and treat system would capture mobilized contaminants.

Possible shifts could occur in the existing microbial population due to the addition of electron donors, electron acceptors, or nutrients. However, at the low concentrations that would be used, changes in the microbial population would be limited in the area of the subsurface affected and would only persist if the electron donors, acceptors or nutrients were to continue to be added. Further information on the proposed use of electron donors and acceptors and nutrients at the FRC is available in Appendix A.

4.2.3.3.3 Microorganisms

To determine whether it might be feasible to add microorganisms to a contaminated subsurface environment, a small quantity (2×10^7 colony forming units per ml [cfu/ml]) of native microorganisms might be injected into the background and contaminated areas of the proposed FRC. As described in Section 4.2.3.1.3, native microorganisms would most likely be strains that would be isolated from the contaminated area and reinjected. Reinjection of native microorganisms would not be expected to be of concern either at the background or contaminated area. Although they would not

be expected to move through the groundwater (Dybas et al. 1997), it is conceivable that they could survive. In some cases, the push-pull technique might be used to inject native microorganisms. In other cases, one injection and one or more different extraction wells might be used. In either situation, the microorganisms would be captured in the proposed NABIR extraction wells or in the existing pump and treat extraction wells.

If nutrients were to be added along with microorganisms, the added microorganisms could proliferate. While a proliferation of added microorganisms could effect a change in the groundwater chemistry such that a contaminant would be mobilized, any contaminants that might be mobilized would be captured either in the proposed NABIR extraction wells or in the existing pump and treat extraction wells.

PNNL has stated that non-native microorganisms would be those from a non-Hanford field site (Long 1999b). Non-native microorganisms would not be injected either at the background or contaminated areas. Similarly, genetically engineered microorganisms would not be used either at the background or contaminated areas. Further information on the proposed use of microorganisms at the FRC is available in Appendix A.

4.2.3.3.4 Other Substances

As discussed in section 4.2.3.1.4, the two primary classes of other substances that could be injected would be biosurfactants and chelators. However, unlike the proposed ORNL FRC, PNNL would not consider using these two classes of substances either at the background or the contaminated areas. Because they would not be used, there would be no impacts to the groundwater.

In summary, it is anticipated that NABIR basic research at the proposed contaminated area would serve to better define the nature of existing contamination and aid in the development of bioremediation technologies to assist in clean-up of both groundwater and sediments in the 100-H Area. Overall, the hydrogeology and geochemistry of the 100-H Area would not be altered by the small-scale research activities. Groundwater gradient modifications, including pump/slug tests, would only temporarily alter groundwater characteristics and would not affect the existing direction of overall groundwater flow. Injection of tracers, electron donors and acceptors, nutrients, and microorganisms in the small amounts proposed would not be expected to alter the groundwater chemistry of the background or contaminated areas. In cases where a push-pull system were to be used, approximately 95% of the injected material would be recovered. In cases where separate injection and extraction wells were to be used, the proposed NABIR extraction wells would be used to recover injected materials. Secondary containment would be provided by the existing pump and treat system (EPA 1996). Through the use of the extraction well systems, impacts beyond the background or contaminated areas would not be expected.

4.2.4 Ecological Resources

The proposed contaminated area and background area would be situated in what has been botanically characterized as a shrub-steppe ecosystem commonly referred to as high desert. The region contains plant and animal species adapted to a semi-arid environment. The areas identified are previously disturbed areas of shrub-steppe habitat; therefore, the proposed action would not adversely affect native plant and animal species.

4.2.4.1 Terrestrial Resources

Biological resources within the proposed contaminated area and background area are typical of a high desert, shrub-steppe, arid environment. Most of the site has not experienced tillage or livestock grazing since the early 1940s. Extensive remedial activity is occurring in proximity to the proposed contaminated area and background area. As a consequence, it is unlikely that significant wildlife resources are in the area. Moreover, because research activities would encompass a very small portion of the proposed contaminated area and background area, it is not anticipated that wildlife or terrestrial resources would be impacted.

The U.S. Department of Interior, Fish and Wildlife Service provided a list of threatened and endangered species, candidate species and species of concern, which may be present in the Benton County portion of the Hanford Site. In addition, PNNL conducted a biological review of the proposed FRC (see Appendix E). The U.S. Fish and Wildlife Service and PNNL's biological review concluded that there are no plant or animal species protected under the Endangered Species Act, candidates for such protection, or species listed by the Washington State government as state threatened or endangered within the proposed contaminated area or background area.

Bald eagle roost trees are located to the north and the south of 100-H Area. The Hanford Site Bald Eagle Site Management Plan (DOE 1994b) restricts routine work within 2,630 feet (800 m) of the roost sites between the hours of 10 a.m. and 2 p.m. Non-routine activities, such as excavations and well drilling, require case-by-case evaluations. However, the proposed contaminated area and background area would be located beyond the 2,630-foot radius from the night roost locations and would have no required restrictions.

4.2.4.2 Aquatic Resources

Much of the land area encompassing the proposed FRC is located immediately adjacent to the Columbia River. The Hanford Reach of the Columbia River is an important spawning ground for the Upper Columbia River steelhead, the Upper Columbia River spring-run chinook salmon, and the bull trout. All three species are federally listed as endangered. These important fish species would not be expected to be impacted as a result of proposed FRC research. However, because of their importance and status as federal endangered species, the National Marine Fisheries Service would be notified under Section 7 of the Endangered Species Act prior to implementation of any field research. No other sensitive plant or animal species are known to occur either within the proposed FRC or adjacent areas.

4.2.5 Archaeological, Cultural, and Historic Resources

According to PNNL, approximately half of the proposed contaminated area has been intensively surveyed for cultural resources (Appendix E). No archaeological or isolated artifacts were identified in the survey area. There are no known historic properties within the proposed contaminated area. The background area has also been surveyed for cultural resources. No cultural resources were located within the background area.

A portion of the proposed contaminated area is within about 440 yards (400 m) of the Columbia River. The Columbia River and its shorelines are considered culturally sensitive. Any intrusive research action conducted in this area would require a cultural resource expert to be present.

Management of Hanford Site cultural resources follows the Hanford Cultural Resources Management Plan (PNL 1989). As such, any site in which development activities would be proposed would be evaluated prior to implementation of development plans.

4.2.6 Land Use, Recreation, and Aesthetic Resources

The proposed contaminated area and background area would not conflict with any existing land use at the 100-H Area. The size and shape of the proposed contaminated area and background area were determined in part through discussions with the Hanford Environmental Restoration Contractor. The proposed field sites were positioned to avoid any interference with existing haul routes, potential remediation sites, or other ongoing or anticipated activities.

The proposed contaminated area and background area would not adversely affect recreation activities or recreational experiences on the Columbia River. Recreational users on the river would most likely not be aware of FRC activities in the region. The locations in which the proposed contaminated area and background area would be situated are not currently used for any other recreational purpose.

Trailers supporting proposed FRC research would be needed only in the vicinity of the proposed contaminated area and background area. They would be removed upon completion of research activities.

The proposed contaminated area and background area locations in the 100-H Area would not adversely impact any component of visual or aesthetic resources.

4.2.7 Socioeconomic Impacts

Socioeconomic impacts would be minimal. The work force required for installation and operation of the proposed FRC would be small and drawn from the existing work force. Visiting staff and scientists would contribute in a beneficial manner to the local economy by staying in local hotels and using local services. There would be no negative impact to the socioeconomics of the Hanford area as a result of FRC activities.

4.2.8 Human Health

As described in Appendix C, PNNL would develop an overall Management Plan for the FRC that would explain the goals and objectives of the FRC, roles and responsibilities of FRC staff, procedures for investigators to follow, and procedures for storage of material and waste disposal. To address potential ES&H issues associated with human health and environmental protection, PNNL would also develop the following plans:

- an action-specific health and safety plan detailing potential pathways of exposure and best management practices to reduce those hazards;
- a characterization and waste control plan;
- a contingency plan to address offsite migration of any nutrients or other chemicals used in conjunction with NABIR research activities; and

- a site closure plan.

Although important for operating the proposed FRC, this EA seeks to evaluate potential impacts to human health and the environment prior to selecting the FRC. For purposes of this evaluation, health and safety issues to be evaluated include:

- exposure to contaminated soils and groundwater,
- occupational hazards associated with a drilling/construction site, and
- hazards associated with accidental releases of stored liquid chemicals or materials.

4.2.8.1 Exposure to Contaminated Soils and Groundwater

There are two primary human health issues associated with exposure to contaminated soils and groundwater from the contaminated area at PNNL. The first issue is potential radiation exposure from groundwater and soils/sediments with radioactive contaminants. The second issue is potential chemical toxicity of the contaminants that may be in groundwater and soils/sediments from the contaminated area.

Because of the proposed nature of operation, potential exposures could occur during drilling and sampling operations in the contaminated area and/or in the processing and analysis of samples obtained from the contaminated area. Such exposures could be to FRC staff or to scientists. To mitigate these potential exposures, a combination of personal protective equipment, personnel training, physical design features, and other controls (e.g., limiting exposure times) would be required to ensure that worker and visitor protection would be maintained for all proposed FRC-related activities. In addition, OSHA regulations that pertain to construction and well-installation would be adhered to in all situations.

For the majority of investigators, potential exposures would be from samples obtained from the contaminated area and would occur while they performed sample processing or analyses. For scientists and FRC staff, who would be involved with drilling and sampling operations, potential exposures would be from accidents associated with drilling and sampling operations in the contaminated area.

Title 10, *CFR*, Part 835, "Occupational Radiation Protection," establishes radiation protection standards, limits, and program requirements for protecting workers and the general public from ionizing radiation resulting from the conduct of DOE activities. For workers, 10 *CFR* 835 requires a 5-rem per year dose limit. For the general public, 10 *CFR* 835 requires a 100 millirem (mrem) per year dose limit. In addition, it requires that measures be taken to maintain radiation exposure as low as reasonably achievable. The 5-rem dose limit would be applicable to FRC staff and those scientists involved in drilling and sampling operations in the contaminated area. The 100 mrem dose limit would be applicable to scientists who process or analyze both soil/sediment and groundwater samples from the contaminated area.

For purposes of this EA, the maximum allowable exposure to FRC staff or to scientists was assumed to be 100 mrem per year. In addition, because potential exposures most likely would be during drilling and sampling operations, the following analysis of potential doses was assumed to be for hypothetical workers involved in drilling and sampling operations.

Doses to workers were bounded by evaluating a "bounding analysis" scenario, in the absence of any existing data on worker doses for this kind of work in the field. Workers were assumed to spill small amounts of soil/sediment (1 gram of contaminated soil/sediment five times per year for a total of 5 grams) or groundwater (1 milliliter of contaminated groundwater five times per year for a total of 5 milliliters) on themselves during the course of handling the core samples. To maximize the potential dose, it was further assumed that the workers did not wash off the contamination, but actually ingested it.

Radionuclide ingestion was calculated from the average measured activity values for H³, C¹⁴, Sr⁹⁰, Tc⁹⁹, U²³³, U²³⁸ and Am²⁴¹ in soil and groundwater (see Table 4-2). Where average values were not available, maximum measured values were substituted. The measured data provided in Table 4-2 were obtained from several sources including Liikala et al. 1988, DOE 1993, and Peterson et al. 1996). Totals were based on a yearly consumption of 5 grams of soil and 5 milliliters of groundwater. Dose factors for the Committed Effective Dose Equivalent were taken from the EPA report, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion, Federal Guidance Report No. 11" (EPA-5201/1-88-020), published in September 1988. The dose factor for C-14 was taken from the value for labeled organic compounds.

For the soil ingestion pathway, the total dose (for all radionuclides) came to less than 0.004 mrem/year, which is 25,000 times less than the limit of 100 mrem/year allowed for members of the public under 10 CFR 835, Section 208. The groundwater ingestion pathway is slightly smaller, with a total dose of approximately 0.002 mrem/year.

To estimate the total potential risk to workers from this "bounding analysis" exposure scenario, it was further assumed that the workers were exposed during the entire life of the project, which is ten years. The combined annual dose from both the soil and groundwater ingestion pathways was 6.16E-03 mrem per year (3.85E-03 + 2.32E-03). Over the ten-year lifetime of the project, the total dose was ten times that amount, or 6.16E-02 mrem. The lifetime fatal cancer risk is calculated by multiplying this ten-year dose by the dose-to-risk conversion factor of 4E-04 deaths per person-rem (NRC 1991). This calculation yields a lifetime risk of 3.08E-08, or roughly three in 100 million.

Table 4-2: Human Health Exposure Rates

Soil Ingestion (5 g/y)					Groundwater Ingestion (5 ml/y)			
Radionuclide	mrem/ pCi	pCi/g (max)	Total pCi	mrem/y	pCi/l (avg)	Total pCi	mrem/y	
H-3	6.40E-08	0	0	0.00E+00	3455	17.275	1.11E-06	
C-14	2.09E-06	13.2	66	1.38E-04	72	0.36	7.52E-07	
Sr-90	1.42E-04	1.4	7	9.94E-04	9.9	0.0495	7.03E-06	

Tc-99	1.46E-06	6.2	31	4.53E-05		303	1.515	2.21E-06
U-233	2.89E-04	0.46	2.3	6.65E-04		18.6	0.093	2.69E-05
U-238	2.55E-04	1.4	7	1.79E-03		2.38	0.0119	3.03E-06
Am-241	3.64E-03	0.012	0.06	2.18E-04		125	0.625	2.28E-03
			TOTAL:	3.85E-03			TOTAL:	2.32E-03

Although radioactive exposure would not be a problem, the potential chemical toxicity of the contaminants in the soils/sediments and groundwater from the proposed contaminated area also needs to be considered. Because the proposed contaminated area would be within the 100-HR-3 CERCLA operable unit, contaminant concentrations are evaluated according to CERCLA standards. Several recent studies of the 100-H Area indicate that only chromium and nitrate are of regulatory concern (Liikala 1998, DOE 1993, and Peterson 1996). Chromium concentrations are not at a level that would be of concern to human health, but they are high enough to be of concern to Columbia River salmon that spawn nearby. The CERCLA pump and treat system in the 100-H Area was put into place to extract the chromium so that it would not enter the Columbia River. Nitrate concentrations are also of regulatory concern, but unlike many organic contaminants, nitrate does not pose a cancer risk. Because groundwater from the contaminated area would not be used for drinking water, and because scientists would not consider drinking any groundwater collected either from the background or contaminated area, there would not be any potential for human exposure.

4.2.8.2 Site Specific Hazards and Accidents

Reasonably foreseeable accidents associated with the proposed FRC could involve: construction accidents associated with well-drilling and sampling; striking a subsurface structure during drilling; spilling a tank of stored liquid chemical, such as glucose or acetate; and leaks of contaminated purgewater from fittings and valves.

Very few accidents associated with well-drilling/sampling or striking a subsurface structure have occurred recently at the Hanford Site (Dunigan 1999). For example, many years ago there was a fatality during a drilling operation. A drill operator became trapped in a well while trying to retrieve a drill component and suffocated. Over the past 20 years, there have also been a few instances where drill rigs were not properly stabilized and tipped over. In these cases the operators did not follow appropriate operating procedures.

Although spills of chemicals used at the background or contaminated area would be possible, the quantities of materials stored or transported onsite would be small (i.e., a few gallons of concentrated material or at most 55 to several hundred gallons of a one percent solution). For experiments where long-term injections of nutrients, tracers or other materials would take place, the rate of injection is likely to be less than ten gallons per day. Therefore, 200 to 300 gallons of diluted material would last at least two weeks.

A direct spill to the Columbia River would not be possible since the route from PNNL laboratories (where chemicals might be prepared) to the background and contaminated areas does not cross the

Columbia River or any tributaries. In addition, FRC activities would not occur any closer than 150 feet to the Columbia River.

As discussed in Section 4.2.3, there would be no impacts to groundwater or surface water as a result of injection of the materials.

Noise

Activities to be undertaken at the proposed contaminated area and background area are listed in Section 2.2.3. Noise associated with drilling would be temporary and would potentially disturb wildlife or other sensitive receptors for only short periods during daylight hours. Drilling operators would be required to meet all OSHA requirements.

Representative activities and average noise levels are presented below:

- The average noise level of a compressor at a point 1 foot (0.3 m) distant is 88-90 decibels (dB/A).
- The average noise level of well sampling is 75-78 dB/A for the sampler.
- The average noise level of a generator at a point 1 foot (0.3 m) distant is 93-95 dB/A.
- The average noise level of well drilling at a point 49 feet (15 m) distant is 89-111 dB/A.

Noise levels would not exceed noises heard during routine daily activities. Decibel levels are below that considered to be harmful (see Figure 3-6). Noise from FRC activities would be temporary and likely to disturb wildlife or other sensitive receptors for only short periods during daylight hours.

Because of ES&H planning and controls, and the small-scale research expected at an FRC, there would be no adverse impacts to human health.

4.2.9 Waste Control

Washington Administrative Code (WAC) 173-303 requires the identification and appropriate management of dangerous wastes and the dangerous component of mixed wastes, and identifies standards for the treatment and land disposal of these wastes. The code would be applicable to wastes that are anticipated to be designated as mixed waste. DOE Order 435.1 provides requirements for radioactive waste control. WAC 173-304 requires the identification and appropriate management of solid wastes. It would be applicable to any solid waste generated at the proposed FRC.

In accordance with the Hanford Purgewater Strategy (July 1990), should purgewater contain levels of hazardous and radioactive constituents above agreed-to health and environmental-based criteria, the purgewater is sent to a central Hanford facility for future treatment and disposal. The "Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington" (WHC-MR-0039) was approved by DOE, EPA and Washington Department of Ecology on August 21, 1990. The strategy is incorporated by reference in Appendix F of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement.)

All wastes would be evaluated and managed in compliance with the appropriate requirements. The regulatory standards would be met through the use of appropriate waste packaging and labeling; placement in designated waste storage areas, and routine inspections and maintenance. It is expected that solid wastes might be disposed of in the Environmental Restoration Disposal Facility (ERDF),

the Low-Level Burial Grounds (LLBG), other Hanford Site waste control units, or at offsite permitted facilities. Liquid wastes would be disposed of in the ETF. Low-level radioactive contaminated materials might be disposed of in the LLBG.

The ERDF is designed to meet RCRA minimum technological requirements for landfills including standards for a double liner, a leachate collection system, leak detection, and final cover. It also meets performance standards under Title 10, *CFR*, Part 61 for disposal of low level waste. The LLBG meet the performance standards under 10 *CFR* 61. Any offsite facility to which dangerous waste would be sent would meet the requirements of RCRA.

Approximately 3,500 gallons of purgewater would be generated and considered waste for each research event. Four such events could be expected to occur each year. Purgewater would be collected in tanker trucks and disposed at the ETF. Soils waste is estimated to be approximately one-third of the total material removed during drilling. This would total approximately 275 kilograms per test bed. All wastes would be evaluated and managed in compliance with the appropriate requirements. The regulatory standards would be met through use of appropriate waste packaging and labeling; placement in designated waste storage areas, and routine inspections and maintenance. Best management practices would be instituted wherever applicable. The majority of non-hazardous solid waste material generated during drilling would be in the form of subsurface drill cuttings (soil materials). This soil material and bentonite clay would be used to backfill the test holes at the completion of field work. If there were any soil material remaining after backfilling, it would be distributed around each drill site.

Contaminated wastes (i.e., radioactive, chemical, and mixed wastes) would be handled under existing procedures for dealing with such wastes. All wastes generated from normal everyday activities by human workers, including biological wastes, garbage, and similar materials, would be kept in containment and exported from the work sites to proper disposal facilities, to preclude leaving any wastes behind during and at the termination of this activity. Trailers for the FRC would be equipped with portable chemical toilets, which would be serviced periodically.

4.2.10 Transportation

Miscellaneous chemicals, acids (e.g., sulfuric, nitric and hydrochloric), bases (sodium hydroxide), reagents (e.g., Hach Kit), formaldehyde, or other chemicals used onsite for conducting chemical analyses and sample preparation might be infrequently transported. Generally, less than 2.2 gallons (one liter) of these chemicals would be used on a yearly basis. U.S. Department of Transportation (DOT) Hazardous Materials Regulations (Title 49, *CFR*, Parts 171-180) establish the requirements governing packaging and shipping of hazardous materials. These standards would be applicable to any necessary shipments of hazardous materials to or from an FRC.

The PNNL Shipping and Transportation Program ensures compliance with the DOT Hazardous Materials Regulations and DOE requirements specific to packaging and transportation safety. The PNNL Hazardous Materials Transportation Officer would be consulted to assure the safe packaging and transport of any regulated samples, hazardous materials, or wastes.

4.2.11 Utilities and Infrastructure

The existing facilities proposed to be used, as mentioned in Section 3.0, have ample office/laboratory space to allow for the addition of the small number of FRC staff and researchers. Because of the

small number of people expected to work at the FRC, impacts to infrastructure features such as housing, education, health care, police and fire protection, and water and sewage would not be anticipated as a result of implementation of FRC research. Initiation of FRC-related activities likely would not require an increase in staff, as the majority of the activities could be implemented with existing personnel. Any additional personnel involved in FRC activities, such as visiting researchers, would not impact existing infrastructure.

Staging areas (approximately 100 x 100 feet) would be used for material and equipment laydown and as temporary satellite accumulation areas for wastes (in drums, tanks, or other containers) generated by characterization actions (e.g., drill cuttings and decontamination wastes). Staging areas would be operated and maintained in compliance with site waste control procedures for the duration of their operation and during setup of decontamination trailers/change houses. Staging areas would be established in previously disturbed areas (or in areas that would require minimal grading) and would be covered with gravel or gravel and geotextile material. Temporary access roadways (or temporary extensions of existing roadways) might also be constructed, as necessary. Clearing of low brush or removal of trees and shrubs with the goal of minimization of clearing might also occur.

4.2.12 Environmental Justice

No potential impacts have been identified that would affect other 100-H employees or offsite public. The vicinity surrounding the 100-H Area is large and the proposed action would not result in adverse human health or environmental effects on the public, including low-income or minority populations.

The Hanford Site NEPA Characterization Report (Neitzel et al. 1999) determined that the 100-H Area is located within a census block that contains no residents. Sections 4.2.3.1 and 4.2.3.3 state that there would be no impacts to surface waters (i.e., the Columbia River) or the groundwater. Therefore, there would be no impacts to individuals using the Columbia River for subsistence fishing or other subsistence purposes. There would be no disproportionate and adverse impacts to low-income and minority populations.

4.3 No Action

Under the No Action alternative, there would be no FRCs at the Oak Ridge and Hanford sites. As a result, DOE would not be able to conduct integrated field-based research and no intrusive actions would be taken by the NABIR Program, resulting in no impacts to the affected environment at Oak Ridge and Hanford (as described in Section 3.0). Future research could take place at other field sites (e.g., STEFS); however, the site conditions would not meet the needed criteria or the preferred characteristics (see Section 2.2.1.2) that would enable the NABIR Program to assist DOE with identifying new bioremediation technologies.

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5.0 CUMULATIVE EFFECTS OF THE ALTERNATIVES

Cumulative effects are those that result from the incremental impact of an action considered in addition to impacts of past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (Title 40 *CFR*, Part 1508.7). Cumulative effects can result from individually minor but collectively significant actions taken over a period of time.

5.1 Cumulative Effects of Siting and Operating an FRC on the ORNL/Y-12 Site

The actions that DOE considers reasonably foreseeable and pertinent to the analysis of cumulative effects for the ORNL/Y-12 Site are described in the section below.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Activities in the Bear Creek Valley Watershed. The RI/FS for the Bear Creek Watershed has been completed to address contamination associated with former waste disposal activities in Bear Creek Valley. The Record of Decision is scheduled to be signed in calendar year 2000. Several CERCLA remedial actions have been identified for implementation in the Bear Creek Valley Watershed. Proposed CERCLA actions that could impact levels of groundwater and soil contamination within the proposed FRC boundaries include but are not limited to the following:

1. Hot spot removal and capping of the BY/BY. The purpose of this action is to reduce the flux of uranium discharging into Bear Creek and the Maynardville Limestone through North Tributary 3 (NT-3). It is anticipated that this action would eventually decrease the concentration of uranium in Bear Creek and the Maynardville Limestone downstream from NT-3.
2. S-3 Ponds plume tributary interception. The purpose of this action is to reduce the flux of contaminants from the S-3 groundwater plume into the surface stream NT-1 and the main-stem of Bear Creek.
3. Removal of soil and sediment hot spots of contamination within the Bear Creek floodplain.

Procedures and protocol ensuring FRC activities do not interfere with CERCLA remediation activities would be described in the FRC Management Plan. In addition, "Operating Instructions" describing these procedures and protocol would be added to the CERCLA Federal Facilities Agreement (FFA).

CERCLA Waste Disposal Facility. DOE has published a RI/FS for the disposal of ORR CERCLA wastes (DOE January 1998). Alternatives in the RI/FS study include disposal of CERCLA wastes offsite and in a new disposal facility, the Environmental Management Waste Management Facility (EMWMR) to be constructed on the ORR. Three alternative sites on the ORR have been considered: two just north of Bear Creek Road and the third along State Highway 95 at the interchange with State Highway 58. The Proposed Plan and Record of Decision for the CERCLA Waste Disposal Facility have not been published, so no decisions concerning the construction of this facility on the ORR have been made. It is not anticipated that the disposal cell would be constructed within the boundary of the proposed FRC. Due to controls used at the EMWMF there are no anticipated releases (DOE January 1998).

Construction and Operation of the Spallation Neutron Source. DOE issued a NEPA Record of Decision on June 30, 1999 (64 FR 125) to proceed with the construction and operation of a Spallation Neutron Source (SNS) facility at ORNL. The SNS is an accelerator-based research facility that will provide U.S. scientific and industrial research communities a source of pulsed neutrons. The facility will be used to conduct research in such areas as materials science, condensed matter physics, the molecular structure of biological materials, properties of polymers and complex fluids, and magnetism. The SNS is being built near the top of Chestnut Ridge approximately four miles (6 km) southwest of the proposed FRC contaminated area. According to the EIS for the SNS (DOE 1999a), radioactive contamination of the earthen berms surrounding the SNS is expected. However, SNS is located on a ridge (away from the proposed FRC) and there is no expected contamination of groundwater. Emissions from the SNS will drain into White Oak Creek in the Bethel Valley, whereas the proposed FRC, located in the Bear Creek Valley, would drain into Bear Creek. As described in Section 4.0, virtually no impact would be expected in developing and operating the FRC. Incremental impacts would be minimal and would not be cumulative with those associated with construction and operation of the SNS. SNS and the proposed FRC are in different drainage basins of the ORR. As neither activity is expected to produce adverse impacts from its liquid emissions, it is expected that there would be no cumulative impacts from these geographically separate facilities.

Transportation of Low-Level (Radioactive) Waste and Mixed Low-Level (Radioactive) Waste from the ORR to Offsite Treatment or Disposal Facilities. DOE proposes to package and transport low level waste (LLW) and mixed LLW offsite for treatment and disposal. Onsite disposal is not available for the expected lifecycle volumes nor the technical constituents of many Oak Ridge LLW streams. Because waste disposal is critical to ongoing environmental cleanup and reindustrialization of the Reservation as well as to ongoing research and defense missions, the DOE proposes to package and transport significant quantities of existing and forecasted ORR LLW to other DOE sites or to licensed commercial facilities for treatment or disposal. There are currently two draft EAs being prepared for these projects. Based on available information, some of the contaminated wastes from research conducted at the proposed FRC would be considered both LLW and mixed LLW and could be transported to an offsite facility for treatment or disposal. However, waste quantities have been estimated to be very small (12,000 gallons [about 46,000 L] of groundwater and 20 cubic feet [0.56 cubic meters] of soil per year). These volumes are less than one percent of the total ORR wastes considered in the EAs (DOE 1999a). It is expected that wastes from the proposed FRC would not contribute to cumulative effects of transporting LLW for the ORR.

5.1.1 Earth Resources

Operation of the proposed FRC would not contribute to the cumulative impact on geology or soils of the ORR or surrounding communities. As described in Section 4.1.1, no significant problems have been identified with regard to site stability or the soil medium that would constitute impacts by themselves or combined with existing or future conditions to create cumulative impacts. None of the projects or reasonably foreseeable activities described above are expected to affect the earth resources of the BCV, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.1.2 Climate and Air Quality

Operation of the proposed FRC would not contribute to the cumulative impact on the climate or air quality of the ORR. The ORR is in an attainment area for NAAQS and no activities (e.g., drilling or small-area land clearing) planned for the FRC would constitute an impact by themselves (see Section

4.1.2) or, combined with existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above are expected to affect the climate or air quality of the BCV, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.1.3 Water Resources

Operation of the proposed FRC would not contribute to the cumulative impact on the surface water and groundwater of the ORR or surrounding communities. The possible addition of tracers, electron donors and acceptors, nutrients and microorganisms, and other substances (see Section 4.1.3) have been shown to have little consequence on the quality of the surface water (Bear Creek) or the surrounding groundwater. These activities would not constitute an impact by themselves or, combined with existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above are expected to affect the water resources of the BCV, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

As stated in the Floodplain Assessment for Site Investigation Activities at the Oak Ridge Y-12 Area of Responsibility (DOE 1996), "The activities addressed by the floodplain assessment will result in no measurable impact of floodplain cross-sections or flood stage, and thus do not increase the risk of flooding." The proposed FRC activities planned within the floodplain would be small in nature (see Section 4.1.3.2) and would not constitute an impact by themselves or, combined with the existing or reasonably foreseeable future conditions, create cumulative impacts.

5.1.4 Ecological Resources

Terrestrial and aquatic species within the area of the proposed FRC would not be impacted (see Section 4.1.4) because of measures that would be taken to avoid areas of sensitivity (e.g., the Environmental Research Park and areas used for seasonal hunting). Section 4.1.3 discusses the potential impacts to Bear Creek and demonstrates that no impacts would be expected. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above are expected to affect the ecological resources of the BCV, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.1.5 Archaeological, Cultural, and Historic Resources

According to the Tennessee State Historic Preservation Officer, no cultural resources have been identified within the proposed contaminated area and background area (Appendix E). In addition, no historic sites are located within the proposed boundaries of the FRC. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.1.6 Land Use, Recreation, and Aesthetic Resources

The land uses of the Bear Creek Valley include developed areas such as those near the Y-12 Plant, the S-3 Ponds Site, and waste control areas that are open and highly visible. In addition, there are some

forested areas. As discussed in Section 4.1.3, research similar in nature to that proposed for the FRC has been taking place. There would be no major changes in the existing use of the areas proposed for the FRC and no major construction necessary for the operation of the proposed FRC. Trailers, drill rigs and other equipment would be placed in previously disturbed areas. Areas used for seasonal hunting would be avoided during hunting season. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.1.7 Socioeconomic Conditions

Employees of the proposed FRC would be existing employees from ORNL and researchers would be small in number (see Section 4.1.7). The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts. When combined with the number of workers and researchers expected to be present at the SNS when it becomes operational, workers on the FRC could contribute to minor positive economic impacts, and only minor effects on housing availability and regional community services.

5.1.8 Human Health

The proposed activities conducted at the FRC would not pose any potential for adverse impacts to workers or the offsite public (see Section 4.1.8). These activities would not add any significant quantities of radioactive emissions to the air, would not impact groundwater to levels above drinking water standards, and workers would not be exposed to any doses of radiation or chemicals that would be of concern. These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.1.9 Waste Control

The approximate volume of waste generated and requiring storage for the proposed FRC would be minimal (see Section 4.1.9) in comparison with quantities generated through environmental remediation activities on the ORR (DOE 1998). These activities would not constitute an impact by themselves, or combined with the existing or future conditions, create cumulative impacts.

5.1.10 Transportation

The employees of the proposed FRC are currently employed by ORNL so there would be no impact to traffic within the ORR. In addition the number of expected visitors to the FRC is expected to be minimal (see Section 4.1.7). The main traffic route expected for the workers at the SNS facility will be via Bethel Valley Road and Bear Creek Road as FRC workers and researchers drive between ORNL and the FRC. It is expected that the FRC-related traffic will be very light and would not create any incremental or cumulative impacts. The majority of SNS-related traffic would occur during the construction period of the facility and then would decrease; this would occur approximately half-way through the expected ten-year life of the FRC.

Transportation of minimal quantities of hazardous materials is expected throughout the course of FRC operations (see Section 4.1.10). Transportation offsite of LLW and mixed LLW is currently being

evaluated; however, the amounts generated from FRC operations would be insignificant in comparison to quantities generated by the ORR requiring transportation (DOE 1999e, DOE 1999f).

These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.1.11 Utilities and Infrastructure

Impacts to utilities and infrastructure such as housing, education, health care, police and fire protection, and water and sewage are not anticipated as a result of the small number of individuals involved in the operation or research activities of the proposed FRC. No new construction would be required for operation of the FRC. The siting of trailers and small staging areas for support equipment would be in previously disturbed areas and therefore would have impact on existing infrastructure. These activities would not constitute an impact by themselves or combined with the existing or future conditions create cumulative impacts.

5.1.12 Environmental Justice

Based on the analysis in this document as well as information derived from the SNS EIS (DOE 1999a), there would be no disproportionate risk of significantly high and adverse potential impacts to low-income and minority populations (see Section 4.1.12). There are no known subsistence populations residing in or near the BCV. Therefore, the addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2 Cumulative Effects of Siting and Operating an FRC on the PNNL/100-H Area

The actions that DOE considers reasonably foreseeable and pertinent to the analysis of cumulative effects for the PNNL/100-H Area are described in the section below.

Interim Remedial Action at the 100-HR-3 Operable Unit. The proposed FRC lies within the 100-HR-3 CERCLA Operable Unit that falls under the Tri-Party Agreement. This operable unit is currently undergoing an interim remedial action (pump-and-treat system) for chromium contamination in accordance with a CERCLA Interim Record of Decision. The proposed FRC would be located hydraulically upgradient of the pump-and-treat system. The system is currently pumping contaminated groundwater from two wells immediately adjacent to the Columbia River, passing the water through an ion-exchange filter, and injecting the treated water into several wells located 600 to 700 yards upgradient of the river. Through the CERCLA Interim Record of Decision, the EPA and DOE are scheduled to review the status and success of this pump-and-treat effort in 2002.

Excavation of the 107-H Retention Basin. The 107-H Retention Basin is currently undergoing excavation, which will continue into FY 2000. The excavation requires the removal of large quantities of contaminated soils by truck across the 100-H Area. The 107-H Retention Basin is located southeast of the proposed contaminated area and east of the proposed background areas. The proposed FRC was located in conjunction with the site environmental contractor to avoid the planned remediation activities. Due to the small number of investigators that would be involved at an FRC, there would be no increase in the overall traffic through the 100-H area.

H Reactor Building Cocooning. Within the next five years (1999 to 2004) the H Reactor Building is scheduled for "cocooning." Cocooning involves the dismantlement of ancillary reactor facilities and placement of the reactor core into safe, interim storage. The core will be kept within a storage enclosure designed to provide safe storage for up to 75 years with minimal maintenance required. The H Reactor is located outside the proposed FRC contaminated area. The cocooning process will require a short-term increase in the traffic and number of workers traveling across the 100-H area.

Comprehensive Land Use Plan-Columbia River Corridor. The 100-H Area lies within an area defined in the Record of Decision for the Hanford Comprehensive Land-Use Plan EIS as the Columbia River Corridor (DOE/RL November 1999b). The Columbia River is used by the public and tribes for boating, water skiing, fishing and hunting of upland game birds and migratory waterfowl. Along the southern shoreline (access restricted) of the Columbia River Corridor, the 100 Areas occupy approximately 26 miles (68 km). RCRA closure permit restrictions have been placed in the vicinity of the 100-H Area, which is associated with the 183-H Solar Evaporation Basins. Additional deed restrictions or covenants for activities that potentially extend more than 15 feet (4.6 m) below ground surface are expected for the CERCLA remediation areas.

5.2.1 Earth Resources

Operation of the proposed FRC would not contribute to the cumulative impact on geology or soils of the 100-H Area or surrounding areas. As described in Section 4.2.1, no significant problems have been identified with regard to site stability or the soil medium that would constitute impacts by themselves or, combined with existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above would be expected to affect the earth resources of the 100-H Area, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.2.2 Climate and Air Quality

Operation of the proposed FRC would not contribute to the cumulative impact on climate or air quality of the Hanford Site. The Hanford Site (in Benton County) is in attainment for NAAQS except for particulate matter (PM). Benton County is "unclassified" for PM. No activities (e.g., drilling or small-area land clearing) planned for the FRC would constitute an impact by themselves (see Section 4.2.2) or, combined with existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above would be expected to affect the climate or air quality of the 100-H Area, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.2.3 Water Resources

Operation of the proposed FRC would not contribute to the cumulative impact on the surface water and groundwater of the 100-H Area or surrounding areas. The possible addition of tracers, electron donors and acceptors, nutrients and microorganisms, and other substances (see Section 4.2.3) would have little consequence on the quality of the surface water (the Columbia River) or the surrounding groundwater. These activities would not constitute an impact by themselves or, combined with existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above would be expected to affect the water resources of the 100-H

Area, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.2.4 Ecological Resources

Terrestrial and aquatic species within the area of the proposed FRC would not be impacted (see Section 4.2.4). Section 4.2.3 discusses the potential impacts to the Columbia River and demonstrates that no impacts would be expected. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts. None of the projects or reasonably foreseeable activities described above would be expected to affect the ecological resources of the 100-H Area, thus the minimal effects from proposed FRC activities would not contribute to cumulative impacts.

5.2.5 Archaeological, Cultural, and Historic Resources

According to PNNL, no cultural resources have been identified within the proposed contaminated area and background area (Appendix E). A portion of the contaminated area is located within 440 yards (400 m) of the Columbia River. The Columbia River and its shorelines are considered culturally sensitive; however, consultation with PNNL's cultural resource experts would be required before any activities could take place in that area. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.6 Land Use, Recreation, and Aesthetic Resources

The proposed contaminated area and background area would not conflict with or have any adverse impacts to any existing land uses in the 100-H Area, including ongoing remediation activities. The designation in the Comprehensive Land Use Plan EIS as the Columbia River Corridor does not preclude the types of activities that have been discussed. Section 4.2.3 concluded that there were no impacts to the Columbia River by the injection of tracers, electron donors and acceptors and nutrients, microorganisms, and other substances. Therefore, use of the Columbia River for boating, fishing and water skiing would not be effected. The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.7 Socioeconomic Conditions

Employees of the proposed FRC would be existing employees from PNNL and researchers would be small in number (see Section 4.2.7). The addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts. When combined with the number of workers and researchers expected to be present at the cocooning operations at the H-Reactor and the cleanup work at the 107-H Evaporative Basin, workers on the FRC could contribute to minor positive economic impacts, and only minor effects on housing availability and regional community services.

5.2.8 Human Health

The proposed activities conducted at the FRC would not pose any potential for adverse impacts to workers or the offsite public (see Section 4.2.8). These activities would not add any significant quantities of radioactive emissions to the air, would not impact groundwater to levels above drinking water standards, and workers would not be exposed to any doses of radiation or chemicals that would be of concern. These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.9 Waste Control

The approximate volume of waste generated and requiring storage for the proposed FRC would be minimal (see Section 4.2.9) in comparison with the quantities generated through the environmental remediation activities on the Hanford Site (DOE 1998). The volumes of waste produced by the FRC would be less than one percent of the total waste produced on the Hanford Site. These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.10 Transportation

The employees of the proposed FRC are currently employed by PNNL so there would be no impact to traffic within the 100-H area. In addition the number of expected visitors to the FRC would be expected to be minimal (see Section 4.2.7). It is expected that the FRC-related traffic would be very light and would not create any incremental or cumulative impacts. The majority of FRC-related traffic in the 100-H Area would occur during the start-up period of the FRC and then would decrease; this would occur approximately half-way through the expected ten-year life of the FRC.

Transportation of minimal quantities of hazardous materials would be expected throughout the course of FRC operations (see Section 4.2.10). These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.11 Utilities and Services

Impacts to utilities and infrastructure such as housing, education, health care, police and fire protection, and water and sewage would not be anticipated as a result of the small number of individuals involved in the operation or research activities of the proposed FRC. No new construction would be required for operation of the FRC. The siting of trailers and small staging areas for support equipment would be in previously disturbed areas and therefore would have impact on existing infrastructure. These activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

5.2.12 Environmental Justice

No potential impacts have been identified that would affect 100-H employees or offsite public. The Columbia River is the only resource that could possibly cause disproportionate risk or significantly high and adverse impacts to low-income and minority populations, as it is potentially used for

subsistence fishing (Neitzel et al. 1999). However, Section 4.2.3 concluded that there would be no impacts to the Columbia River as a result of FRC research. Therefore, the addition of the proposed FRC activities would not constitute an impact by themselves or, combined with the existing or future conditions, create cumulative impacts.

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6.0 RELATED NEPA AND OTHER DOCUMENTS

Draft DOE/EA 1315, Department of Energy. *Draft Environmental Assessment for Transportation of Low-Level Radioactive Waste from the Oak Ridge Reservation to Offsite Treatment or Disposal Facilities, Oak Ridge, Tennessee, 1999e.*

Draft DOE/EA 1317, Department of Energy. *Draft Environmental Assessment for the Transportation of Low-Level Radioactive Mixed Waste from the Oak Ridge Reservation to Offsite Treatment or Disposal Facilities, 1999f.*

U.S. Department of Energy. *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source, DOE/EIS-0247, Vols. 1 and 2, Office of Science, Washington, D.C., April 1999.*

U.S. Department of Energy. *Notice of Intent for Preparation of a Site-Wide Environmental Impact Statement for the Y-12 Plant (64 FR 13179), Oak Ridge, Tennessee, March 17, 1999.*

U.S. Department of Energy. *Record of Decision: Hanford Comprehensive Land Use Plan Environmental Impact Statement, Washington, D.C., November 12, 1999.*

U.S. Department of Energy, Richland Field Office (DOE/RL). *Record of Decision: Hanford Comprehensive Land Use Environmental Impact Statement, (64 FR 218), Richland, Washington, November 1999b.*

U.S. Department of Energy. *Report of the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (DOE/OR/01-1455 & D2), March 1997.*

U.S. Department of Energy. *Report on the Feasibility Study of the Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (DOE/OR/02-1525 & D2), November 1997.*

U.S. Department of Energy. *Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan, DOE/EIS-0222D, Washington, D.C., 1999.*

U.S. Department of Energy, Office of Environmental Management. *Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, (DOE/OR/02-1637&D2), January 1998. (NEPA values were considered in the RI/FS.)*

U.S. Department of Interior (DOI). *United States Department of Interior Record of Decision – Hanford Reach of the Columbia River: Final Environmental Impact Statement for Comprehensive River Conservation Studies, Washington, D.C., July 16, 1996.*

U.S. EPA. Record of Decision, 100-HR-3, 100-KR-4 Operable Units, Hanford Site, Benton County, Washington, EPA/ROD/RIO-96/134, Washington, D.C., April 1, 1996.

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7.0 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Based on the analysis in this EA, and based upon previously conducted research similar in nature to that which is preferred, no unavoidable adverse impacts are expected. (See Appendix F.)

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8.0 SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The FRC would be used for approximately ten years to support bioremediation research. The various types of bioremediation research activities that would take place during the lifecycle of the FRC would result in a greater understanding of fundamental biogeochemical processes in a contaminated subsurface environment.

Resources (staff, land area, etc.) expected to be used during the lifecycle of the FRC, would be minimal. The proposed research at the FRC would not preclude any other activities that might take place at the field locations. However, all future research proposals would be analyzed for their potential to impact long-term productivity. This would be done under the NABIR Program's Tier II NEPA process (as described in Appendix A.)

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9.0 APPLICABLE ENVIRONMENTAL REGULATIONS, EXECUTIVE ORDERS, PERMITS AND DOE ORDERS

All operations conducted at the FRC would be conducted in conformance with applicable environmental standards established by federal and state statutes and regulations, executive orders, DOE orders, work smart standards, and compliance and settlement agreements.

The principal regulatory agencies would be the U.S. EPA and state regulators. These agencies issue permits, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

The three DOE program offices with potential interest in the proposed FRC activities are the Office of Science, the Office of Environmental Management (EM), and the Office of Defense Programs. These program offices would be responsible for compliance with the environmental requirements applicable to activities associated with their individual missions. Depending on the nature of the activity to be conducted at the FRC, regulatory oversight and requirements of any of the three program offices might be applicable. Major federal environmental statutes that would apply to the various activities conducted by these programs include:

- Act to Authorize a Study of the Hanford Reach
- Anadromous Fish Conservation Act
- Atomic Energy Act of 1954
- Bald and Golden Eagle Protection Act
- Clean Air Act
- Clean Water Act, including 404 concerning wetlands requirements
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Endangered Species Act (ESA)
- Federal Land Policy and Management Act (FLPMA)
- Federal Wildlife Restoration Act
- Fish and Wildlife Coordination Act
- Hazardous Materials Transportation Act (HMTA)
- Migratory Bird Treaty Act (MBTA)
- Mineral Leasing Act
- National Environmental Policy Act (NEPA)
- National Historic Preservation Act (NHPA)
- Occupational Safety and Health Act (OSHA)
- Occupational Radiation Protection
- Oil Pollution Act

- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)
- Sikes Act
- Surface Mining Control and Reclamation Act
- Toxic Substances Control Act (TSCA)
- Wild and Scenic Rivers Act

Executive orders would include:

- Executive Orders 11644 and 11989: Off-Road Vehicles on Public Lands
- Executive Order 11987: Exotic Organisms
- Executive Order 11988: Floodplain Management
- Executive Order 11990: Protection of Wetlands

The primary state statutes and resource management initiatives would be:

Tennessee

- Tennessee Air Quality Act
- Tennessee Hazardous Waste Management Act
- Tennessee Petroleum Underground Storage Tank Act
- Tennessee Solid Waste Disposal Act
- Tennessee Water Quality Control Act of 1977

Washington

- Draft Hanford Site Biological Resource Management Plan
- Draft Hanford Site Biological Resources Mitigation Strategy Plan
- Washington Administrative Code (WAC) 173-470 through 173-481, radionuclides and fluorides
- WAC 246-247, "Radiation Protection—Air Emissions"
- WAC 173-218, "Underground Injection Control Program"
- WAC 173-160, water well drilling on the Hanford site
- WAC 173-216, state permit program for the discharge of waste materials from industrial, commercial, and municipal operations into ground and surface waters of the state
- WAC 173-303, "Dangerous Waste Regulations"
- Washington State Hunting and Fishing Regulations

- Washington State Hydraulic Code
- Washington State Natural Heritage Program
- Washington State Priority Habitats and Species Program
- Washington State Shoreline Management Act
- Definitions of Public Land and their Applicability to Hanford

Relevant DOE policies and orders include:

- DOE P 142.1 and N 142.1, Unclassified Foreign Visits and Assignments
- DOE P 441.1, Radiological Health and Safety Policy
- DOE P 450.4, Safety Management System Policy
- DOE P 450.5, Line Environmental, Safety and Health Oversight
- DOE O 151.1, Chg. 2, Emergency Preparedness
- DOE O 232.1A, Occurrence Reporting
- DOE O 241.1, Scientific and Technical Information Management
- DOE O 430.1A, Life Cycle Asset Management
- DOE O 435.1, Radiological Waste Management
- DOE O 440.1A, Worker Protection
- DOE O 451.1A, National Environmental Policy Act Compliance Program
- DOE O 460.1A, Packaging and Transportation Safety
- DOE O 470.1, Chg. 1, Safeguards and Security Program
- DOE O 474.1, Control and Accountability of Nuclear Materials
- DOE O 1230.2, American Indian Tribal Government Policy
- DOE O 4300.1C, Chg. 1, Real Property Management
- DOE O 5400.5, Chg. 2, Radiological Protection of the Public and the Environment

Other regulations include:

- 49 *CFR* 397, Department of Transportation, "Transportation of Hazardous Materials: Driving and Parking Rules"
- 10 *CFR* 20.1002, Nuclear Regulatory Commission, "Possession License"
- U.S. Fish and Wildlife Service Mitigation Policy
- Public Trust Doctrine

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12.0 GLOSSARY

Abiotic: Not caused or produced by living beings.

Accelerated Bioremediation: Bioremediation accelerated beyond the normal actions of the naturally occurring microbial community and chemical and geological conditions, usually by the addition of nutrients or specialized microbes.

Aerobic: Living, active, or occurring only in the presence of oxygen.

Alluvium: Any stream-laid sediment deposit.

Anaerobic: Living, active, or occurring in the absence of free oxygen.

Anisotropy: The condition of exhibiting properties with different values when measured in different directions.

Anoxic: An environment without oxygen.

Aquifer: Stratum of permeable rock, sand, or gravel that can store and supply groundwater to wells and springs.

Archaea: A group of prokaryotic single-celled microorganisms that constitute the recently recognized Archaea phylogenetic domain. Archaea can be distinguished from bacteria in that their cell walls do not have murein, a peptidoglycan-containing muramic acid. Another unique feature of archaea is the presence of isoprenyl ether lipids in their cell membranes. The Archaea domain includes the methanogens, most extreme halophiles (needing salt for growth), certain sulfate reducers, hyperthermophiles (optimum growth temperature of 80C or higher), and the genus *Thermoplasma*.

Areal: The measure of a planar region or the surface of a solid.

Bacteria: A group of prokaryotic single-celled microorganisms that constitute the Bacteria phylogenetic domain. Unlike archaea, their cell walls have murein, a peptidoglycan-containing muramic acid. Bacteria may have spherical (coccus), rod-like (bacillus), or curved (vibrio, spirillum, or spirochete) bodies. They inhabit virtually all environments, including soil, water, organic matter, and the bodies of eukaryotes.

Bacteriophage: A virus that attacks bacteria.

Basalt: A fine-grained igneous rock dominated by dark-colored minerals.

Bioaccumulation: Intracellular accumulation of environmental pollutants, such as heavy metals, by living organisms.

Bioaugmentation: The addition of microorganisms to the environment.

Biodegradation: The breakdown of organic materials into simpler components by microorganisms.

Bioremediation: The use of living organisms to reduce or eliminate environmental hazards resulting from accumulations of toxic chemicals and other hazardous wastes.

Biosequestration: The conversion of a compound through biological processes to a form that is chemically or physically isolated or inert.

Biostimulation: Addition of nutrients, oxygen, or other electron donors and acceptors to increase microbial activity and biodegradation.

Biotic: Caused or produced by living beings.

Biotransformation: Alteration of the structure of a compound by a living organism or enzyme.

Catalyst: A substance that activates a chemical reaction and is not itself changed in the process.

Chelator: Any of a class of relatively stable coordination compounds consisting of a central metal atom attached to a large molecule, called a ligand, in a cyclic or ring structure.

Clastic: A texture shown by sedimentary rocks from deposits of mineral and rock fragments.

Complexing Agent: A dissolved ligand that binds with a simple charged or uncharged molecular species in a liquid solution to form a complex, or coordination compound.

Contaminant: Harmful or hazardous matter introduced into the environment.

Denitrification: The formation of gaseous nitrogen (N_2) or nitrogen oxide (NO) from nitrate (NO_3^-) or nitrite (NO_2^-) by microorganisms.

Diagenesis: All of the changes that occur to a fossil (or more generally any sediment) after initial burial; includes changes that result from chemical, physical as well as biological processes.

Electromagnetics : Electromagnetic instruments work by emitting a current into the ground from a transmitting coil at one end of the instrument. A secondary magnetic field, which is proportional to the subsurface conductivity is received at the other end of the instrument and recorded. Later the operator, using a graphical computer program converts the readings (expressed in millmho per meter) into a two dimensional map.

Electron: A stable atomic particle that has a negative charge.

Electron Acceptor: Small inorganic or organic compound that is reduced in a metabolic redox reaction.

Electron Donor: Small inorganic or organic compound that is oxidized in a metabolic redox reaction.

Enzyme: A complex protein that acts as a catalyst in living organisms, regulating the rate at which chemical reactions proceed without itself being altered in the process.

Eukarya: The phylogenic domain consisting of one-celled and multicelled organisms called eukaryotes that maintain their genome within a defined nucleus.

Evapotranspiration: The loss of water from the soil, both by evaporation and by transpiration from the plants growing there.

Flow Cells: Containers that are a few meters in size and serve as tools for examining blocks of soils and subsurface cores that are larger than the laboratory-scale core samples. They provide "controlled environments" that simulate the natural subsurface environment in a laboratory setting without field releases.

Fungi: Spore-producing eukaryotic organisms that lack chlorophyll; examples of fungi include molds, rusts, mildews, smuts, mushrooms, and yeasts.

Ground Penetrating Radar (GPR): Emit short pulses of radio-frequency electromagnetic energy into the subsurface from a transmitting antenna. The energy passes through the ground and some is reflected back to the receiving antenna. A computer processes the reflected signal, measures the strength and time between emission and reception and produces a visual representation of the subsurface.

Groundwater: Water found beneath the earth's surface that fills pores between materials, such as sand, soil, or gravel; supplies wells and springs.

Heavy Metals: Metallic elements with high molecular weights. Such metals are often residual in the environment, exhibit biological accumulation, and are generally toxic in low concentrations. Examples include chromium, mercury, and lead.

Heterogeneity: Consisting of dissimilar constituents.

Hydraulic Conductivity: The rate at which water will move through soil in response to a given potential gradient.

Hydrology: The study of the occurrence, distribution, and circulation of natural waters of the earth.

Infrastructure: Utilities and other physical support systems needed to operate a laboratory or test facility. Included are electric distribution systems, water supply systems, sewage disposal systems, and roads.

Inorganic Compounds: Chemicals that do not contain carbon, which is usually associated with life processes; for example, metals are inorganic.

In situ: In the original position or place.

Intrinsic Bioremediation: Bioremediation at a given site as a function of the naturally occurring microbial population and naturally occurring chemical, biological, and geological conditions. Also known as natural attenuation when dominated by biological processes, or natural bioremediation.

Isotope: Any of two or more species of atoms of a chemical element with the same atomic number (number of protons) and nearly identical chemical behavior but with a different number of neutrons, hence a different atomic weight.

Karst: A barren limestone region characterized by fissures, caves, and underground channels.

Lysimeters/Caissons: Large (holding tons of soil) open-ended canisters that can be closed with a lid, creating a closed system. Soil and sediment can be placed in the lysimeter to simulate the natural environment.

Magnetometer: Uses a sealed vessel containing a coiled copper wire surrounded by oil. The instrument generates a small current that causes the protons within the oil to spin in the direction of magnetic north. The protons then generate a small signal, which is sent to the collection part of the device via the coiled wire. By measuring the signal intensity and comparing it to a known atomic constant—the gyromagnetic ration of the proton—the magnetic field intensity at a discrete location can be obtained.

Methanogen: Microorganism that produces methane.

Microbe (microorganism): any living organism invisible or barely visible to the naked eye and generally observable only through a microscope.

Multi-level Well Sampler: A device, up to six feet long with separators every five centimeters, that can be lowered into a well. The separators form vertical barriers to prevent water from flowing between sampling intervals. Researchers can collect samples from any depth within the well to study the water constituents, homogeneity or heterogeneity. The sampler can be left in the well for an extended period or removed after samples are collected daily.

Natural Attenuation: Degradation or transformation of contaminants in an environment via naturally occurring physical, chemical, and biological processes. May include intrinsic bioremediation.

Non-reactive Tracer: An inert substance, such as helium gas, perfluorocarbons, or bromide, that can be used to obtain a greater understanding of groundwater flow paths and movement. When extracted from a downgradient well, an inert tracer is the same chemical or compound as that injected. See “Reactive Tracer.”

Operable Unit: A regulatory term meaning the division of cleanup of a release site into discrete action units that eliminate or mitigate a release, a threat of a release, or an exposure pathway.

Organic Compounds: Chemical compounds that contain carbon and hydrogen, elements usually associated with life processes.

Oxidation-Reduction Reaction: Coupled reactions in which one compound becomes oxidized, releasing electrons, while another becomes reduced, gaining the electrons released.

Pathogen: A specific causative agent (such as a bacterium or virus) of disease.

pH: A measure of acidity and alkalinity of a solution that is a number on a scale from 0 to 14. A value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers increasing alkalinity. Each unit of change represents a tenfold change in acidity or alkalinity. This change in acidity or alkalinity is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution.

Phytoremediation: Remediation using plants to remove contaminants from soils.

Piezometers: Used to measure fluctuating groundwater levels. Piezometers are installed in monitoring wells and operate by converting pressure exerted on a submersed diaphragm into a frequency signal that is transmitted up the well to a data recorded via a wire. For each pressure, there is a corresponding frequency signal. The signal generated by each piezometer is collected in a central data recorder. The depth of groundwater is calculated factoring varying weather conditions, such as temperature and barometric pressure. Measurements of the water table can be collected at any specified time interval, depending on the researchers' needs.

Plume: An elongated body of fluid, usually mobile and varying in shape. Used to define the contaminated areas of an environment.

Precipitate: The process whereby a solid settles out of a solution.

Prokaryote: One-celled microorganism whose genome is not contained within a nucleus. Comprising the two domains Bacteria and Archaea.

Protozoan: Any of a phylum or subkingdom (Protozoa) of chiefly motile and heterotrophic unicellular protists (as amoebas, trypanosomes, sporozoans, and paramecia) that are represented in almost every kind of habitat.

Radioactivity: Spontaneous emission by radionuclides of energetic particles through the disintegration of their atomic nuclei; the rays emitted.

Radionuclide: A radioactive species of an atom. Tritium, strontium-90, and uranium -235 are radionuclides.

Reactive Tracer: A substance, such as sulfate or ammonium that may interact with groundwater, minerals in sediments, or microorganisms. When extracted from a downgradient well, a reactive tracer is not the same chemical or compound as that injected. See "Non-reactive Tracer."

Receptors: Plants, animals, and people that may be exposed to contamination. A receptor can be exposed via the air and soil pathways (e.g., inhalation, ingestion, and contact), and the surface and groundwater pathways (e.g., contact and ingestion).

Redox Reaction: Oxidation-reduction reaction, involving transfer of electrons.

Resistivity: A technique using electrodes in contact with the ground to measure electrical resistivity. The depth of investigation is a function of the electrode spacing and geometry.

Saturated Zone: An underground geologic layer in which all pores and fractures are filled with water.

Sediment: Material in suspension in water or deposited from suspension or precipitation.

Seismic Refraction: Works by inducing a sound wave into the ground by means of a percussive device and measuring the return signal at predetermined distances from the source. By measuring the time it takes for the sound wave to arrive at the receivers, the researcher is able to infer the nature of the subsurface material.

Siliceous: Of, relating to, or containing silica or a silicate.

Stratified Sedimentary Rock: Formed, deposited, or arranged sedimentary rock in a sheetlike mass of one kind lying between beds of other kinds.

Stratigraphy: A branch of geology that deals with the origin, composition, distribution, and succession of strata.

Substrate: The substance acted upon by an enzyme.

Subsurface: The geologic zone below the surface of the earth; includes rock and sediment materials lying near but not exposed to the earth's surface.

Subsurface Geophysical Tomography: Subsurface geophysical (cross hole) tomography allows the researcher to create a horizontal profile of the subsurface using a method similar to that used from the surface to generate a vertical profile. This method first requires that bore holes be installed. The depth and diameter of the bore holes used are limited only by the size of the instruments to be lowered into them and the depth to which researchers are concerned. Instruments are lowered into at least two bore holes and a current is induced on one end. On the other end, a receiver measures the current. That reading is sent to a computer where the researchers can map the subsurface profile in the horizontal plane. By repeating this process at varying depths throughout the bore holes, they are able to generate a three dimensional profile of the subsurface. The bore holes can be backfilled when researchers have collected the data desired.

Surfactant: A natural or synthetic chemical that promotes the wetting, solubilization, and emulsification of various types of organic chemicals.

Tracer Elements: See reactive and nonreactive tracers.

Transmissivity: The rate at which water is passed through a unit width of rock under a unit hydraulic gradient.

Unsaturated Zone: An underground geologic layer in which pores and fractures are filled with a combination of air and water.

Vadose Zone: The unsaturated zone above the water table. Also known as the zone of aeration.

Volatile Organic Compounds (VOCs): Organic compounds that evaporate at room temperature.

Water Table: The upper limit of a geologic layer wholly saturated with water.

Zone of Root Influence: Soils or sediments in which roots from surface plants may be found or that may have an altered geochemistry due to nearby root/fungal associations.

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APPENDIX A

DETAILED DESCRIPTION OF THE PROPOSED ACTION

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1.0 DETAILED DESCRIPTION OF THE PROPOSED ACTION

1.1 General Description of an FRC

As designed, an acceptable Field Research Center (FRC) would consist of a contaminated area and a background area, laboratory/analytical facilities, and office space/trailers. The FRC would be of sufficient size to accommodate multi-investigator studies over the ten-year lifespan of the Natural and Accelerated Bioremediation Research (NABIR) Program. To the maximum extent possible, the program would use existing office, laboratory, and field facilities, including access and infrastructure support, to reduce costs and environmental impacts, to make efficient use of existing Department of Energy (DOE) facilities and infrastructure, and to reduce the need for new construction.

The Field Research Center would consist of a contaminated area and a background area. Within these areas would be test plots. The development and operation of an FRC is the focus of this Environmental Assessment.

The Office of Environment and Biological Research (OBER) proposes to establish one FRC for a long-term (ten-year) field research program. The FRC would be used for much of the field research sponsored by the NABIR Program, and would thereby provide a focus for integrating the field-based program within NABIR. The FRC and supporting infrastructure would be used to facilitate long-term, interdisciplinary research. It would be available as a user site for investigator-initiated research by scientists funded through this and other programs (e.g., the Environmental Management Science Program.)

The FRC would provide NABIR investigators with field research sites containing a spectrum of waste types and subsurface environmental media (vadose zone and zone of saturation) that are representative of both background and contaminated conditions within the DOE complex. The FRC would offer a source for standardized subsurface samples for NABIR researchers, and locations for *in situ* research. Field scale research at the FRC would offer the researcher the opportunity to move laboratory-based research to the field, and observe and manipulate bioremediation processes involving heavy metals and radionuclides in a small-scale field setting.

The FRC would be staffed by a full-time FRC manager and several full and part-time technical and administrative staff. FRC staff would help facilitate the researchers' access to field locations at the DOE site, and ensure coordination of research activities and compliance with applicable DOE environmental, safety and health (ES&H) requirements. OBER would provide funding for infrastructure, staff, and additional characterization and field campaigns. It also would anticipate "in-kind" support from the host DOE site. In-kind support could include matching funding, staffing or facilities from the host DOE site.

During the first year of FRC operation, work done at the site would primarily focus on planning and field site development and characterization. By the second year, some *in situ* research might also be conducted. Because intrinsic bioremediation of radionuclides and heavy metals is a slow process, any activities focused on intrinsic bioremediation would be expected to be performed throughout the life of the FRC.

1.1.1 Potential FRC Research Activities

The expected workforce for the proposed FRC is anticipated to be small: possibly a staff of up to six individuals, some of whom would be part-time employees of the FRC. Interns and/or postgraduate students might be employed. The number of visiting scientists at any one time would be small, but could be as many as 24 on occasion.

The FRC would be a primary source for groundwater and sediment samples for NABIR investigators. Obtaining research-quality samples would be critical to the research conducted under the NABIR program at the FRC. Groundwater would be sampled by pumping water from existing wells or by installing new wells. Approximately 200 groundwater samples per year would be expected. These would be small quantity samples, approximately one liter each and totaling less than 20,000 gallons (76,000 L) per year, and would not change the groundwater flow rates or availability of groundwater. Approximately 600 core samples of sediments would be taken over the ten-year life of the proposed FRC through the use of a drill rig or split-spoon sampler. Again, the sediment samples would be small in volume (approximately less than one cubic meter) and the drilling holes would be backfilled when no longer needed.

Other DOE program offices and programs that have conducted such research activities include the DOE Office of Environmental Management, which conducts remediation investigations of subsurface contamination; the former Subsurface Science Program (SSP), which conducted small-scale field research studies to obtain basic information on the subsurface; and the current small-scale investigations at Oyster, Virginia, which focused on understanding bacterial transport in a sandy environment. Work also has been conducted through DOE's Office of Environmental Management in collaboration with the Department of Defense, U.S. Environmental Protection Agency (EPA), and Dover Air Force Base, Dover, Delaware, to establish a groundwater remediation field laboratory to demonstrate and compare *in situ* detection, monitoring, and remediation technologies (Dover EA 1995). An environmental assessment prepared for the Dover project concluded that insignificant impacts to the environment and human health would be anticipated even if the proposed containment devices failed. Other examples of NEPA reviews that were conducted for those activities and Categorical Exclusions that were prepared are included in Appendix E. A description of how specific research activities would be incorporated into field studies at the proposed FRC contaminated and background areas is presented below in the general order in which field operations would be conducted.

1.1.1.1 Site Development and Characterization Activities at the FRC

Before any research activities would be undertaken, some "passive" surface and subsurface site characterization activities at both the background and contaminated areas would be initiated. Non-intrusive characterization of the subsurface might include the use of: a) ground penetrating radar (GPR) to determine moisture distribution and buried materials, b) electromagnetics to identify shallow contaminant plumes, and c) resistivity to determine lithology and geologic structure. Subsurface (intrusive) characterization might include: a) seismic tomography to determine geologic structure, fractures and moisture distribution; b) radar to determine clay and water content; c) direct-push (cone) penetrometer tests to determine mechanical properties of soils; d) creation of injection/extraction wells (Figure A-1); e) well logging to determine clay types, porosity, and aquifer characteristics; f) use of multi-level well samplers to collect groundwater samples and microorganisms; and g) installation of piezometers to measure

fluctuating groundwater levels. (Examples of these characterization activities and their associated NEPA actions are presented in Appendix F and in the Dover EA 1995.) Uncontaminated sediment and core removed from the well/bore holes would be distributed in accordance with site-specific DOE requirements. Contaminated sediment and core would be handled and disposed of in accordance with applicable regulations (see Section 9.0, Applicable Environmental Regulations, Permits and DOE Orders).

In addition to specific characterization evaluations, "active" characterizations might occur at the contaminated and background areas. An "active" characterization can be defined as the addition of some substance to the subsurface under controlled conditions. Three kinds of "active" characterization tests would be proposed at the FRC. Most of these are standard types of subsurface characterization techniques.

Pump/slug tests. Once a specific series of wells is installed in a specified area, the hydraulic properties of the subsurface must be determined. To do this, a pump test would be performed. Water level indicators would be installed in wells along the perimeter of the test area. A pump would be placed into the central well and water would be pumped out of the central well. The water level indicators in the perimeter wells would measure the drawdown, or the drop in the water level. The flow rate of the pump would be monitored and a plot of the drawdown over time would be created. Simple groundwater equations for flow properties through the subsurface could then be solved. In a slug test, a water level indicator would be lowered into a well after noting the initial water level. A slug of known volume, made of plastic or metal, would be dropped into the well. The water level indicator would record the displacement. Once a new equilibrium is reached the slug would be removed and the displacement would be measured again. This information could also be used to solve simple equations to determine hydraulic properties.

Tracer Experiments. These types of characterization experiments are often used to obtain a detailed understanding of groundwater flow paths and the speed at which groundwater and other substances might move through an aquifer. In general, a small quantity of a tracer in the form of a solid (e.g., 1 gram of bromide) would be dissolved into water to achieve a concentration that might range from 500 to 10,000 parts per million. The tracer solution would then be injected into a well. In the case of a gas tracer such as helium or neon, a cylinder of the gas (ranging in size from 20 to 30 liters, depending on the research to be conducted) would be injected into a well. Groundwater samples would then be collected from downgradient wells at discrete time intervals. These samples would be analyzed for the tracer. Based on the time it takes the tracer to reach the downgradient wells and in which wells the tracer is detected, physical and chemical properties of the aquifer could be determined.

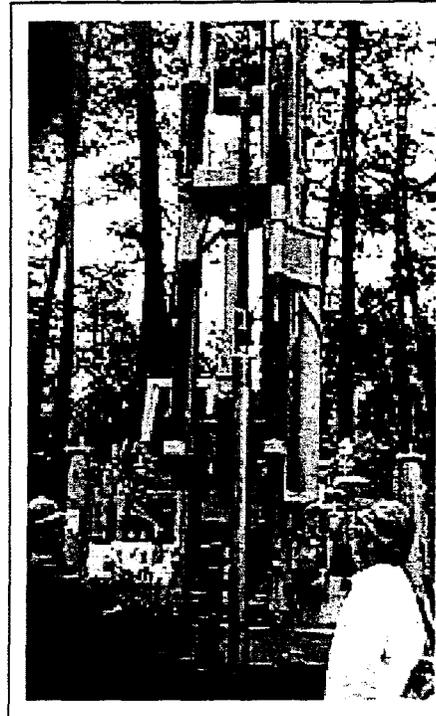


Figure A-1 Standard drill rig used for characterization activities

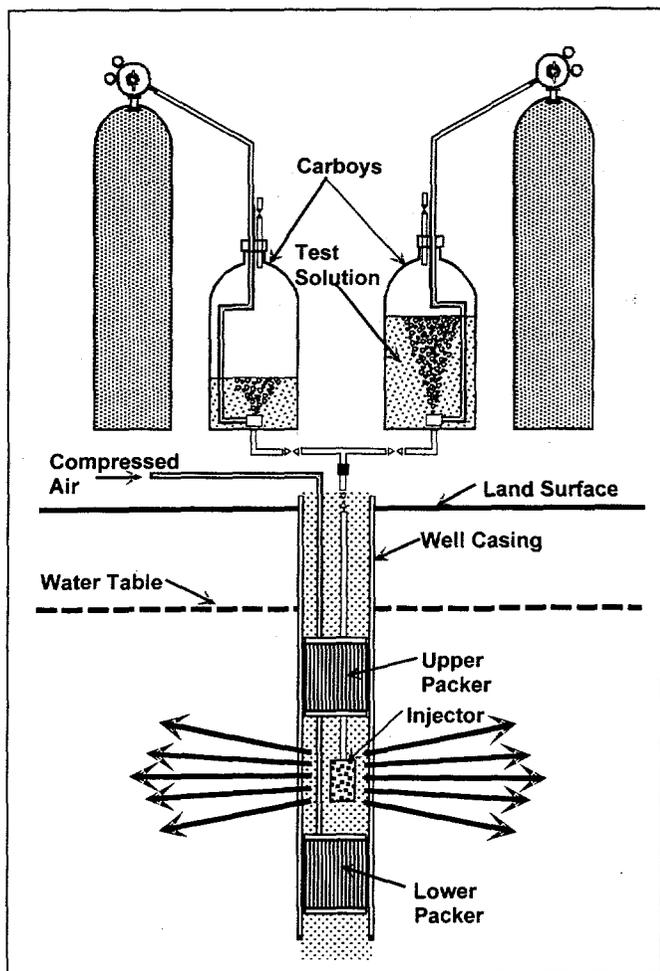


Figure A-2 Equipment used in field push-pull tests

an electron acceptor) is injected ("pushed") into a single well and left for up to a couple of hours. The test solution and groundwater are then extracted ("pulled") from the same well until background concentrations are reached. Often up to 90 percent of the injected water is extracted. Groundwater samples collected during the extraction phase are then analyzed to obtain information concerning the transport of the tracer and/or rate of transformation of the injected solutes (Figure A-2).

1.1.1.2 Research-Quality Samples to be Collected at the FRC

Obtaining research-quality samples would be critical to the research conducted under the NABIR Program. Samples obtained from the FRC could be used by researchers in laboratories at the host DOE site or could be sent to researchers at universities or DOE labs. The samples would be used in the laboratory as "starting points" to gain the knowledge needed prior to taking research to the test plots at the FRC.

Groundwater tracers used at the FRC would be nontoxic and are generally subdivided into two types: non-reactive and reactive. Non-reactive tracers are tracers that are inert and when extracted from a downgradient well are the same chemical or compound as that injected. A reactive tracer is a tracer that may interact with the groundwater, minerals in the subsurface sediments, or with microorganisms. When a reactive tracer is used, what is extracted from a downgradient well would not be the same chemical or compound as that injected. In general, NABIR investigators would use non-reactive tracers at the proposed FRC. The non-reactive tracer method would provide investigators with the information they would need regarding groundwater flow paths and other physical and chemical properties of the aquifer.

Push-pull experiments. A push-pull test is a relatively new technique that could be used to determine some additional chemical and physical properties of an aquifer. In a push-pull experiment, a few liters of water with a water-soluble tracer or some other type of solution (e.g., containing

In January 1999, OBER issued a "Letter Request for Field Research Center Proposals." (See Section 2.2.5 of this EA.) Both ORNL and PNNL prepared responses to scenarios/questions concerning sampling that were posed in the OBER Letter Request. The responses provide details concerning the approaches to be used to obtain research-quality samples. A general summary of the responses to these scenarios/questions follows. (In addition, the Dover EA 1995 and Appendix E provide NEPA documentation applicable to other sites where activities similar to those at the proposed FRC have previously occurred.)

Collection of groundwater samples containing radionuclides to be used for research on natural communities of microorganisms.

The purpose of the collection method would be to ensure that samples would be representative of the target environment, that entrained microorganisms and geochemical constituents would be stable, and that any dangerous constituents would be safely handled. Although an existing well could be used, a new well might need to be drilled. In that case, a well would be drilled to the desired depth and a mechanical pump would be used to extract the groundwater. Investigators might use peristaltic pumps, argon-bladder pumps, or submersible pumps as applicable to the needs of the researchers and the environment from which groundwater would be collected. Water and entrained constituents extracted from the well would be considered representative of the *in situ* formation water.

All equipment that would come in contact with the sample water, such as hoses, pumps, and fittings, would be cleaned and subjected to antiseptic treatment (e.g., autoclaving, bleach and rinse, as practical) before sampling. Sample bottles and associated supplies would be prepared and sterilized in the laboratory before transport to the FRC. Prior to sampling for microorganisms, some groundwater might have to be purged to ensure a quality sample.

Collection of core samples from saturated zones containing a heavy metal constituent to be used for research on natural communities of microorganisms.

One of the most effective means for obtaining samples from the subsurface for microbiological analysis would be to drill and recover intact core samples. The drilling methods employed might be air-rotary, cable tool, or sonic. One way to obtain a minimally disturbed sample would be to push a split-spoon sampler out ahead of the drilling bit. Sterile lexan liners would be used in the split-spoon sampler to maintain the physical, chemical, and microbiological integrity of the samples and to permit examination of the sedimentary features of the core. All drilling tools would be cleaned before sampling. Immediately on retrieval of the drill string from the borehole, the core would be removed from the split spoon and airtight caps would be placed on the ends of the liner. Once sealed, the exterior of the lexan liner would be washed free of mud and debris, disinfected, and the core sample would be immediately transferred to the field laboratory.

While still at the field site, the core would be opened, logged, pared to remove the outer, potentially contaminated surfaces, subdivided, and packaged for archiving or shipment to investigators (Figure A-3). For analysis of strictly anaerobic microorganisms and for oxygen-sensitive solutes, core samples would have to be protected from atmospheric oxygen. A core-processing chamber filled with an anoxic atmosphere would be used to store, process, dissect and pack core samples. Some additional analyses might need to be initiated on-site in the field. Storage and shipping of samples would be handled in a manner similar to that described for the groundwater samples and would follow all applicable regulations. For core samples from

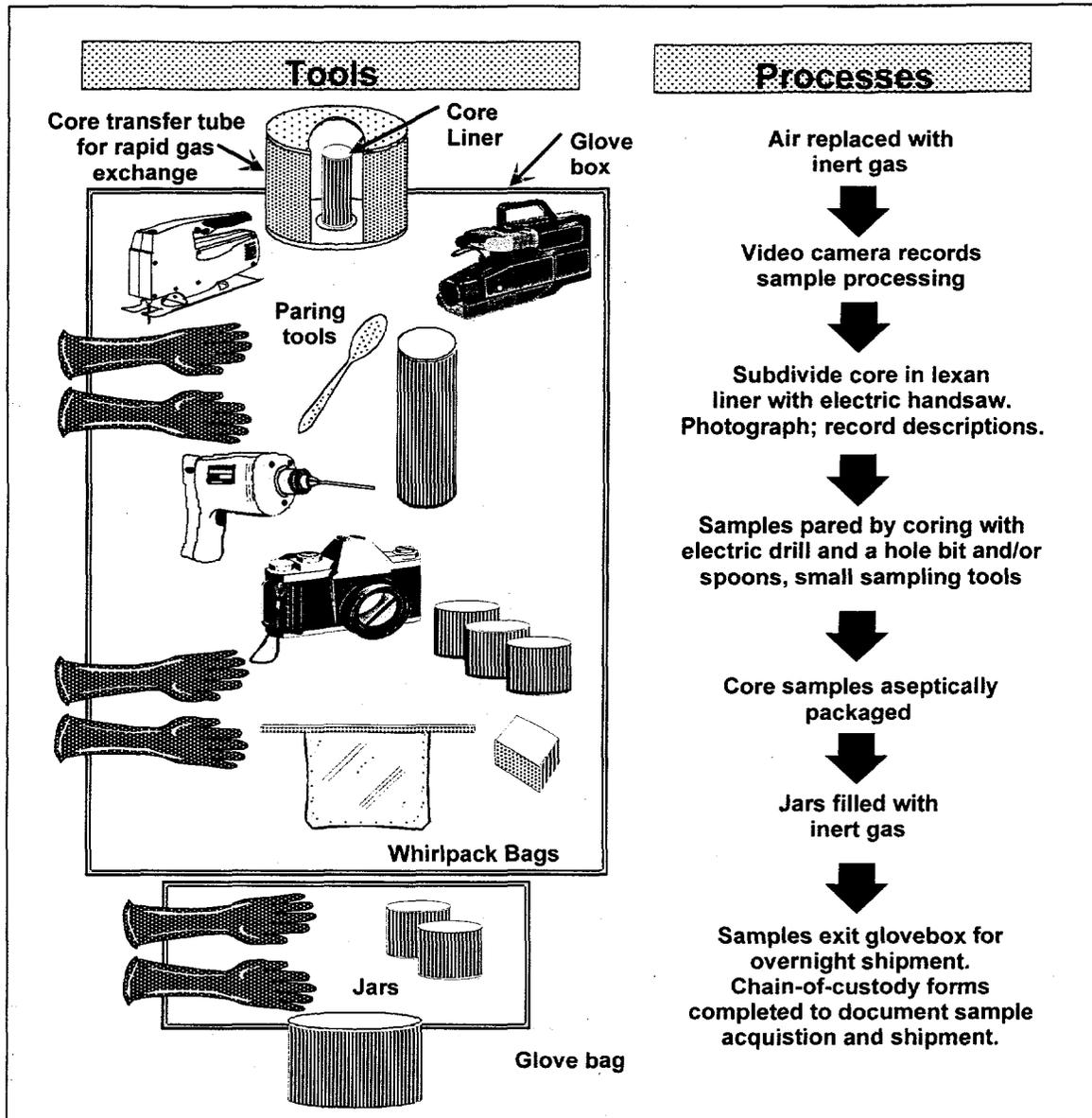


Figure A-3 Typical approach for processing of subsurface samples for microbiological and geochemical analysis

radioactively contaminated zones, special handling and training would be required (see Section 9.0, Applicable Environmental Regulations, Permits and DOE Orders).

1.1.1.3 Small-Scale In Situ Research Activities at the FRC

Because most of the activities at the proposed FRC would be undertaken in an area limited to less than an acre and a depth of 75 feet, the scale of *in situ* research activities is considered small.

(Examples of other studies in which similar activities have occurred, as well as their attending documentation, is presented in Appendix F and the Dover EA 1995.)

There are three standard ways to implement bioremediation as a remediation technology: a) intrinsic bioremediation, b) biostimulation, and c) bioaugmentation. *In situ* research at the proposed FRC would be oriented toward understanding the subsurface biogeochemical processes that control the success of any of these three technological approaches for remediating a site. Intrinsic bioremediation is an accepted remedial approach that relies upon the natural (intrinsic) activities of microorganisms to clean up a contaminated site. In contrast, biostimulation relies upon the addition of other substances (e.g., nutrients) to the subsurface to accomplish remediation. Bioaugmentation relies upon the addition of microorganisms to enhance any existing intrinsic processes in the subsurface to accomplish remediation. The primary focus of *in situ* research activities would be to understand subsurface biogeochemical processes associated with biostimulation and bioaugmentation.

Biostimulation

For a biostimulation experiment, a specific substance or set of substances would be introduced into the subsurface environment to stimulate existing microorganisms to bioaccumulate or transform a heavy metal or radionuclide (Figure A-4). Biostimulation activities might include: 1) the injection of electron donors (e.g., organic compounds such as acetate, lactate, glucose or molasses) or electron acceptors (e.g., oxygen, nitrate, methane or sulfate) to change a part of the chemical environment of the subsurface so that it is more favorable for microbial activity or growth; 2) the injection of nutrients (e.g., nitrogen, phosphorus) to stimulate the growth of

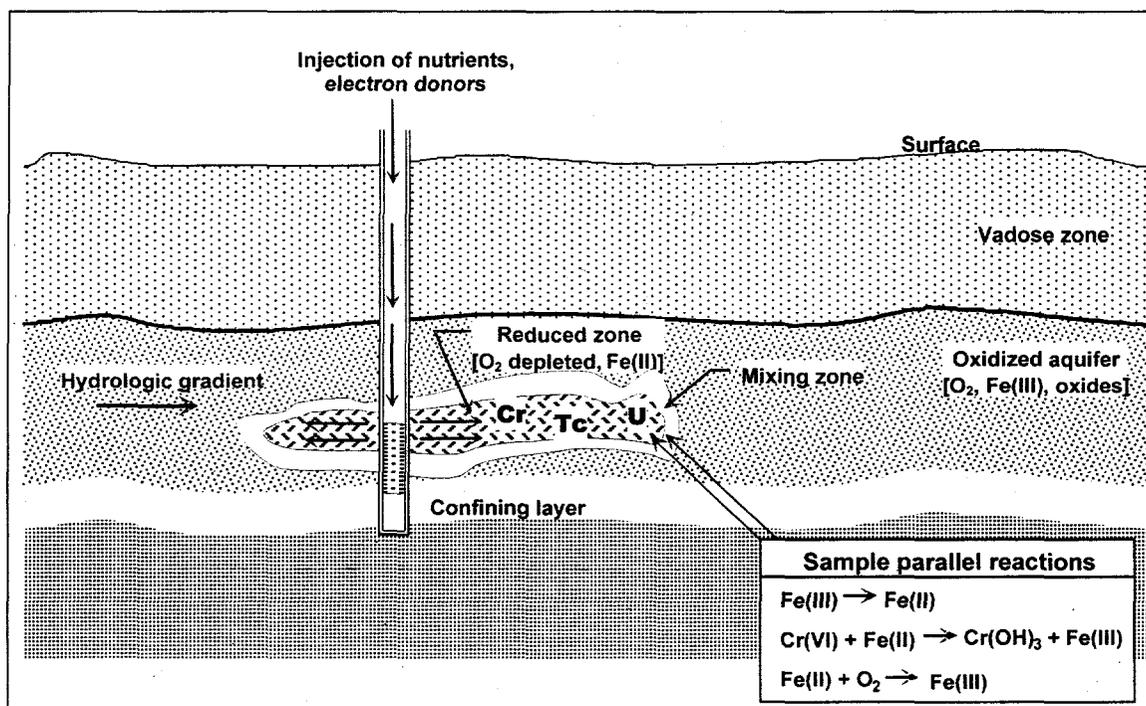


Figure A-4 In situ stabilization of metals through biostimulation

selected microorganisms; or 3) the injection of surfactants (e.g., rhamnolipids or other biopolymers) or chelators (e.g., nitrilotriacetic acid, ethylenediaminetetraacetic acid, hydroxyapatite) to better mobilize or immobilize contaminants for removal.

Prior to a biostimulation experiment, NABIR investigators would obtain information concerning groundwater flow rates and patterns, microbial populations, contaminant distributions, and geochemical and mineral content of the field site. In addition, they would have conducted laboratory-based biostimulation experiments with cores from the field site. Using these data, the investigators would also have created computer models to simulate what they would expect to occur in a real field site experiment.

An example of a typical biostimulation experiment is shown in Figure A-4. Nutrients such as low levels of nitrogen or phosphorus, or electron donors such as sugars or hydrogen gas, are injected into the subsurface in an area contaminated with radionuclides or metals, such as Cr(VI). Cr(VI) is a soluble form of chromium that is toxic and carcinogenic. The reduced form of chromium (Cr(III)), however, is relatively non-toxic and can be immobilized in place through precipitation with iron minerals. Addition of nutrients and electron donors enhances the growth of metal-reducing bacteria and leads to immobilization of chromium, reducing risk to humans and the environment.

Another type of biostimulation experiment that might be conducted would involve the injection of electron acceptors. This type of experiment could be conducted in an anaerobic subsurface environment. By adding an electron acceptor such as nitrate, sulfate or carbon dioxide to the subsurface, a specific microorganism might be able to remove electrons from a heavy metal or radionuclide (i.e., oxidize the heavy metal or radionuclide) through a series of chemical reactions. Depending on the subsurface geochemistry, the transformed heavy metal or radionuclide might then be less mobile in groundwater.

A standard method to deliver nutrients and other substances into the subsurface could include using a pump to inject substances (e.g., carbon sources, electron donors or acceptors, and nontoxic tracers).

Bioaugmentation

Bioaugmentation-type activities would involve the injection of a small quantity (1.5×10^6 bacteria/gram of soil) microbial strain or mixed culture of microorganisms into the subsurface at the FRC (Saylor 1999). Bioaugmentation-type activities might include the injection of: 1) a specific strain or strains previously isolated from the site (native), 2) a specific strain or strains isolated from some other field site (non-native), or 3) a combination of the first and second approaches. However, while non-native microorganisms might be considered, no GEMs would be injected at the FRC.

Because the strains or mixed cultures that would be injected would have been previously shown (in laboratory experiments) to be able to bioaccumulate or transform a heavy metal or radionuclide, experiments at the FRC would be oriented toward determining whether the microbial strain(s) could be appropriately distributed in the subsurface, whether they could survive under field conditions, and/or whether they would bioaccumulate or transform heavy metals or radionuclides under field conditions. To date, most attempts to distribute a strain or mixed culture within the subsurface environment have not been highly successful. Both in the

unsaturated and the saturated zones, microorganisms often do not move very far (a few meters) from the point of injection (Piotrowski and Cunningham 1996, Mosteller et al. 1997). The result is that the microorganisms often do not reach much of the contaminated area.

Perhaps of more importance, non-native microorganisms that are introduced into the subsurface often have difficulty surviving (ITRC 1998), and their population levels have been shown to decrease rapidly both in laboratory studies (Ramos et al. 1994) and in actual field studies (Krumme et al. 1994). In some cases, non-native microorganisms have been found to be undetectable in the subsurface after more than two years (Drahos 1991, Kluepfel et al. 1991), but in other cases, they have been shown to still be detectable at very low levels after two (Sayler 1999), four (Hirsch and Spokes 1994), and even six years (Ryder 1994). Among the reasons for the apparent rapid die off are factors such as predation by protozoans (Kuske 1995, Kinner 1998) and the poor ability of non-native microorganisms to compete with native microorganisms (ITRC 1998).

In spite of these difficulties, there are a number of commercial firms that "sell" bioaugmentation approaches to organizations that are required to clean up sites that have organic contaminants in the subsurface (Boyd 1996, Fustos and Lieberman 1996). These commercial firms attempt to overcome some of the bioaugmentation limitations by performing multiple injections, by injecting microorganisms every few meters in a contaminated area, or by injecting large volumes of nutrients and microorganisms. In some cases, bioaugmentation for the remediation of organic contaminants has been shown to be successful (Duba et al. 1996, Stefan et al. 1997). In contrast, there is only limited understanding of bioaugmentation for heavy metals and radionuclides.

Prior to undertaking a bioaugmentation experiment at the FRC, NABIR investigators would require some understanding of the natural transport of microorganisms through the subsurface environment. For example, some NABIR investigators are planning studies of bacterial transport in the subsurface at a fairly simple environment (deposited sands) at an uncontaminated, non-DOE field site in Oyster, Virginia. At the Oyster site, NABIR investigators will be undertaking a series of tracer and bacterial transport experiments. For the bacterial transport experiments, bacteria to be injected are native. Knowledge gained in an uncontaminated environment with a simple geologic structure is expected to help NABIR investigators when it comes to the more complex geologic environment at either ORNL or PNNL. In addition to the field experiments, computerized models of the subsurface at Oyster and the expected patterns and rates of transport of the microorganisms will be created. The actual field experiments will be correlated with the models.

In the case of a bioaugmentation experiment at an FRC, a similar process would be employed. NABIR investigators would first seek to understand the natural transport properties of the groundwater by injecting nontoxic tracers. NABIR investigators would use core extracted from the field site to conduct laboratory-based experiments to examine the transport of microorganisms through the cores. Once sufficient preliminary understanding is obtained, a team of NABIR investigators would conduct a field experiment that would involve the injection of multiple nontoxic and non-reactive tracers and microorganisms. Monitoring and sampling for the tracers and microorganisms would be conducted at multiple levels in downstream wells. Investigators would also seek to determine how well or whether the injected microorganisms survive (i.e., whether they survive predation by protozoans or whether they are "stuck" in the interstitial or pore spaces in the sediments and are unable to move).

More complex bioaugmentation field experiments might follow and might include combining a bioaugmentation experiment with a biostimulation experiment (i.e., injecting microorganisms and nutrients). The concept behind such an experiment would be to retain microorganisms at a desired location in a contaminated area and to have them actively transform heavy metals or radionuclides such that they become less toxic or less mobile in the subsurface. The standard method to deliver nontoxic tracers and microorganisms to the subsurface is to use a pump to inject water or a nutrient solution that contains the tracers and/or microorganisms. Specific field experiments at the proposed FRC, such as those described above, could be undertaken only when appropriate permitting and NEPA reviews were completed.

1.1.2 Assessing and Managing Environmental, Health and Safety Risks at the FRC

A critical aspect of the current NABIR Program and its proposed field-based component on the preferred FRC site, is compliance with applicable ES&H regulations. The NABIR Program conducts research activities in a way that poses the least impact to the human environment. Following current DOE practice, the appropriate DOE Operations Office ensures compliance with all regulatory and permitting requirements before research funding is released and/or laboratory/field activities commence for all research activities conducted under the NABIR Program. This also would apply for all work that would be conducted at the proposed FRC. In addition to satisfying DOE's ES&H requirements, the appropriate Operations Office would comply with the requirements of other applicable federal, state, and local laws for each research project. For activities at the proposed FRC, the FRC Manager would provide the coordination necessary to ensure DOE ES&H requirements were met, all site policies and procedures were followed, and site training and security requirements were met.

1.1.2.1 NABIR NEPA Strategy

One tool that can be used to evaluate the potential impacts posed by research activities is the NEPA process. A NEPA document examines proposed activities and evaluates their potential impact on the human environment. The following paragraphs highlight how the use of the NEPA process within the NABIR Program would be used to assess risk, as well as what some of the potential areas of impact would be for conducting research under the NABIR Program. Although the NEPA process addresses, in detail, how risks to the human environment would be dealt with, there are management practices that NABIR Program management would implement to reduce the risks to acceptable levels. These also are discussed below.

The strategy for NEPA compliance associated with selection and operation of the proposed FRC is two-tiered. The first tier includes the preparation of this EA to evaluate the potential environmental impacts of selection and operation of the proposed FRC. This EA attempts to bound the type of work expected to occur at the FRC based on work that has occurred in other similar programs. This EA also bounds the potential environmental consequences expected from the proposed activities.

The second tier of the NABIR NEPA compliance process would be evaluation of the appropriate level of NEPA documentation that would be prepared for proposed specific field research. Resources that might require further NEPA evaluation might include groundwater, sensitive

species, and archaeological and historic resources. The Tier II evaluation would consider whether the proposed field research is bound by this EA. If, during the course of the Tier II evaluation, it was decided that the actions were not bound by this EA and could potentially significantly affect the human environment, appropriate NEPA review would be initiated.

1.1.2.2 Site Management and Peer Review

To ensure compliance with all applicable environmental rules and regulations, NABIR would, at a minimum: 1) implement all pertinent Tier II NEPA review requirements for specific FRC activities; 2) manage activities via field sampling plans, health and safety plans and any other pertinent operation plans as has been done at DOD field research sites (University of Michigan 1995 a,b,c); 3) evaluate FRC activities via a Field Research Advisory Panel (FRAP); and 4) implement a DOE Operations Office review process. The following paragraph describes review process activities for typical NABIR field activities.

For research that would involve intrusion into the soils and/or groundwater at the preferred DOE FRC site, there could be potential risks to the safety of the public and workers as well as potential risks to the surrounding natural environment. However, risks would be managed and reduced through the use of best management practices (BMPs) and by following applicable federal, state and local regulations as well as internal DOE requirements. The NABIR Program is committed to ensuring that BMPs and regulations are implemented in the course of FRC-funded research. A FRAP would be developed to review research work plans (see more on FRAP and work plans in Appendix C) for all FRC-related research activities. The FRAP would be coordinated through the NABIR Program Office. It would primarily consist of the FRC Managers, host site regulatory experts, appropriate DOE Operations Office staff, and at least three non-conflicted peer reviewers external to the NABIR Program Office staff and experts from the Lawrence Berkeley National Laboratory. Any activity that would have even a small potential risk to ongoing studies, regulatory limitations, and FRC resources would be evaluated by the FRAP.

1.1.2.3 Training

In addition to the development of an overall FRC Management Plan, an FRC Health and Safety Plan, and Field Sampling Plans, the NABIR Program would require the development of an ES&H training program specific to the FRC activities prior to the initiation of any activities at the proposed FRC. Both the plans and the training programs would be reviewed for overall adequacy in addressing environmental and health and safety concerns and would be approved by the OBER Field Activities Manager, the FRAP, and the management at the appropriate DOE Operations Office. Further details on FRC health and safety planning, documentation, and training are contained in Appendix C.

Sampling activities at the FRC would require training at a level appropriate to the potential hazards. All groundwater samples would be handled according to regulatory requirements; the primary driver would likely be the potential for exposure to radioactivity. Sample collection in areas designated as having radioactive soil and sediments would be collected by personnel with Radiation Worker I or II training (Title 10, *Code of Federal Regulations* Part 835.) The outside of sample containers would be surveyed by a Radiological Control Technician for alpha, beta, and gamma radiation using field detection instruments. Appropriate shipping category,

packaging, and preparation of appropriate documents to allow shipment of samples to other locations on the host DOE site would be prepared by qualified personnel (e.g., the Hazardous Material Transportation Officer). For off-site shipment, glass sample containers would be wrapped in bubble pack and inserted into a protective cardboard tube. The completed chain-of-custody and field record paperwork would be placed in the insulated containers holding the samples for overnight shipment to the appropriate researchers. Chain-of-custody documentation would be used to ensure samples do not get lost. Before shipment, qualified personnel (e.g., Hazardous Material Transportation Officer) would verify that the receiving organization possesses the appropriate authorizations (e.g., a current state radioactive material license) to receive the material.

1.1.2.4 Review Process for Chemical Toxicity

Research with chemicals toxic to humans would not be used. Information concerning the toxicity to humans of a specific chemical is available in the peer-reviewed toxicology literature. Material Safety Data Sheets would need to be examined. In cases where this type of information is available, this level of review would be the immediate responsibility of the FRC Manager with concurrence from the appropriate DOE Operations Office, and possibly the state regulatory agency and the appropriate regional office of the U.S. Environmental Protection Agency. For chemicals with limited safety data available, several types of review processes would be required for their use. The first level of review would be the FRC Manager. The second level would involve a scientific review by the FRAP. Because host site regulatory experts would be on the FRAP, the regulatory process would have early notification of this proposed activity. There would also be a NEPA review, and if applicable, a permit application process to the appropriate regulatory agencies.

APPENDIX B

COMMENT AND RESPONSE DOCUMENTATION

**Comment and Response Document
for the
Environmental Assessment for Selection and Operation of the
Proposed Field Research Centers for the NABIR Program**

Comment	Location of Response (if applicable)	Commentor
DOE assured the State that the NABIR Program would not interfere with CERCLA remedial actions. At least two of the nine proposed test plots depicted in Figure 3-2 appear to lie in close proximity to the S-3 Ponds Reactive Barriers...CERCLA integration issues should be fully addressed in the final EA.	Section 3.1 and Section 5.1 Cumulative Impacts	State of Tennessee Department of Environment and Conservation - DOE Oversight Division
Some mention is needed concerning contamination from the S-3 Ponds into the Upper East Fork Poplar Creek Hydrogeologic Regime as well.	Section 3.1.3.3 - Groundwater	
This section does not mention precautions taken to prevent downhole contamination from contaminated soils into deeper fracture zones in the bedrock that might take place during advancement of soil borings or drilling into bedrock.	Section 4.1.1.2 - Geology	
The EA should address the fact that the USACOE and TDEC have responsibility for Wetland (sic) management and for proposed mitigation for impacted resources areas. The backfilling of soil borings and abandonment of wells should mention the use of bentonite or make reference to a procedure utilizing such material during backfilling and abandonment. Bentonite should be used to prevent downhole migration of groundwater and associated contaminants into fracture zones connected to well or boring annular space.	Section 4.1.3.2 Floodplains and Wetlands	
There is no discussion of drilling operations possibly impacted contaminated groundwater and creating additional paths for migration of contaminants to other aquifers, etc.	Section 4.1.3.3 Groundwater	

APPENDIX B: Environmental Assessment
for Selection and Operation of the Proposed Field Research Centers for the NABIR Program

Comment	Location of Response (if applicable)	Commentor
The Endangered Species Act should be referenced on the pertinent regulation listings	Section 9.0	
Section 4.1.4.1 should be modified to more accurately define the presence of various bat species and the extent of bat surveys and research in the East Fork Poplar Creek and Bear Creek watersheds	Section 4.1.4.1 and Appendix G	United States Department of Interior - Fish and Wildlife Service, Cookeville TN.
Section 9.0 of the draft EA should also be modified to include the Endangered Species Act as a applicable environmental regulation pertaining to proposed DOE activities on the ORR	Section 9.0	
As part of this DOE assessment we recommend that all potential summer roosting habitat for the Indiana bat in the East Fork Poplar Creek and Bear Creek watersheds be identified.	Appendix G	
A third listed species is the bull trout (<i>Salvelinus confluentus</i>) which can be found in the Hanford Reach and should be included in the text where appropriate.	Section 3.2.4.2 and Section 4.2.4.2	State of Washington Department of Fish and Wildlife
We have noted 2 federal environmental statues missing under Applicable Environmental Regulations....For the Hanford Site the Migratory Bird Treaty Act and Endangered Species Act would be applicable. Please add.	Section 9.0	
If a FRC is located at the Hanford Site, we ask that the USDOE follow guidance established in the <i>draft Hanford Site Biological Resource Management Plan</i> and <i>draft Hanford Site Biological Resources Mitigation Strategy Plan</i> .	Section 9.0	
ERDF cannot accept liquids so I am assuming ERDF should be replaced with ETF.	Section 4.2.3.1 and Section 4.2.9	State of Washington Environmental Protection Agency
Need to add a statement that any work will not have any adverse impact on current remediation.	Section 4.2.2 and Section 5.2.6	
EPA is not opposed to including waste generated under science work into the IDW strategy if it appears to support overall remediation. This would mean waste control plans would need to describe the work/waste.	Section 4.2.8 and Appendix A - Section 2.2.1	

APPENDIX B: Environmental Assessment
for Selection and Operation of the Proposed Field Research Centers for the NABIR Program

NORMAN A. MULVENON
118 Concord Road, Oak Ridge, TN 37830-7126 USA

Tel: 423.482.3153 Fax: 423.483.9234 E-mail: mulvenon@juno.com

March 4, 2000

Mr. Paul Bayer
Office of Biological and Environmental Research
US Department of Energy
SC-74, GTN
19901 Germantown Road
Germantown, MD 20874

Dear Mr. Bayer:

REFERENCE: DRAFT ENVIRONMENTAL ASSESSMENT FOR SELECTION AND OPERATION OF THE PROPOSED FIELD RESEARCH CENTERS FOR THE NATURAL AND ACCELERATED BIOREMEDIATION RESEARCH (NABIR) PROGRAM, DOE/EA-1196. DECEMBER 22, 1999.

Due to an oversight on my part, I missed the deadline for comments on the above referenced Environmental Assessment (EA). I reviewed the EA and I completely support the use of Oak Ridge Operations Site in Bear Creek Valley.

I am the Chair of the Citizens' Advisory Panel (CAP) of the Oak Ridge Reservation Local Oversight Committee, Inc. (LOC). I have consulted with the majority of the members of both groups and they all support this NABIR Program. Please recall that we wrote a letter of support during the previous phase.

I have a copy of the State of Tennessee Department of Environment and Conservation DOE Oversight Division letter commenting on this EA. I concur with their remarks that the NABIR Program not interfere with CERCLA remedial actions. Please take special care to incorporate their comments.

Please call me at 865.482.3153 if I can clarify or expand on my comments.

Sincerely,



Norman A. Mulvenon



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-7072

February 18, 2000

Mr. Paul Bayer
Office of Biological and Environmental Research
US Department of Energy
SC-74, GTN
19901 Germantown Road
Germantown, MD 20874

Dear Mr. Bayer

Document NEPA Review: *Draft Environmental Assessment for Selection and Operation of the Proposed Field Research Centers for the Natural and Accelerated Bioremediation Research (NABIR) Program, DOE/EA-1196. December 22, 1999*

The Tennessee Department of Environment and Conservation, DOE Oversight Division (TDEC/DOE-O) has reviewed the subject document in accordance with the requirements of the National Environmental Policy Act (NEPA) and associative regulations of 40 CR 1500-1508 and 10 CFR 1021 as implemented.

The State recognizes the importance of developing safe and effective remediation and cleanup technologies and the need to test under actual field conditions. After reviewing the Draft Environmental Assessment (EA), the State supports the use of the Bear Creek site if the following comments can be addressed. In past discussion, DOE assured the State that the NABIR Program would not interfere with CERCLA remedial actions. At least two of the nine proposed test plots depicted in Figure 3-2 appear to lie in close proximity to the S-3 Ponds Reactive Barriers. The barriers are CERCLA remedial actions designed to prevent contaminants of concern from entering Bear Creek. These barriers are currently not performing as planned; indicating some alterations or upgrade to the system will be required in future CERCLA decisions. In addition, there are several areas where it appears the remediation experiments could increase the migration of or provide additional pathways for existing contaminants. CERCLA integration issues should be fully addressed in the final EA.

The following specific comments are also offered for your consideration.

Section 3.1.3.3, page 3-9, Groundwater

This section focuses on groundwater flow from the S-3 Ponds hydrologic divide into Bear Creek and its tributaries. Some mention is needed concerning contamination from the S-3 Ponds into the Upper East Fork Poplar Creek Hydrogeologic Regime as well.

Mr. Paul Bayer
February 18, 2000
Page Two

Section 4.1.1.2, page 4-1, Geology

This section does not mention precautions taken to prevent down hole contamination from contaminated soils into deeper fracture zones in the bedrock that might take place during advancement of soil borings or drilling into bedrock.

Section 4.1.3.2, page 4-7, Floodplains and Wetlands

The EA should address the fact that the USACOE and TDEC have responsibility for Wetland management and for proposed mitigation for impacted resource areas. The backfilling of soil borings and abandonment of wells should mention the use of bentonite or make reference to a procedure utilizing such material during backfilling and abandonment. Bentonite should be used to prevent downhole migration of groundwater and associated contaminants into fracture zones connected to well or boring annular space.

Section 4.1.3.3, page 4-8, Groundwater:

There is no discussion of drilling operations possibly impacting contaminated ground water, and creating additional paths for the migration of contaminants to other aquifers, etc.

Section 9.0, page 9-1, Applicable Environmental Regulations, Permits, and DOE Orders

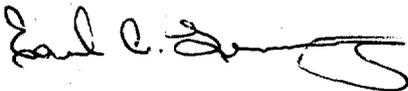
The Endangered Species Act should be referenced on the pertinent regulation listings.

Appendix C

It appears that several of the notices are incomplete, and their arrangement in the Appendix is incorrectly presented (pages do not follow numerical sequences).

If you have any questions concerning the above comments, please contact me at (865) 481-0995.

Sincerely



Earl C. Leming
Director

xc: Justin P. Wilson
Dodd Galbreath
Dick Green
Rod Nelson
Bob Poe



United States Department of the Interior

FISH AND WILDLIFE SERVICE

446 Neal Street
Cookeville, TN 38501

February 10, 2000

Mr. Paul Bayer
U.S. Department of Energy
Office of Biological and Environmental Research
SC-74, GTN
19901 Germantown Road
Germantown, Maryland 20874

Dear Mr. Bayer:

U.S. Fish and Wildlife Service (Service) personnel have reviewed the draft Environmental Assessment for Selection and Operation of the Proposed Field Research Centers for the Natural and Accelerated Bioremediation (NABIR) Program. This draft environmental assessment (EA) indicates that the Bear Creek watershed on the Oak Ridge Reservation (ORR) is the Department of Energy's (DOE) preferred alternative for siting the field research center (FRC) associated with the NABIR program. Please consider the following comments during preparation of a final EA for the project.

Section 4.1.4.1 of the draft EA states that mistnetting for bats had been conducted in the East Fork Poplar Creek basin and that no bats were captured. According to information provided by Oak Ridge National Laboratory and Dr. Michael J. Harvey of Tennessee Technological University in Cookeville, Tennessee, significant mistnetting efforts were conducted in the East Fork Poplar Creek watershed, including Bear Creek, in 1992 and 1997. The 1997 efforts resulted in the collection of fourteen bats representing six species. No Indiana bats (*Myotis sodalis*) or gray bats (*Myotis grisescens*) were captured in the 1997 efforts. The 1992 efforts were not as extensive as those in 1997, and four bats representing two species were collected. It was noted in both surveys that significant potential habitat for the Indiana bat existed in the East Fork Polar Creek watershed. An Indiana bat was collected on the ORR in the 1950's, and survey efforts on the ORR have not been extensive enough to definitively establish or refute current use by this species.

In 1994, a moribund gray bat was found in the Beta-3 building of the Y-12 complex, near areas proposed for siting of the FRC. This specimen was identified by researchers at the University of Tennessee and submitted to the Service. The condition of this juvenile specimen indicated it may have utilized the building as roosting habitat. Other suitable buildings on the ORR may also serve as roosting habitat for a variety of bat species. Little Turtle Cave, located on the ORR near the Y-12 plant, was surveyed by the Tennessee Department of Environment and Conservation in 1996. Ten male gray bats were found in the cave and it was determined that the cave could serve as a

hibernaculum for a bachelor colony. Based on the best information available to the Service, it does not appear that the upper reaches of Bear Creek have been sufficiently surveyed to support a conclusion that the area is not utilized by gray or Indiana bats.

Section 4.1.4.1 should be modified to more accurately define the presence of various bat species and the extent of bat surveys and research in the East Fork Poplar Creek and Bear Creek watersheds. Section 9.0 (Applicable Environmental Regulations, Permits and DOE Orders) of the draft EA should also be modified to include the Endangered Species Act as an applicable environmental regulation pertaining to proposed DOE activities on the ORR.

The Service does not anticipate that the injection of dyes or electron donors/receptors into groundwater would adversely affect the gray bat or Indiana bat. Delineation of groundwater flowpaths in these karst areas may, in fact, aid in determining the potential migration of site-related contaminants to bat hibernacula on the ORR. As part of this DOE assessment, we recommend that all potential summer roosting habitat for the Indiana bat in the East Fork Poplar Creek and Bear Creek watersheds also be identified. We would appreciate periodic updates on the results and findings of activities associated with the NABIR program on the ORR.

Since the draft EA states that the construction and operation of the proposed FRC would occur outside of a 100-foot buffer zone along Bear Creek, the Service can concur with a not likely to adversely affect finding for the gray bat. Since construction, operation, and support activities for the FRC will occur in previously disturbed areas, the Service can concur with a not likely to adversely affect finding for the Indiana bat. In view of these, we believe that the requirements of Section 7 of the Endangered Species Act of 1973, as amended, are fulfilled. Obligations under Section 7 of the Act must be reconsidered if (1) new evidence reveals impacts of the proposed action that may affect listed species or critical habitat in a manner not previously considered, (2) the proposed action is subsequently modified to include activities which were not considered during this consultation, or (3) new species are listed or critical habitat designated that might be affected by the proposed action.

We appreciate the opportunity to comment on the proposed action. Should you have any questions, please contact Steve Alexander of my staff at 931/528-6481 (ext. 210) or via e-mail at steven_alexander@fws.gov.

Sincerely,



Lee A. Barclay, Ph.D.
Field Supervisor

xc: Jim Lee, DOI-OEPC, Atlanta
Bruce Bell, FWS-ES, Atlanta
Doug McCoy, TDEC, Oak Ridge
Bob Hatcher, TWRA, Nashville

OAK RIDGE

TENNESSEE

CITY OF OAK RIDGE
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February 11, 2000

Mr. Paul Bayer
Office of Biological and
Environmental Research
U.S. Department of Energy
SC-74, GTN
19901 Germantown Road
Germantown, MD 20874

Dear Mr. Bayer:

**ENVIRONMENTAL ASSESSMENT FOR THE NATURAL AND ACCELERATED
BIOREMEDIATION RESEARCH PROGRAM DOE/EA-1196**

Thank you for the opportunity to review the draft environmental assessment for the selection and operation of field research centers under the Natural and Accelerated Bioremediation Research (NABIR) Program.

While staff has reviewed the draft EA and found no substantive concerns, I believe it is important to communicate my support for the preferred alternative at the Y-12 site, and for the program overall. Research and controlled field testing involving innovative methods such as bioremediation is extremely important to Oak Ridge, and this project may help the Department of Energy address challenging subsurface contamination such as groundwater.

Please keep the City informed, and I wish you success as you move forward with the program.

Sincerely,



Paul C. Boyer, Jr.
City Manager



STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE

1701 S 24th Avenue • Yakima, Washington 98902-5720 • (509) 575-2740 FAX (509) 575-2474

1315 W 4th Ave.
Kennewick, WA 99336

2 February, 2000

Rebecca Inman
Environmental Coordination Section
Washington Department of Ecology
P.O. Box 47600
Olympia, WA 98504

Dear Ms. Inman:

Subject: Comments on *Environmental Assessment for Selection and Operation of the Proposed Field Research Centers for the Natural and Accelerated Bioremediation Research (NABIR) Program*, Draft December 22, 1999, DOE/EA-1196.

The Washington Department of Fish and Wildlife appreciates the opportunity to comment on the aforementioned document. We are commenting because the PNNL/Hanford Site could potentially be identified and funded as a Field Research Center at some point in the future. We also want to make U.S. Department of Energy (USDOE) aware of species of concern and mitigation guidance in the event a FRC is sited at the Hanford Site.

The Section on Aquatic Resources in Chapter 3 mentions only 2 federally listed salmonids. A third listed species is the bull trout (*Salvelinus confluentus*) which can be found in the Hanford Reach. This species was identified by USFWS in their letter dated May 11, 1999 and should be included in the text where appropriate. Also, it would appear that USDOE has not coordinated with the National Marine Fisheries Service (NMFS) since no letter appears in Appendix D. However, USDOE does recognize the need to consult NMFS under Section 7 of the Endangered Species Act prior to implementation of any field research.

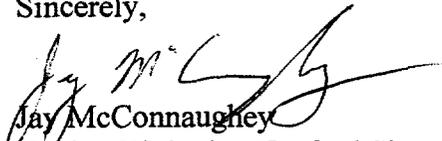
We have noted 2 federal environmental statutes missing under the Applicable Environmental Regulations, Permits and USDOE Orders. For the Hanford Site, the Migratory Bird Treaty Act and Endangered Species Act would be applicable. Please add.

Ms. Rebecca Inman
2 February, 2000
Page 2 of 2

If a FRC is located at the Hanford Site, we ask that USDOE follow guidance established in the *draft Hanford Site Biological Resource Management Plan* and *draft Hanford Site Biological Resources Mitigation Strategy Plan*.

Again, thank you for the opportunity to provide comments. If you have any questions regarding these comments, please contact me at 509/736-3095.

Sincerely,


Jay McConnaughey
Habitat Biologist, Hanford Site

cc:

Paul Dunigan, USDOE
Jane Hedges, Ecology
Ted Clausing, WDFW
Cynthia Pratt, WDFW



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

P.O. Box 47600 • Olympia, Washington 98504-7600
(360) 407-6000 • TDD Only (Hearing Impaired) (360) 407-6006

February 8, 2000

Mr. Paul Bayer
Office of Bio. & Envir. Research
US Dept of Energy
SC-74, GTN
19901 Germantown Rd
Germantown MD 20874

Dear Mr. Bayer

Thank you for the opportunity to comment on the environmental assessment for the selection and operation of the proposed field research centers for the NABIR Program (DOE/EA-1196). The Department of Ecology has been designated to coordinate Washington State agency review and response for documents issued under the National Environmental Policy Act. In that capacity we enclose a comment letter received from Washington Department of Fish and Wildlife (WDFW).

WDFW has concerns about additional information and coordination needed to address the Endangered Species Act and the Migratory Bird Treaty Act. They have also requested that the guidance contained in the draft Hanford Site Biological Resource Management Plan and the draft Hanford Site Biological Resources Mitigation Strategy Plan be followed should the Department of Energy chose to site a field research center at the Hanford Site.

If you have any questions, please contact Mr. Jay McConnaughey with WDFW at (509) 736-3095.

Sincerely,

Rebecca J. Inman
Environmental Coordination Section

#000290

cc: Jay McConnaughey, Kennewick
Cynthia Pratt, WDFW





United States Department of the Interior

NATIONAL PARK SERVICE
Columbia Cascades Support Office
909 First Avenue
Seattle, Washington 98104-1060

IN REPLY REFER TO:

L7619(SSO-PPR)
Hanford Reach, WA-W&S

January 19, 2000

Paul Bayer
Department of Energy
SC-74, GTN
19901 Germantown Road
Germantown, Maryland 20874

Dear Mr. Bayer:

We have reviewed the provided documents on the proposed addition of a Field Research Center component to the existing Natural and Accelerated Bioremediation Research Program. We do not believe the addition would have any significant negative impacts on the proposed wild and scenic river designation, nor would any impacts be sufficient to trigger a review and determination under Section 7 of the Wild and Scenic Rivers Act.

Thank you for consulting with the National Park Service. If you have any questions, please contact me at (206) 220-4120.

Sincerely,

Daniel Haas
National Rivers Program

cc:
Jeff Haas, Deputy Project Leader
Arid Lands National Wildlife Refuge Complex

Bayer, Paul

From: Long, Philip E [philip.long@pnl.gov]
Sent: Thursday, January 27, 2000 4:20 PM
To: 'Paul Bayer'
Cc: Weeks, Regan S
Subject: FW: EA for NABIR

Paul, FYI. Phil

From: Faulk, Dennis A
Sent: Thursday, January 27, 2000 10:51 AM
To: Hansen, James E; Long, Philip E
Cc: Soper, Wayne W; Tortoso, Arlene C
Subject: EA for NABIR

All,

Wanted to let you know EPA looked over the EA and would recommend a couple of changes:

1. on page 4-22 as well as other locations statements are made that water would be sent to ERDF. ERDF cannot accept liquids so I am assuming ERDF should be replaced with ETF.
2. Need to add statement that any work will not have any adverse impact on current remediation.
3. Global issue for all science projects is how waste will be handled. EPA is not opposed to including waste generated under science work into the IDW strategy if it appears to support overall remediation. This would mean waste control plans would need to describe the work/waste.

Dennis

Bayer, Paul

From: Hickey, Clarence
Sent: Friday, March 17, 2000 11:40 AM
To: Bayer, Paul
Cc: Dyson, Emily; 'Annabelle Rodriguez'; 'Paul Dunigan'; Hickey, Clarence
Subject: Discussion with Dennis Carlson, NMFS Re: NABIR EA

Paul,

I received a telephone call at about 11:00 am this morning from Dennis Carlson of the U.S. National Marine Fisheries Service (NMFS), Lacey, Washington. Mr. Carlson is the reviewing official for marine fisheries endangered species issues relative to the Hanford Site. Mr. Carlson stated that he had received the Draft EA (DOE/EA-1196) of December 22, 1996, for the NABIR Program's selection and operation of the proposed Field Research Centers. He also received your fax of information on March 16, 1999, requesting his feedback on marine fisheries and endangered species issues as analyzed in the EA.

Mr. Carlson and I discussed the information in the EA and its analysis of endangered fish species in the Columbia River with respect to the NABIR proposals. We specifically discussed EA section 4.2.4.2 Aquatic Resources (page 4-29) on the PNNL/Hanford Alternative Site, which Mr. Carlson had read. We discussed the EA's conclusion that the proposed action would not affect endangered fishes of the Columbia River. Mr. Carlson stated that he agrees with the EA conclusions and that he can concur with the EA. He found no glaring issues and concurs that the EA's conclusions seem reasonable. If there are no changes to the proposed action as described in the EA, then DOE's call (as the action agency) of no effect would stand.

Mr. Carlson understands that DOE's preferred location for the proposed action is the Oak Ridge, Tennessee, site. If the project were to occur at the PNNL/Hanford Site at a future time, and specifically if the proposed action were to change from that described in the EA, then DOE would re-initiate further consultation with the NMFS. We discussed this and Mr. Carlson agreed.

Mr. Carlson stated that this telephone call would suffice as the official response from the NMFS on the EA and the matter of the analysis of potential effects to fish species under its jurisdiction.

I tried to connect you with this phone call, but you were out of the office. I suggest that this email could be forwarded to GC-51 and to EH-42 in order to close the final loop on the consultations, for completion of the EA and for our recommendation to SC-1 that a Finding of No Significant Impact appears to be appropriate.

If there are questions, please call.

Clarence Hickey
NEPA Compliance Officer
Office of Science
(301) 903-2314

APPENDIX C

NABIR PROGRAM MANAGEMENT PLAN

NABIR Program Management Plan

**Prepared by
U.S. Department of Energy
Office of Science
Office of Biological and Environmental Research**

June 16, 1999

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1.0 INTRODUCTION

The Natural and Accelerated Bioremediation Research (NABIR) Program Management Plan describes the Office of Environmental and Biological Research's (OBER) methods for managing the overall research funding under the NABIR Program, the management of a proposed Field Research Center (FRC), and the management of potential risks to the human environment.

The NABIR Program is a ten-year fundamental research program designed to better understand the biotic and abiotic processes in the subsurface, to control and accelerate the biotic processes, and to provide dedicated field sites for field-based research. The program is directed at the specific goal of supporting fundamental research to understand bioremediation processes on complex mixtures of heavy metals and radionuclides in the subsurface. The NABIR Program supports the funding of laboratory-based research as well as computer modeling and other types of research. Field research would focus on the subsurface environment below the zone of root influence, and would be expected to include investigations of both the saturated (e.g., groundwater) and unsaturated (e.g., vadose) zones.

The NABIR Program will only be funding basic fundamental research on promising new methods and technologies that might have the potential to be used by another part of DOE or some other agency for a full cleanup at a future time. The NABIR Program will not fund a DOE Environmental Management cleanup project involving the use of bioremediation. Research involving organic contaminants is only considered to the extent that it influences the primary goal of understanding the fundamental biogeochemical factors that affect bioremediation of heavy metals and radionuclides. Research to evaluate the risk to humans or to the environment, and research on phytoremediation are outside the scope of the NABIR Program. Finally, the NABIR Program will not fund any research that would involve the use of microbes that are human pathogens and field releases of any GEMS.

1.1 Management Structure

1.1.1 Facilitating Coordination/Communication of Research Opportunities and Results

The NABIR Program is managed by a team of Program Managers from OBER. The management team's areas of responsibility include: overall management of research funded under the NABIR Program, the management of a proposed FRC, and the management of potential risks to the human environment. Specifically, two OBER Program Managers coordinate the NABIR Program (Co-coordinators); several OBER Program Managers provide leadership for a number of technical areas of focus (elements) within the NABIR Program (Program Element Managers); and one OBER Program Manager would oversee the NABIR FRC (Field Activities Manager). The NABIR Program Co-coordinators and the Program Element Managers are responsible for developing and soliciting new research for the NABIR Program through the publication of research announcements in the *Federal Register*.

A critical role for the management of the NABIR Program is to facilitate the coordination and communication of research opportunities and results of NABIR-funded research. This

coordination and communication is fostered through an annual meeting at which NABIR investigators are encouraged to present the results of their research. In addition, the NABIR Program periodically sponsors small workshops on specific topics of interest to NABIR investigators. Publication of peer-reviewed research in open scientific literature is strongly encouraged, as is participation in open scientific meetings.

In addition to OBER Program Managers, OBER uses national experts in bioremediation from several DOE National Laboratories. Their efforts are consolidated under the NABIR Program Office. The role of the NABIR Program Office is to assist OBER Program Managers with the development of technical documents and communication tools to facilitate communication among NABIR researchers and other interested parties. For example, in addition to providing assistance with the annual meeting, the NABIR Program Office currently provides information concerning ongoing bioremediation research on the World Wide Web, (<http://www.lbl.gov/NABIR>), and distributes a quarterly NABIR Program newsletter. Recently the NABIR Program Office developed a primer on bioremediation for use by NABIR researchers and other interested parties.

Individuals external to DOE are also asked to provide advice to OBER concerning the NABIR Program and to assist with communication and coordination of NABIR Program research. A NABIR subcommittee of the Biological and Environmental Research Advisory Committee (established by the Federal Advisory Committee Act) has been established to: a) advise OBER Program Managers on future research directions in bioremediation, b) ensure coordination with other, complementary Federal programs, and c) identify opportunities for leveraging scientific and infrastructure investments.

The management structure developed for the NABIR Program facilitates the coordinated, interdisciplinary research approach, first in the laboratory and then in the field. Table 1 contains a description of the roles and responsibilities of the team members associated with the NABIR Program.

TABLE 1. NABIR Program Management - Roles and Responsibilities

NABIR MANAGEMENT TEAM	ROLE AND RESPONSIBILITY
DOE OBER	
OBER Program Coordinators	Manage and coordinate activities among the seven program elements and all of the field activities.
OBER Program Element Managers	Responsible for general management and oversight (including Environment, Safety and Health issues) of at least one program element.
OBER Field Activities Manager	Works with the OBER Program Element Managers to coordinate field activities associated with the research conducted under each of the NABIR program elements. Oversees activities at the proposed FRCs and at other small-scale research sites.
Non-OBER	
NABIR Program Office Staff (Lawrence Berkeley National Laboratory)	Supports the OBER Program Coordinators by providing communication services and other management and technical assistance.
FRC On-site Manager	Manages the proposed contaminated and background field areas, including obtaining applicable permits from the host state, preparing and implementing site safety plans, scheduling FRC field activities and operations, supervising FRC staff and support personnel, and interacting with NABIR investigators and local stakeholders.
Field Research Advisory Panel (FRAP)	Evaluates and recommends work plans for field research activities at the proposed FRC. Consists of the NABIR Field Activities Manager, FRC Manager(s), host site regulatory experts, appropriate DOE Operations Office staff, at least 3 non-conflicted peer reviewers external to the NABIR Program Office staff and to the Lawrence Berkeley National Laboratory.
NABIR Subcommittee of the Biological and Environmental Research Advisory Committee	Provides management advice to the Program Coordinators. Ensures coordination with other, complementary federal programs and identifies opportunities for leveraging scientific and infrastructure investments.

The NABIR Program is committed to ensuring that best management practices (BMPs) and regulations are implemented in the course of FRC funded research. A Field Research Advisory Panel (FRAP) would be developed to review research work plans (more on work plans in Section 2.2.) for all FRC- related research activities. The FRAP would be established by the NABIR Program Office and would primarily consist of the FRC Managers, host site regulatory experts, appropriate DOE Operations Office staff, and at least three non-conflicted peer reviewers external to the NABIR Program Office staff and the Lawrence Berkeley National Laboratory. Any activity

that would have even a small potential risk on on-going studies, regulatory limitations, and FRC resources would have to be evaluated by the FRAP.

1.1.2 Existing Science-Based Program Elements

The NABIR Program is an integrated effort containing seven interrelated science-based technical program elements. A societal/legal/educational program element also investigates the societal issues and concerns associated with bioremediation. These program elements, described below, would be conducted in the lab and at the proposed FRC.

Biotransformation and Biodegradation—Research focused on understanding the mechanisms of how microorganisms actually transform, degrade, and immobilize complex contaminant mixtures into detoxified materials.

Community Dynamics and Microbial Ecology—Research focused on the natural ecological processes and interactions of biotic and abiotic components of microbial subsurface ecosystems in order to understand their natural influence on the degradation, persistence, and toxicity of mixed contaminants.

Biomolecular Science and Engineering—Research in molecular and structural biology focused on improving the efficiency of bioremediation activities by genetically modifying molecules and organisms to detoxify contaminants of concern to DOE. This research would be conducted strictly in a controlled laboratory setting. There would be no field-based research with genetically modified molecules or organisms at FRCs.¹

Biogeochemical Dynamics—Research focused on understanding the relationships among several environmental factors that interact or interfere with the survival, growth, and activity of microbial communities and their ability to bioremediate contaminants. The environmental factors are related to the dynamic relationships among geochemical, geological, hydrological, and microbial processes.

Bacterial Transport—Research focused on bioaugmentation of bioremediation by the addition of microorganisms. Microbial degradation activity might be enhanced by altering the flow and transport of microorganisms. This element would develop effective methods for accelerating and optimizing bioremediation rates.

¹ Scientists have been investigating the use of genetically engineered microorganisms (GEMs) for bioremediation. Genetic engineering is the manipulation of genes to enhance the metabolic capabilities of an organism (LBNL NABIR Primer, January 1999). While the NABIR Program is funding laboratory-based genetic engineering research, at this time, the release of a GEM, according to the EPA definition (TSCA Final Rule, 1997), in the field is not considered to be a part of the NABIR Program. NABIR Program management has determined that the fundamental laboratory research that is prerequisite to the introduction of GEMs for radionuclides and heavy metals in the field has not progressed scientifically to the point where the NABIR Program use of such GEMs in the field within the immediate future can be reasonably assumed, planned or approved. NABIR Program management will re-evaluate at a later time the status of GEMS research to determine whether the program will ever support GEMS research in the field. The final decision on whether to include GEMs field research as part of the future NABIR Program would be evaluated in a separate NEPA process, when appropriate.

Assessment—Research focused on developing methods to measure, monitor, and characterize the success of bioremediation processes and the rates at which they work.

System Engineering, Integration, Prediction, and Optimization—Research focused on integrating the results of all of the program elements and on synthesizing the information so that the effectiveness of bioremediation can be predicted and optimized.

The first five of the science elements study the biology of microorganisms, their ecology and physical environment, their effects on various contaminants, and various mechanisms to enhance or accelerate their bioremediative processes. The sixth science element provides the means to assess and quantify these processes. The last scientific element is designed to integrate the research results so that predictive models can be developed.

The NABIR program is based on an interdisciplinary research approach to the study of bioremediation. Each science program element supports researchers from a broad spectrum of disciplines besides microbiology: such as biology, ecology, hydrology, geology, chemistry, statistics, etc. Some of these researchers conduct independent research studying individual problems within a science element. Other projects involve collaborative efforts on specific problems and would involve researchers from various science program elements to draw on a variety of different perspectives, disciplines, and experiences.

Research involving organic contaminants would only be considered to the extent that it influences the primary goal of understanding the fundamental biogeochemical factors that influence bioremediation of heavy metals and radionuclides. Research to evaluate the risk to humans or to the environment, and research on phytoremediation are outside the scope of the NABIR Program. The NABIR Program will not fund a full cleanup project involving the use of bioremediation. The NABIR Program will not fund any research that would involve the use of microbes that are human pathogens, and it will not conduct any field releases of opportunistic human pathogens.

1.2 Coordinating the Direction, Review and Funding of Research

Historically, OBER has funded a variety of bioremediation-related research through a series of separate programs and projects, including the former Subsurface Science Program. Since late 1996, this funding process has been directed through the NABIR Program. For example, nearly \$10 million was made available in the FY 1997 solicitation and awarded. An additional \$3 million was awarded in FY 1998 for laboratory-scale research. This funding provides support for research under the NABIR program's seven scientific research elements, and the social-legal Bioremediation and its Societal Implications and Concerns (BASIC) initiative. Depending on the funding available, these awards support research programs of multiple-year duration (typically up to three years).

OBER will continue to periodically solicit applications for funding to conduct coordinated bioremediation research under the NABIR Program. New research activities under the NABIR Program would be conducted at laboratories in universities, industrial facilities, and DOE national laboratories, and in the field. Research project funding awarded to universities, private industry, and individuals is in the form of grants; funding awarded to DOE's national laboratories is provided through the DOE laboratory financial plan process.

As with previous subsurface and bioremediation research funded by OBER, the NABIR Program uses both programmatic peer reviews and proposal peer reviews to aid in the selection and direction of research. Programmatic peer reviews are used to evaluate the overall effectiveness of the program and how well it is achieving its goals. Proposal peer reviews consist of annual scientific peer reviews used to evaluate and select proposed research projects.

Following current DOE practice, each individual research project undertaken as a result of the NABIR Program funding awards undergoes an ES&H review by the appropriate DOE Operations Office. These reviews also ensure full compliance with the requirements of NEPA, and are completed prior to the release of the funding and initiation of the research.

1.2.1 Integrating Laboratory and Field Research Approaches

Much of the bioremediation research funded under the NABIR Program would likely proceed from the laboratory to the field. For example, a researcher might obtain sediment or groundwater samples from a field site. Sediment samples could be in the form of a core sample (a column of sediments taken out of the ground) or in the form of sediments cut out of an exposed outcrop. NABIR-funded researchers could then begin conducting laboratory-scale research on the samples. The results of this research might then be applied to an intermediate-scale of research or pilot field studies.

Intermediate-scale research might include the use of intermediate-scale flow cells or even lysimeters. While intermediate-scale flow cells are large containers for holding subsurface sediments, they are confined to a laboratory. In contrast, lysimeters are structures that resemble large canisters that are embedded in the ground and are closed at the bottom. Lysimeters can be filled with bulk sediments from field sites to study physical-chemical heterogeneities of the sediments, movement of contaminants, and growth of microbial populations. While these two approaches are cheaper than actual field experiments and they can be more easily controlled, intermediate-scale research does not replace research in an open, natural field environment.

The next step in research might be to move to field-scale studies in the open, natural environment. Research at FRC field sites would involve conducting activities in the subsurface within marked plots of land. These types of studies could include well-to-well flow and bacterial and/or contaminant transport studies.

1.3 Providing Field-based Research Activities

Field-based research allows NABIR to apply a coordinated approach to its overall goal of understanding the fundamental biogeochemical processes that determine the success of any bioremediation technology. Two types of field-related research approaches and activities are being undertaken by the NABIR Program, and one is proposed. The two activities that are currently being undertaken are: 1) laboratory/field transition resources, and 2) research on Short-Term Experimental Field Sites (STEFs). The one activity that is proposed and evaluated in this EA is to establish and conduct field research at the FRCs on DOE lands.

1.3.1 Laboratory/Field Transition Resources

Laboratory/field transition resources are tools that are available to NABIR researchers to promote a smooth transition from laboratory research to field research. Laboratory/field transition resources should be considered as intermediate resources that could be used by NABIR researchers to address two major impediments to conducting scientific research in the field: the issue of natural heterogeneity, and the problem of "scaling" research results from the laboratories' micro-scale level to the field-scale. Laboratory/field transition resources currently available to NABIR researchers include facilities such as intermediate-scale instrumented flow cells and lysimeters, and subsurface collections such as:

- the Pacific Northwest National Laboratory (PNNL) Sediment Collection Repository;
- the NABIR "Reference" sample (standardized set of reference sediments including natural and amended sediments and a standard set of humic materials); and
- the Subsurface Microbiology Culture Collection (a reference collection of aerobic and anaerobic bacterial cultures).

Located at laboratories DOE's Pacific Northwest National Laboratory in Richland, Washington, the intermediate-scale flow cells are existing structures that were used during the former Subsurface Science Program (SSP). These resources have been incorporated into the NABIR Program. The intermediate-scale flow cells are containers that are a few meters long and serve as tools for examining blocks of sediments and subsurface materials that are larger than laboratory-scale core samples. Flow cells can be used for investigating subsurface features such as natural physical heterogeneity under controlled conditions, and they provide "controlled environments" that simulate the natural subsurface environment in a laboratory setting without field releases. Flow cells are likely to be used before or during field-based research.

Approximately 20 lysimeters are available through DOE's Oak Ridge National Laboratory in Oak Ridge, Tennessee. They range in size from 8 feet by 10 feet deep to 3 feet by 6 feet deep. The lysimeters are 1/8 inch galvanized steel and have a solid bottom and a cover to form a closed system. They are buried in the ground and filled with soil.

NABIR also has repository responsibility for the microbial culture collection and for several subsurface sample collections, all from the former SSP. This culture collection and the sediment materials form the nucleus of a reference collection of materials and microbial cultures available for use by NABIR researchers. Additional reference materials and microbial cultures would be collected from the proposed FRC and incorporated into the existing repositories.

1.3.2 Short Term Experimental Field Sites (STEFS)

Short term Experimental Field Sites (STEFS) are field sites for special studies that may be on or off DOE lands. These field sites have characteristics that are analogous to the range of hydrogeologic conditions (e.g., rainfall, groundwater, soil types) on DOE sites that are potential FRCs; however, there is only limited manipulation of the subsurface environment. Scientific insights that are gained at these sites would be transferred to the proposed FRC. STEFS are

currently located on non-DOE sites and they have no onsite staff, permanent trailers or laboratories.

An example of a STEFS is in Oyster, Virginia. For several years, NABIR investigators have been conducting fundamental research into the mechanisms by which microorganisms are transported in the subsurface environment of unconsolidated sediments (sand) on non-DOE land. Scientific knowledge gained from this research in a simple system of unconsolidated sediments is useful to the broad community of NABIR researchers. Appendix F contains NEPA documentation for the Oyster Site.

While any one STEFS may not be available for the duration of the NABIR Program, the use of STEFS provides the NABIR Program with:

- a low-cost (relative to an FRC) diversity of field sites and source of samples;
- sources of subsurface samples for NABIR researchers;
- sites to meet the specific, short-term needs of a small team of researchers;
- sites for conducting mechanistic research experiments that support any or all NABIR elements;
- opportunities for *in situ* field research that is expected to transition into research at an FRC; and
- an opportunity for conducting additional or parallel research to test the applicability and transferability of research results from the hydrogeologic regime represented at an FRC, to other analog sites that could represent conditions at other DOE sites.

Similar to the activities that might be conducted at an FRC, activities proposed for a STEFS include: drilling of sampling wells, collection of cores and groundwater samples, geophysical analyses, monitoring of subsurface conditions, and conducting tracer and bacterial transport studies. Because STEFS are selected and used to meet the short-term needs of a small group of NABIR researchers, the environmental impacts of their selection and use are analyzed as Tier II NEPA actions (see Section 2.0 for additional information on Tier II NEPA actions).

1.3.3 Proposed FRCs

Proposed FRCs would be field sites on DOE lands. These sites would serve as the primary "outdoor laboratory" for small-scale *in situ* bioremediation research activities. They would be a primary source for groundwater and sediment samples for NABIR investigators and would also be test sites for manipulation of the subsurface environment. The FRC would consist of one background area and one contaminated area. The environmental analysis portion of this EA focuses on the siting of the FRC, the potential research activities proposed at an FRC, and the selection of up to three sites for the location of the proposed FRC. Detailed information concerning FRCs is provided in Section 3.0 of this EA.

As designed, an acceptable FRC would include a contaminated area and a background area, laboratory/analytical facilities, and office space/trailers. The areas would be of sufficient size to accommodate multi-investigator studies over the 10-year lifespan of the NABIR Program. To the maximum extent possible, the program would use existing office, laboratory, and field facilities, including access and infrastructure support to reduce costs and environmental impacts, to make efficient use of existing DOE facilities and infrastructure, and to reduce the need for new construction.

OBER proposes to establish one FRC at a DOE site for a long-term (10-year) field research program. The FRC would be the preferred location on DOE lands for much of the field research sponsored by the NABIR Program, and would thereby provide a focus for integrating the field-based program into NABIR. The FRC and supporting infrastructure would be used to facilitate long-term, interdisciplinary research, and would be available as a user site for investigator-initiated research by scientists funded through this and other programs.

The FRC would provide NABIR researchers with areas containing a spectrum of waste types and subsurface environmental media (vadose zone and zone of saturation) that are representative of both background and contaminated conditions across the DOE complex. The FRC would offer both a source for standardized subsurface samples for NABIR researchers, and locations for *in situ* research. Field scale research at the FRC would offer the researcher the opportunity to:

- move laboratory-based research to the field, and
- observe and manipulate bioremediation processes involving heavy metals and radionuclides in a field setting.

The FRC would be staffed by a full-time FRC manager and several full and part-time technical and administrative staff. FRC staff would help facilitate the researchers' access to field locations at the DOE site, and ensure coordination of research activities and compliance with applicable DOE ES&H requirements. OBER would provide funding for infrastructure, staff, additional characterization and field campaigns, but also would anticipate "in-kind" support from the host DOE site. In kind support could include matching funding, staffing or facilities from the host DOE site.

During the first year of FRC operation, work done at the proposed sites would primarily focus on planning and field site development and characterization. By the second year, some *in situ* research might also be conducted. Because intrinsic bioremediation of radionuclides and heavy metals is a slow process, any activities focused on intrinsic bioremediation would be expected to be performed throughout the life of each FRC. *In situ* research on microbial transport, microbial heterogeneity, complexation of contaminants and microorganisms, transformation of contaminants by microorganisms, oxidation/reduction processes, contaminant availability, microbial survival, and nutrient manipulation are some examples of the type of more complex research that would be expected.

2.0 ASSESSING AND MANAGING ENVIRONMENTAL, SAFETY AND HEALTH RISKS

A critical aspect of the current and future implementation of the NABIR Program is compliance with applicable ES&H regulations, particularly for research to be conducted in the field. Following current DOE practice, the appropriate DOE Operations Office ensures compliance with all regulatory and permitting requirements before research funding is released and/or field activities commence for all research activities conducted under the NABIR Program. In addition to satisfying DOE's ES&H requirements, the Operation Office would comply with the requirements of other applicable federal, state, and local laws for each research project. For activities at the proposed FRC, the FRC Manager would provide the coordination necessary to ensure DOE ES&H requirements were met, all site policies and procedures were followed, and site training and security requirements were met. For field projects at other research sites (e.g., STEFS), staff at the appropriate DOE Operations/Site Office coordinate ES&H compliance prior to the distribution of funding.

For research that would involve intrusion into the soils and/or groundwater at DOE FRC sites, there could be potential risks to the safety of the public and workers as well as potential risks to the surrounding natural environment. However, risks can be managed and reduced through the use of BMPs and by following applicable federal, state and local regulations as well as internal DOE requirements.

2.1 NEPA Compliance

One tool that can be used to evaluate the potential impacts posed by field research activities is the NEPA process. A NEPA document examines proposed activities and evaluates their potential impact on the human environment. The following paragraphs highlight how the use of the NEPA process within the NABIR Program would be used to assess risk, as well as what some of the potential areas of impact would be for conducting research under the NABIR Program. Although the NEPA process addresses, in detail, how risks to the human environment would be dealt with, there are management practices that NABIR Program management would implement to reduce the risks to acceptable levels. These also are discussed below.

The strategy for NEPA compliance associated with selection and operation of the proposed FRCs is two-tiered. The first tier includes the preparation of this EA to evaluate the potential environmental impacts of siting and operating the proposed FRC. The second tier of the NABIR NEPA compliance process would be the evaluation of the appropriate level of NEPA documentation that would be prepared for the proposed specific field research. The Tier II NEPA evaluation would consider whether the proposed field research at an FRC is bound by the EA for Selection and Operation of the Proposed Field Research Centers for the NABIR Program. If it were determined that the proposed activities were a major federal action that could significantly impact the environment, an EIS would be prepared. For the FRC, the DOE Operations Office for the proposed FRC would have responsibility for NEPA compliance for that FRC.

2.2 FRC Planning, Documentation and Training

Another set of tools to manage ES&H risks is the documentation and review of all NABIR-funded research projects prior to the initiation of activities. Upon selection of an FRC, and prior to the initiation of any field site characterization or field site research activities, the NABIR Program would expect the FRC manager to develop a set of high-level planning documents to govern the operation of the FRC. These plans would provide the "road map" for the conduct of operations at the FRCs, both in terms of the scientific research to be conducted and the commitments to ES&H. The plans to be developed would include:

- an overall Management Plan for the FRC,
- a Characterization Plan for characterizing both the background and contaminated areas, and
- a Site Closure Outline.

Each of these three plans would have a separate Health and Safety Plan that not only addresses ES&H risks, but includes measures for mitigating those risks.

The NABIR Program is committed to ensuring ES&H specific to the research campaign at the STEFS and at the proposed FRC. The next level of documentation that would be required would be for research campaign-specific documentation that would include a Research Campaign Plan/Approach for any *in situ* research to be conducted at either the background area and/or contaminated areas. Details on the Research Campaign Plans are in Section 3.3 of this Appendix.

In addition to these plans, the NABIR Program would require the development an ES&H training program specific to the STEFS activities and to the FRC activities and field sites. Both the plans and the training programs would be reviewed for overall adequacy in addressing environmental and health and safety concerns and would be approved by the OBER Field Activities Manager, the FRAP and the management at the appropriate DOE Operations/Site Office. The scope of these plans and training programs is described below.

2.2.1 FRC Management Plan

The overall FRC Management Plan would be developed to govern the scientific approach to research at the proposed FRC, as well as to provide the planned approach to ensuring ES&H compliance. The FRC Management Plan would provide a list of the roles and responsibilities of all individuals and organizations involved with research activities at the proposed FRC. The overall FRC Management Plan would contain several ES&H sub-plans, as appendixes, including:

- a Health and Safety Plan (HASP) tiered from the DOE host site HASP,
- a Waste Control Plan for FRC operations,
- an Environmental Compliance Plan,
- a Contingency Plan for potential offsite migration of contaminants, and

- a Site Closure Outline.

The sub-plans would require a review by the OBER Field Activities Manager and approval by the DOE Operations/Site Office where the FRC would be located.

The FRC HASP would provide:

- detailed information as to the types of activities that would take place,
- a listing of FRC staff names along with other named individuals allowed to undertake field activities,
- a description of the location of the proposed activities, and
- information concerning various areas of health and safety. For areas of concern (i.e., confined space; chemical hazards; heat stress; trips, slips and falls; radiological and hazardous materials handling and exposure), the researchers would identify the specific hazards and what mitigating actions or responses would be taken in the event of an accident.

Similar to the Tier II NEPA Process, HASPs would be developed for each individual research project prior to initiation of the work. These HASPs would be developed by a Site Safety Officer and would be approved by the Operations/Site Office at the FRC location.

The Waste Control Plan would identify:

- types and amounts of waste that might be generated as a result of the research conducted, and
- disposal methods and locations that would be used.

An Environmental Compliance Plan would include:

- detailed information concerning the applicable rules, regulations and environmental permits required to conduct the proposed research;
- the approach the proposed FRC and appropriate DOE Operation/Site Office would take to conduct NEPA reviews (e.g., Tier II NEPA); and
- a statement of issues important to federal, state and local regulators and how the FRC manager would address the issues.

The Site Closure Plan would describe:

- the proposed method of closing the proposed research site after the research has been completed. At the start-up of the proposed FRC, many of the details concerning site closure would be unknown. The Site Closure Outline would assist the FRC Manager, appropriate DOE Operations/Site Office, and the NABIR Program management in planning for future site closure needs.

2.2.2 Characterization Activities Plan

Characterization activities are designed to obtain a baseline set of field site conditions. For example, parameters such as ground water and sediment geochemistry, depth to groundwater, and sedimentology would be determined for both the background area and contaminated area.

The Characterization Activities Plan would be developed by the research scientist for each characterization activity that takes place at an FRC. This plan would include:

- a HASP for the specific characterization activity and
- a Waste Control plan.

2.2.3 Research Campaign Plan/Approach

A research campaign would be any *in situ* research at an FRC or a STEFS that would be conducted by one or more investigators. Research campaigns are designed to obtain a greater understanding of the abiotic and biotic interactions in the subsurface (*in situ*). For example, *in situ* research activities might include the injection of tracer elements and nutrient solutions into the groundwater to track groundwater movement.

Each research campaign would have a plan/approach outlining the steps to comply with environmental requirements. The Research Campaign Plan/Approach would include:

- a HASP specific to the research campaign activities (tiered from the FRC HASP, but of sufficient detail to be useful in a field operation),
- a Waste Control Plan for research campaign activities.

2.2.4 ES&H Training

All individuals working full-time as FRC employees or staff would be trained in the required ES&H areas pertinent to their responsibilities. Similarly, all NABIR investigators who would use the proposed FRC for field research would be required to receive ES&H training appropriate to their research activities.

The FRC Manager would be required to have 40-hour Occupational Safety and Health (OSHA) hazardous substance training (Title 29, *Code of Federal Regulations*, Part 1910.120e), and field site-specific radiation safety training (10 *CFR* 835). In addition, the FRC Manager would be required to have hazardous substance supervisor training and field certification (29 *CFR* 1910.120e[4]). Technical staff, who are not working at the contaminated area full-time, would need 24-hour hazardous substance training; however, any staff or NABIR investigator who would be on the contaminated area full-time would be required to have the 40-hour OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) training. In addition to the 24-hour training, technical staff doing field work would be required to have training specific to field operations at the proposed field sites. All individuals funded through the NABIR Program,

conducting research activities at DOE sites, would be required to have the General Employee Radiation Training and the general host DOE site training.

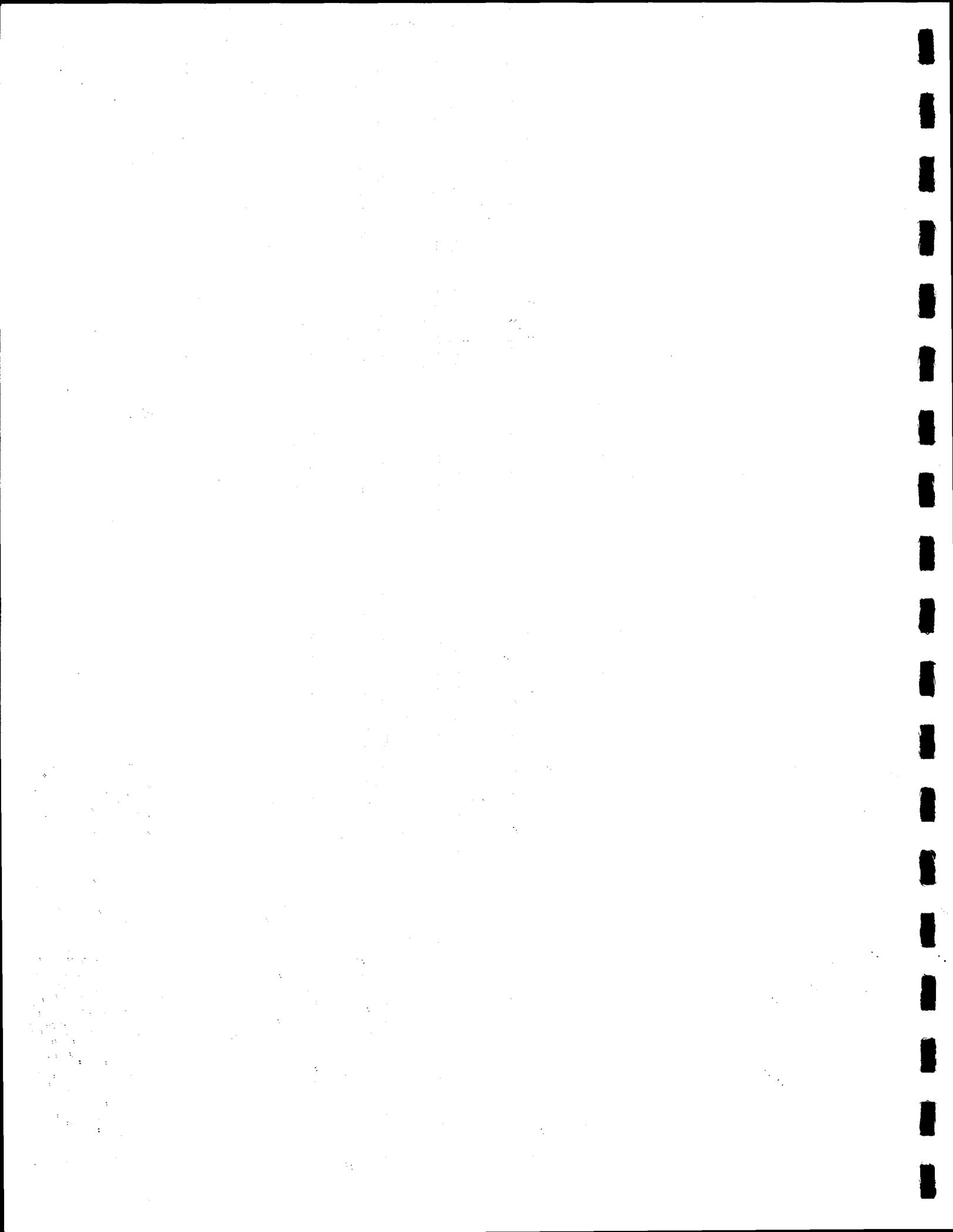
In addition to overall ES&H training, OBER might provide FRC staff with technical training in the areas of sample collection, processing and shipping. The training team would consist of a group of NABIR investigators experienced with obtaining, processing, and shipping research-quality samples. The need for FRC staff to be extremely knowledgeable in this area would be critical to the operation of the proposed FRC.

2.3 Operations/Site Office Management

The third way to manage ES&H risks is for the appropriate DOE Operations/Site Office to maintain a constant awareness and oversight of the FRC operations. The proposed FRC would operate within the ES&H requirements for the host DOE site, and the appropriate DOE Operations/Site Office would be responsible for ensuring that the proposed FRC operates within those boundaries. The appropriate DOE Operations/Site Office would exercise an awareness and oversight of the proposed FRC activities and operations. The appropriate DOE Operations/Site Office would therefore review and approve all ES&H-related documents including, but not limited to, all of the FRC Health and Safety Plans, all FRC Waste Control Plans, and all FRC Contingency Plans associated with mitigating the potential for offsite migration of contaminants. In addition, the appropriate DOE Operations/Site Office would also review the overall FRC Management Plan, the Characterization Plan, the Research Campaign Plan/Approach, and the Site Closure Plan prior to approval by the NABIR Field Activities Manager.

APPENDIX D

**FEDERAL REGISTER NOTICE AND STATEMENT OF FINDINGS
FOR SITE INVESTIGATION ACTIVITIES AT THE OAK RIDGE Y-12
PLANT AREA OF RESPONSIBILITY**



FEDERAL REGISTER
VOL. 58, No. 190

Notices

DEPARTMENT OF ENERGY (DOE)

Notice of Floodplain/Wetlands Involvement for Environmental Restoration and
Waste Management Activities at the Department of Energy's Oak Ridge
Reservation; Oak Ridge, TN

58 FR 51624

DATE: Monday, October 4, 1993

ACTION: Notice of floodplain and wetlands involvement.

SUMMARY: DOE proposes to perform environmental monitoring and site characterization, as well as extensive remedial action activities at the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee. Some areas of the approximately 50,000-acre reservation, as well as areas where baseline information is sought, are within floodplains or include wetlands, and some proposed environmental monitoring and environmental restoration and waste management activities would take place in floodplains or wetlands. Site characterization and remedial actions would be undertaken pursuant to the applicable provisions of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Some of the proposed actions could affect wetlands on or around the site or be located in the floodplains of Poplar Creek, East Fork Poplar Creek, Bear Creek, Scarboro Creek, White Oak Creek and its tributaries, and the Clinch River and its tributaries. In accordance with 10 CFR part 1022, DOE will prepare a floodplain and wetlands assessment and will perform the proposed actions in a manner so as to avoid or minimize potential harm to or within the affected floodplains and wetlands. Maps and further information on the proposed actions are available from DOE at the address below.

DATES: Comments on the proposed action are due to the address below no later than October 18, 1993.

ADDRESSES: Comments should be addressed to: Ms. Nancy K. Hendrix-Ward, National Environmental Policy Act, Program Manager, Environmental Restoration Division, U.S. Department of Energy, Information Resource Center, Post Office Box 2001, Oak Ridge, Tennessee 37831-8541. FAX comments to: (615) 576-6074.

FOR FURTHER INFORMATION CONTACT: Information on general DOE floodplain/wetlands environmental review requirements is available from: Ms. Carol M. Borgstrom, Director, Office of NEPA Oversight (EH-25), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585 (202) 586-4600 or (800) 472-2756.

SUPPLEMENTARY INFORMATION: DOE proposes to carry out site characterization, as well as remedial/corrective activities at the ORR, some of which would be located with floodplains or wetlands. The proposed actions include:

1. *Collection of Samples*-Collection of samples for environmental monitoring, site characterization, and treatability studies will be conducted to better understand the nature of the environment around the ORR and to identify possible releases of contaminants or movement of contaminants already released to the environment. Environmental monitoring would occur throughout the site and would continue for the foreseeable future. Site characterization is tied chiefly to Remedial Investigations/RCRA Facility Investigations (RI/RFI) under CERCLA and RCRA and would be performed for each of the operable units (OUs).

The following types of activities could occur in a floodplain or wetland: (a) Sampling of air, surface water, ground water, sediments, surface and deeper soils; sampling, assessment, and evaluation of terrestrial and aquatic biota, and measurement of meteorological characteristics; (b) drilling of boreholes to obtain soil/geological samples (some of the boreholes would be completed as ground-water monitoring wells); (c) digging soil test pits by hand or backhoe; (d) taking a variety of noninvasive surveys (such as radiological surveys); (e) taking invasive surveys (such as with soil

penetrometers and similar devices); and (f) conducting underground tests (such as aquifer pump, tracer geophysical log, vertical seismic profile, and seismic tests). The majority of the remaining RI/RFI field work to be done at ORR is in OUs that are comprised of predominantly upland areas. Only a few sampling locations, such as those needed for surface waste, sediment, and a very few boreholes or wells and soil test pits, are expected to be in floodplains or wetlands.

2. Drilling or abandonment of boreholes and monitoring wells-Drilling new boreholes and monitoring wells involves driving a drilling rig to the designated site and drilling a hole, usually within a 1-day time-frame. It is possible that one of the wells be drilled in wetlands. Drilling sites would be located outside of wetlands whenever possible.

When relocation is not possible, measures will be taken to minimize disturbance of wetlands, as appropriate. Travel within floodplains will be restricted to established roads and tracks where available; if unavailable, measures will be taken to minimize the disturbance to the floodplain, as appropriate.

Abandoning a well typically involves removal of all foreign material from the well, including the existing bentonite grout, the bentonite seal, the silica-sand filter, and the well casing. The casing can be removed by one of several different methods-pulling it out of the well, destroying the casing in the hole and removing the pieces, over-drilling, or over-coring. Each of these methods involves driving a drilling rig to the well site. Once in the field, it may be determined that some casings are not removable due to well depth, casing condition, or other factors. In these situations, the well casing and possibly the protective surface casing (a larger diameter pipe surrounding the upper portion of the well casing) will be left in place. Abandonment will be accomplished in this manner only when necessary. If the casing is removed, regardless of the removal method used, the resulting hole is reamed to the original construction depth and diameter to remove any remaining annular material and debris. The borehole is then filled with bentonite grout. For wells whose casing is not removed, abandonment would be accomplished by filling the casing with bentonite grout. The well casing and protective casing would be cut off below the ground surface. A concrete pad would be poured at all well abandonment locations to provide a surface seal. A metal cap showing the well identification number and the date of abandonment would be anchored to the concrete slab. Abandonment of a well would typically take 1 to 2 days, depending on the method used and the depth of the well.

3. Construction and Operation-Construction and operation of interim and final remedial/corrective actions and the construction and operation of buildings to implement or facilitate these actions will be based on the results of the RI/RFI being conducted or planned. These proposed actions may consist of in-situ treatment, bioremediation, ground-water treatment, surface water treatment, soil treatments, and soil excavation. While remedial actions are expected to be constructed outside floodplains or wetlands, portions of such projects (particularly activities such as water collection, sampling, and installation of monitoring or similar devices) could be located [*51625] within floodplains or could affect wetlands.

4. Upgrading sanitary sewer or existing collection and transfer pipelines-This would typically involve replacement and hook-up of previously existing pipelines with improved materials; removal of old, unused and/or contaminated lines; or redirection of existing lines to improve the collection of wastes. The process would involve: (a) exposing the existing pipe by hand or backhoe or some other manual means; (b) obtaining a variety of noninvasive and invasive surveys; (c) removal or movement of existing lines, and (d) installation of new pipelines.

5. Placement of small-scale treatment units-This process normally involves the acquisition of required permits, siting and construction of buildings or renovations to existing buildings, and installation of treatment systems. Operation of such a treatment unit normally includes the transportation of stored wastes between storage facilities-and treatment areas. Decommissioning and dismantlement of the treatment system is completed at the end of its useful life or previously-defined time-frame. Handling, storage, and disposal of any residual wastes from the use and shutdown of such a facility would complete the activities surrounding the placement of small-scale treatment units.

6. Siting, construction and upgrades of waste management facilities-This process is usually done to maintain compliance with the Administrative Consent Order and Federal Facility Compliance Agreement between the particular facility, DOE, and EPA.

Various measures are normally taken during construction activities to mitigate potential impacts of all areas of the existing environment and minimize the possibility of allowing a release. Site work would consist of construction or upgrade of driveways from existing streets to the facility, and establishment or extension of utilities from existing

distribution systems. In addition, buildings would have all applicable permits; their design and operation would be in accordance with all environmental, safety and health regulations.

In accordance with DOE regulations for compliance with floodplain and wetlands environmental review requirements (10 CFR part 1022), DOE will prepare a floodplain and wetland assessment for the proposed actions. For an action involving floodplains or wetlands, a Statement of Findings, as required by 10 CFR part 1022, will be issued separately or included in a NEPA document when the floodplain and wetland assessment has been completed and prior to taking the action. The Statement would be published in the Federal Register if an Environmental Assessment or Environmental Impact Statement is not prepared.

Clyde W. Frank,

Acting Principal Deputy Assistant Secretary for Environmental Restoration and Waste Management.

[FR Doc. 93-24310 Filed 10-1-93; 8:45 am]

BILLING CODE 6450-01-M

[Federal Register: March 3, 1997 (Volume 62, Number 41)]
[Notices]
[Page 9416-9417]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr03mr97-59]

DEPARTMENT OF ENERGY

Floodplain Statement of Findings for Site Investigation
Activities at the Oak Ridge Y-12 Plant Area of Responsibility

AGENCY: Department of Energy (DOE).

ACTION: **Floodplain** statement of findings.

SUMMARY: This is a **Floodplain** Statement of Findings for Site Investigation Activities at the Oak Ridge Y-12 Plant, Anderson County, Tennessee, in accordance with 10 CFR part 1022, Compliance with **Floodplain/Wetlands** Environmental Review Requirements. DOE proposes to conduct site investigations and preliminary engineering activities within the boundaries of the Oak Ridge Y-12 Plant as required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), underground storage tank (UST) regulations or other regulations and directives. Some site investigation activities may occur

[[Page 9417]]

within 100-year or 500-year **floodplain** of streams at the plant. DOE has prepared a **floodplain** assessment describing the possible effects, alternatives, and measures designed to avoid or minimize potential harm to floodplains or their flood storage potential. DOE will allow 15 days of public review after publication of the Statement of Findings before implementation of the proposed action.

FOR FURTHER INFORMATION CONTACT: Mr. Robert C. Sleeman, Director, Environmental Restoration Division (EW-91), DOE Oak Ridge Operations Office, Post Office Box 2001, Oak Ridge, TN 37831, Telephone: (423) 576-3534, Facsimile: (423) 576-6074

FOR FURTHER INFORMATION ON GENERAL DOE **FLOODPLAIN** ENVIRONMENTAL REVIEW REQUIREMENTS, CONTACT: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance, EH-42, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, D.C. 20585, Telephone: (202) 586-4600 or (800) 472-2756.

SUPPLEMENTARY INFORMATION: A Notice of **Floodplain** Involvement was published in the Federal Register on October 4, 1993, (58 FR 51624) and subsequently a **floodplain** assessment was prepared. The **floodplain** assessment covers a variety of intrusive and nonintrusive preliminary engineering and site investigation methods and techniques that may be used at one or more sites at the Oak Ridge Y-12 Plant Site. These activities include (as detailed in the October 4, 1993, notice), but are not limited to: (a) sampling of air, surface water, groundwater, sediments, surface and deeper soils; sampling of terrestrial and aquatic biota; and measurement of meteorological characteristics; (b) drilling of boreholes to obtain soil/geological samples (some of the boreholes would be completed as groundwater monitoring wells); digging soil test pits by hand or backhoe; (d) taking a variety of nonintrusive

surveys (such as radiological surveys); (e) taking intrusive surveys (such as with soil penetrometers and similar devices); and (f) conducting underground tests (such as aquifer pump, tracer geophysical log, vertical seismic profile, and seismic tests).''

Alternatives considered in the assessment were (1) no action, (2) prohibition of site investigation activities in floodplains, and (3) restricting site investigation activities to outside the **floodplain** when practicable alternatives exist, i.e., data quality would not be compromised. Only a few sampling locations, such as those needed for surface and sediment samples, and a minimal number of boreholes or wells and soil test pits are expected to be in floodplains. Most of the activities addressed by the **floodplain** assessment will result in no measurable impact on **floodplain** cross-sections or flood stage, and thus do not increase the risk of flooding. Those activities that are identified from site-specific data as possibly impacting negatively upon the **floodplain** (e.g., installation of flumes and construction of access roads) may require separate **floodplain** assessments and the implementation of mitigative measures, e.g., construction during low precipitation periods, prompt stabilization and restoration of affected areas, minimizing vegetation removal, and the use of mats and wide-tracked vehicles. Alternatively, DOE may opt to omit the activity or relocate the activity to an alternate site. Site investigation activities addressed in the **floodplain** assessment conform to applicable **floodplain** protection standards.

Issued in Oak Ridge, TN on February 11, 1997.

James L. Elmore,
Alternate National Environmental Policy Act
Compliance Officer.

[FR Doc. 97-5122 Filed 2-28-97; 8:45 am]

BILLING CODE 6450-01-P

Floodplain Assessment for Site Investigation Activities at the Y-12 Plant Area of Responsibility

4. SUMMARY

If carefully planned and executed, field sampling and measurement activities associated with site investigation and preliminary engineering efforts for the ERWM program at Y-12 would not result in the loss of floodplains or significant floodplain functions and values, would not significantly diminish the cross-sectional area of the floodplain or alter its profile, and would not have an appreciable impact on floodplain capacity, erosional or depositional regimes, and biota. Sampling and measurement activities that may negatively impact upon floodplains include the construction and installation of meteorological stations. Floodplains may be negatively impacted by the movement of heavy equipment associated with activities such as deep soil borings and well construction, the installation of lysimeters, and the construction of meteorological stations. Measures that would be implemented to mitigate the possible effects of these activities are discussed in the appropriate sections.

Implementation of best management practices, engineering controls, mitigative measures, and restoration efforts would ensure that the cross-sectional area or profile of the floodplain is not significantly diminished within the limits of measurement error and that temporary loss/disturbance of floodplains functions and values would be restored. If practicable alternatives exist to the location of these actions in floodplains, they will be utilized. Based on these considerations and the requirements under CERCLA, RCRA, or other laws or directives to investigate and remediate environmental contamination, Alternative 3 has been identified as the best alternative.

APPENDIX E

COORDINATION LETTERS



United States Department of the Interior

FISH AND WILDLIFE SERVICE

446 Neal Street
Cookeville, TN 38501

September 14, 1999

Mr. Paul E. Bayer
U.S. Department of Energy
Environmental Sciences Division
Germantown, Maryland 20874-1290

Dear Mr. Bayer:

Thank you for your letter and enclosures of August 11, 1999, regarding the preparation of an Environmental Assessment (EA) for the implementation of the Natural and Accelerated Bioremediation Research (NABIR) Program and selection of Field Research Centers (FRC) at the Oak Ridge National Laboratory in Roane County, Tennessee. U.S. Fish and Wildlife Service (Service) personnel have reviewed the information submitted and offer the following comments for consideration.

Information available to the Service indicates that wetlands exist in the vicinity of the proposed project. Enclosed are copies of portions of the National Wetlands Inventory's Bethel Valley quadrangle (Attachments 1 and 2) with the referenced wetlands highlighted. This information is provided for your convenience. Our wetlands determination has been made in the absence of a field inspection and does not constitute a wetlands delineation for the purposes of Section 404 of the Clean Water Act. The Corps of Engineers should be contacted regarding the presence of regulatory wetlands and the requirements of wetlands protection statutes.

According to our records, the following federally listed endangered species may occur near the proposed FRC:

Gray bat (*Myotis grisescens*)
Indiana bat (*Myotis sodalis*)

Qualified biologists should assess potential impacts and determine if the proposed project may affect the species. We recommend that you submit a copy of your assessment and finding to this office for review and concurrence. A finding of "may affect" could require the initiation of formal consultation procedures.

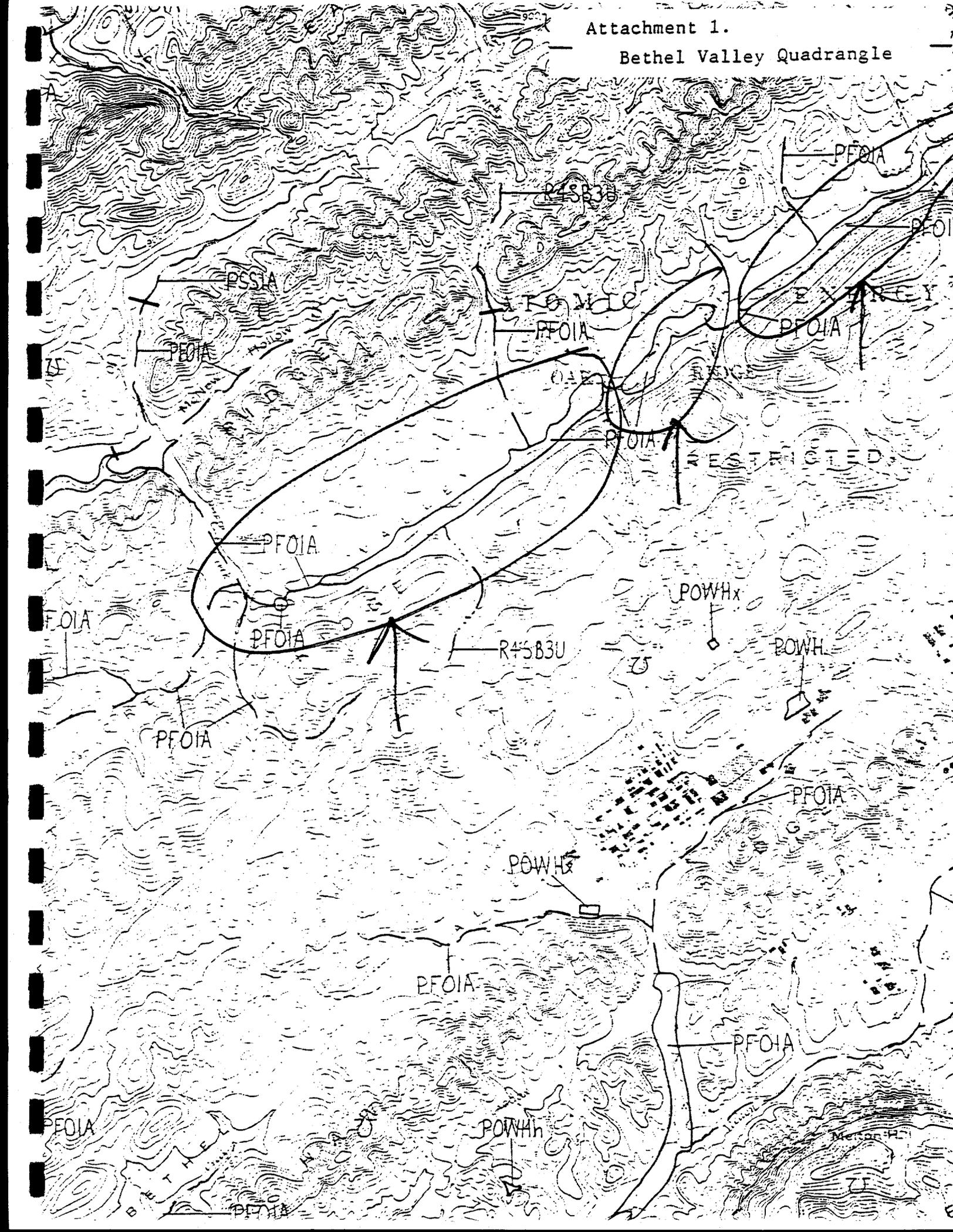
These constitute the comments of the U.S. Department of the Interior in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.). We appreciate the opportunity to comment. Should you have any questions or need further assistance, please contact Steve Alexander of my staff at 931/528-6481, ext. 210.

Sincerely,

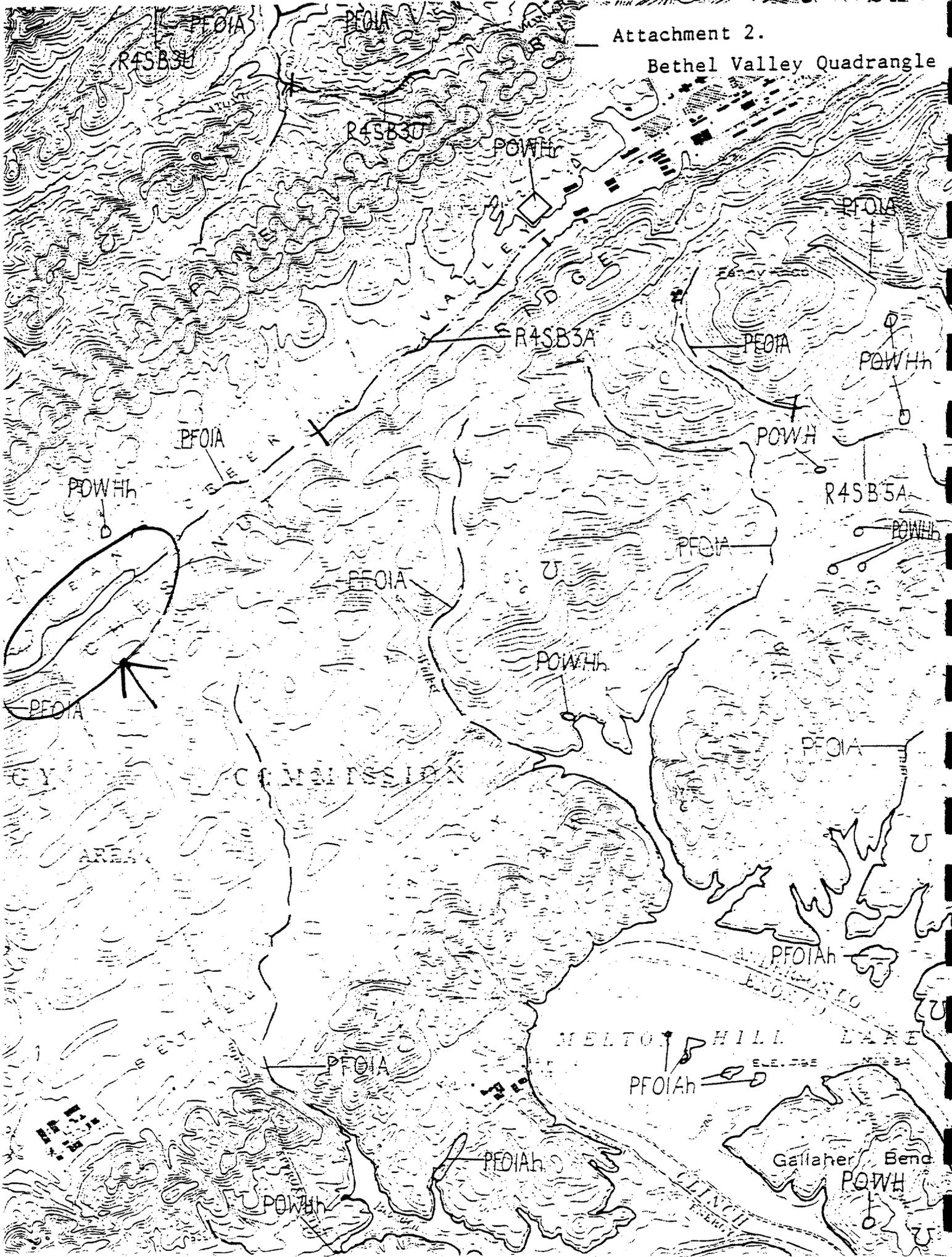
A handwritten signature in cursive script, appearing to read "Lee A. Barclay".

Lee A. Barclay, Ph.D.
Field Supervisor

Enclosure



Bethel Valley Quadrangle





Department of Energy
Germantown, MD 20874-1290

AUG 11 1999

Mr. Reginald G. Reeves
Director
Division of Natural Heritage
Tennessee Department of Environment and Conservation
401 Church Street
Nashville, TN 37243-0443

Dear Mr. Reeves:

Reference: Information Act Request

The U.S. Department of Energy (DOE) proposes to implement the Natural and Accelerated Bioremediation Research (NABIR) Program and selection of Field Research Centers (FRC) and is currently preparing an environmental assessment (EA), pursuant to the National Environmental Policy Act (NEPA) on this Federal Action. The proposed FRC would consist of already existing laboratories, offices, and support facilities as well as appropriate experimental areas to allow ongoing programs of bioremediation research. The proposed site for NABIR is the DOE-owned Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The proposed location of the field site at ORNL is in Bear Creek Valley. The plots of land are adjacent to Bear Creek, outside the floodplain (see enclosed figures).

In an attempt to clean up legacy waste generated by DOE's weapons production and research activities, fundamental research is needed in the biological, chemical, and physical sciences that will contribute to new cost-effective solutions. One possible low cost approach for remediating the subsurface contamination of DOE sites is bioremediation. Bioremediation is the use of microorganisms to reduce or eliminate environmental hazards resulting from accumulation of toxic chemicals and other hazardous wastes. The NABIR program is a ten-year research program designed to better understand the biotic and abiotic processes in the subsurface, to control and accelerate the biotic processes, and to provide fully functional field sites. Field research would focus on the subsurface environment below the zone of root influence and would be expected to include investigation of both the saturated and unsaturated zones.

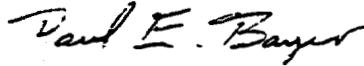
In order to properly assess these properties, I am requesting a review of the historic, cultural or archaeological significance of the referenced properties. Your input will be used in the preparation of the environmental assessment. A reply by September 10, 1999, would be appreciated.



Printed with soy ink on recycled paper

If the property information provided is not sufficient to conduct an accurate file search, or if you have any questions, please contact me at 301-903-5324. Thank you for your assistance.

Sincerely,



Paul E. Bayer
NEPA Document Manager
Environmental Sciences Division

Enclosures:
As stated

cc: C. Hickey



TENNESSEE HISTORICAL COMMISSION
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2941 LEBANON ROAD
NASHVILLE, TN 37243-0442
(615) 532-1550

September 3, 1999

Mr. Paul E. Bayer
Environmental Sciences Division
Dept. of Energy
Germantown, Maryland 20874-1290

RE: DOE, ORNL/NABIR PROGRAM, OAK RIDGE, ANDERSON COUNTY

Dear Mr. Bayer:

Pursuant to your request, this office has reviewed documentation concerning the above-referenced undertaking received Monday, August 16, 1999. This is a requirement of Section 106 of the National Historic Preservation Act for compliance by the participating federal agency or applicant for federal assistance. Procedures for implementing Section 106 of the Act are codified at 36 CFR 800 (64 FR 27044, May 18, 1999).

After considering the documentation submitted, it is our opinion that THERE ARE NO NATIONAL REGISTER OF HISTORIC PLACES LISTED OR ELIGIBLE PROPERTIES AFFECTED BY THIS UNDERTAKING. This determination is made either because of the location, scope and/or nature of the undertaking, and/or because of the size of the area of potential effect; or because no listed or eligible properties exist in the area of potential effect; or because the undertaking will not alter any characteristics of an identified eligible or listed property that qualify the property for listing in the National Register or alter such property's location, setting or use. Therefore, this office has no objections to your proceeding with the project.

If you are applying for federal funds, license or permit, you should submit this letter as evidence of consultation under Section 106 to the appropriate federal agency, which, in turn, should contact this office as required by 36 CFR 800. If you represent a federal agency, you should submit a formal determination of eligibility and effect to this office for comment. You may direct questions or comments to Joe Garrison (615)532-1559. This office appreciates your cooperation.

Sincerely,

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH/jyg



United States Department of the Interior

FISH AND WILDLIFE SERVICE

517 South Buchanan

Moses Lake, Washington 98837

Phone: 509-765-6125 FAX: 509-765-9043

May 11, 1999

Department of Energy
Attn: James E. Rasmussen
Environmental Assurance, Permits and Policy
P.O. Box 550
Richland, WA 99352

Re: Species List Request, Bio-Remediation Research Program
FWS Reference 1-9-99-SP-269

Dear Mr. Rasmussen:

Thank you for your species list request of April 5, 1999. Enclosed is a list of threatened and endangered species, candidate species and species of concern (Enclosure A), that may be present in the action area of the proposed Natural and Accelerated Bio-remediation Research Program.

This list fulfills the requirements of the U. S. Fish and Wildlife Service (Service) under Section 7(c) of the Endangered Species Act of 1973, as amended (Act). We are enclosing a copy of the requirements for federal agency compliance under the Act (Enclosure B). Also enclosed is a information packet (Enclosure C) on the Ute ladies'-tresses, a federally threatened species found recently in Washington State.

Should the Biological Assessment (BA) for the proposed project determine that a listed species is likely to be affected (adversely or beneficially) by the project, the federal agency should request Section 7 consultation through this office. If the BA determines that the proposed action is "not likely to adversely affect" a listed species, the federal agency should request Service concurrence with that determination through the informal consultation process. If the BA determines the project to have "no effect," we would appreciate receiving a copy for our information.

Candidate species and species of concern are included simply as advance notice to federal agencies of species which may be proposed and listed in the future. Protection provided to these species now may preclude possible listing in the future. If early evaluation of your project indicates that it is likely to adversely impact a candidate species, or species of concern, the federal agency may wish to request technical assistance from this office.

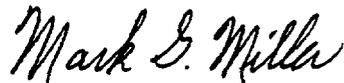
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MAY 13 1999
DOE RL/CCC

There are other species, including anadromous fishes that have been federally listed by the National Marine Fisheries Service (NMFS). Some of these species may occur in the vicinity of your project. Please contact NMFS in Lacey, WA at (360) 753-5828, or in Portland, OR at (503) 231-2319, to request a species list.

Thank you for your efforts to protect our nation's species and their habitats. If you have additional questions regarding your responsibilities under the Act, please contact Richard Smith of this office at (509) 765-6125.

Sincerely,



Mark G. Miller
Project Leader

ENCLOSURES

Enclosure A

May 11, 1999

**LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES
AND SPECIES OF CONCERN WHICH MAY OCCUR IN THE
BENTON COUNTY, WASHINGTON
PORTION OF THE HANFORD SITE**

FWS Reference: 1-9 -99-SP-269

LISTED

Endangered

Peregrine falcon (*Falco peregrinus*)

Threatened

Bald eagle (*Haliaeetus leucocephalus*)

Bull trout (*Salvelinus confluentus*)

Spiranthes dituvialis (Ute ladies' tresses)

PROPOSED

None

CANDIDATE

None

SPECIES OF CONCERN

Animals

Black tern (*Chlidonias niger*)

California floater (mussel) (*Anodonta californiensis* (Lea, 1852))

Columbia pebblesnail (*Fluminicola* (=Lithoglyphus) *columbianus* (Hemphill in Pilsbry, 1899))
[great Columbia River spire snail]

Ferruginous hawk (*Buteo regalis*)

Fringed myotis (bat) (*Myotis thysanodes*)

Loggerhead shrike (*Lanius ludovicianus*)

Long-eared myotis (bat) (*Myotis evotis*)

Long-legged myotis (bat) (*Myotis volans*)

Lynn's clubtail (dragonfly) (*Gomphus lynnae*)

Marginated sculpin (*Cottus marginatus*)

Northern sagebrush lizard (*Sceloporus graciosus graciosus*)

Olive-sided flycatcher (*Contopus borealis*)

1-9 -99-SP-59

December 21, 1998

Pacific lamprey (*Lampetra tridentata*)

Pale Townsend's (= western) big-eared bat (*Corynorhinus* (= *Plecotus*) *townsendii pallescens*)

River lamprey (*Lampetra ayresi*)

Small-footed myotis (bat) (*Myotis ciliolabrum*)

Western burrowing owl (*Athene cucularia hypugea*)

Yuma myotis (bat) (*Myotis yumanensis*)

Plants

Astragalus columbianus (Columbia milk-vetch)

Eriogonum codium (Umtanum wild buckwheat)

Rorippa columbiae (Columbia yellow-cress)

Enclosure B

**FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c)
OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED**

SECTION 7(a) - Consultation/Conference

- Requires:
1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;
 2. Consultation with FWS when a federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and
 3. Conference with FWS when a federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which is/are likely to be affected by a construction project. The process is initiated by a federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with our Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Moses Lake Office, 517 S. Buchanan, Moses Lake, WA 98837.

* "Construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. Biological evaluations are recommended for other federal actions such as permits, grants, licenses, federal authorizations or approval which may result in construction.



United States Department of the Interior **RECEIVED**

FISH AND WILDLIFE SERVICE
Upper Columbia River Basin Field Office
11103 E. Montgomery Drive, Suite #2
Spokane, WA 99206

JUN 22 1998

U.S. FISH & WILDLIFE SERVICE
MOSES LAKE OFFICE

June 17, 1998

Subject: Ute ladies'-tresses, *Spiranthes diluvialis*

Dear Interested Party:

Ute ladies'-tresses, *Spiranthes diluvialis*, an orchid that is federally listed as threatened, was discovered in Washington for the first time in 1997. It was also found in the Snake River basin in southeastern Idaho in 1996. Before these discoveries, this plant was known only from a few locations in Montana, Colorado, Wyoming and Nebraska.

Since Ute ladies'-tresses is now known to be present in northern Washington, southern Idaho, and nearby parts of Montana, the US Fish and Wildlife Service (Service) has determined that, in the absence of adequate surveys, this species may be expected to occur in suitable habitat throughout Idaho and Washington. For this reason, we are placing Ute ladies'-tresses on all species lists for activities occurring in potentially suitable habitat. Also, for projects in suitable habitat, Federal agencies now have the responsibility to consider the species in their planning, and, under section 7 of the Endangered Species Act, the agencies must consult with the Service on projects that may affect this species.

Because the species was not expected in the Upper Columbia Ecoregion, it has not been surveyed for. Therefore, until adequate surveys have been done, Ute ladies'-tresses must be considered to be potentially present in any suitable habitat. We recommend that land managers institute surveys by knowledgeable botanists. Surveys should be conducted during the peak of the blooming period, August and September, since the species is difficult to find and identify at other times.

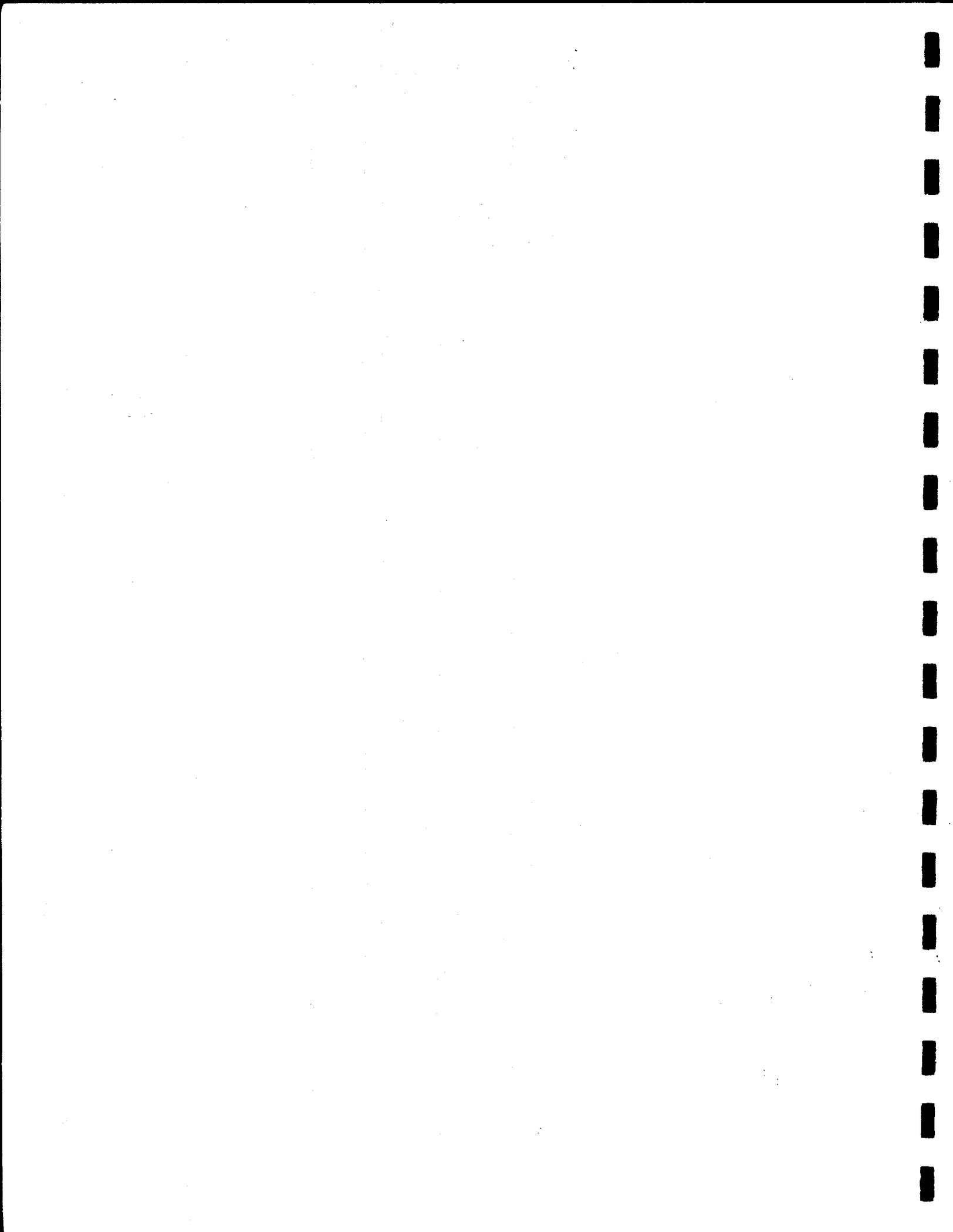
The enclosed package includes the information we have gathered about this species, its habitat and its requirements. We have included some photos of typical habitat in southern Idaho and one of the flowering head. We hope this information will help you determine whether Ute ladies'-tresses is present in your area of concern, and if so, develop appropriate measures for its protection.

If you have any questions about this information, please contact Linda Hallock, at 509-921-0160, or Suzanne Audet, at 509-891-6839, both of this office.

Sincerely,


Philip Laumeyer
Field Supervisor

Enclosures



March 12, 1999

Mr. Tyler Gilmore
Pacific Northwest National Laboratory
P. O. Box 999, MSIN K6-81
Richland, WA 99352

Dear Mr. Gilmore:

BIOLOGICAL REVIEW FOR THE NATURAL AND ACCELERATED BIOREMEDIATION RESEARCH (NABIR) PROGRAM, FIELD RESEARCH CENTER, ENVIRONMENTAL ASSESSMENT, 100 H Area, ECR #99-100-005.

Project Description:

- PNNL and DOE/RL are proposing the general 100-H area as a field research center (FRC) under the NABIR program. If the site is selected a variety of activities may occur within the area, such as well drilling, excavations, surface clearing, and alteration the saturated and/or unsaturated soil zones.

Survey Objectives:

- To determine the occurrence in the project area of plant and animal species protected under the Endangered Species Act (ESA), candidates for such protection, and species listed as threatened, endangered, candidate, sensitive, or monitor by the state of Washington, and species protected under the Migratory Bird Treaty Act,
- To evaluate and quantify the potential impacts of disturbance on priority habitats and protected plant and animal species identified in the survey.

Survey Methods:

- Pedestrian and ocular reconnaissance of the proposed FRC site, and a control site near the southeast corner of 100-H Area were performed by C. A. Duberstein, J. L. Downs, B. L. Tiller, and M. R. Sackschewsky on 23 April 1998. An additional control site, which is proposed to be to the south or the southwest of the original 100-H perimeter has not been recently surveyed. However, information on the habitat of the region was obtained from the habitat classification database of the Ecosystems Monitoring Project (Neitzel et al. 1998). The Braun-Blanquet cover-abundance scale (Bonham 1989) was used to determine percent cover of dominant vegetation,
- Priority habitats and species of concern are documented as such in the following: Washington Department of Fish and Wildlife (1994, 1996), Washington State Department of Natural Resources (1997), and for migratory birds, U.S. Fish and Wildlife Service (1985). Lists of animal and plant species considered Endangered, Threatened,

Proposed, or Candidate by the USFWS are maintained at 50 CFR 17.11 and 50 CFR 17.12.

Survey Results:

- The northern portion of the proposed FRC site is characterized as a Rabbitbrush (*Crysothamnus nauseosus*) / cheatgrass (*Bromus tectorum*) community, with a significant amount of bulbous bluegrass (*Poa bulbosa*). Other portions of the proposed FRC site are primarily characterized as cheatgrass communities. The entire proposed FRC site has been previously disturbed. The proposed control site in the southeast corner of 100H area is characterized as a cheatgrass community. Neither of these habitats are considered to be priority habitats.
- Migratory bird species observed within the proposed project areas include white-crown and grasshopper sparrows, house finch, killdeer, horned lark, cliff and bank swallows, western meadowlarks, and Canadian geese.

Considerations and Recommendations:

- No plant or animal species protected under the ESA, candidates for such protection, or species listed by the Washington state government as threatened or endangered were observed within the proposed site boundaries.
- However, the Columbia River Steelhead (Federal endangered) and Columbia River Spring Chinook Salmon (Federal Proposed Threatened) are known to occur in the Columbia River immediately adjacent to the proposed project sites. The proposed work involves altering the groundwater which flows to the Columbia River and surface work that could result in erosion to the river as well as ground vibrations within the river. These species could be impacted by the proposed activities. A consultation with the National Marine Fisheries Service under Section 7 of the Endangered Species Act will be required for this portion of the proposed work. This consultation will be completed prior to initiation of the proposed work.
- Bald eagles (Federal threatened) use the river area adjacent to the proposed sites during the winter. Bald eagle roost trees are located to the north and the south of 100H area. The Hanford Site Bald Eagle Site Management Plan (DOE 1994) restricts routine work within 800 meters of the roost sites to between the hours of 10 am and 2 pm. Non-routine activities, such as excavations and well drilling, require case-by case evaluations, and may not be allowed between 15 November and 15 March. However, the proposed FRC and Control sites are located just beyond the 800 m radius from the night roost locations.
- Habitat removal that would occur between 15 April and 31 July could affect nesting migratory birds, and will require specific assessments prior to startup.

Mr. Tyler Gilmore
99-100-005
Page 3 of 4

- Otherwise, no adverse impacts to species, habitats, or other biological resources are expected to result from the proposed actions at the proposed FRC site or the control site in the southeast corner of 100H area.
- The additional control site that is proposed to be located south or southwest of the 100 H Area will require site specific evaluations prior to initiation of any disturbance activities. However, no federal or state listed threatened or endangered species are known to inhabit the area containing the proposed control sites, and there is no reason to anticipate any such species in the area.
- This Ecological Compliance Review is based on data collected during the spring of 1998 and previous years. The sites will be re-surveyed during the spring of 1999 as part of the routine baseline ecological compliance effort. If the 1999 surveys detect the presence of additional species of concern the project contacts will be notified.

Sincerely,

CA Brandt, Ph.D.
Project Manager
Ecological Compliance Assessment

CAB:mrs

REFERENCES

- Bonham, Charles D. 1989. Measurements for Terrestrial Vegetation, John Wiley & Sons, Inc. pp. 127-128.
- Neitzel, D. A., et al. (1998) Hanford Site National Environmental Policy Act (NEPA) Characterization. PNNL-6415 Rev. 10. Pacific Northwest National Laboratory, Richland, WA.
- U. S. Department of Energy (1994) Bald Eagle Site Management Plan for the Hanford Site, South-Central Washington. DOE/RL-94-150.
- U. S. Fish and Wildlife Service. 1985. Revised List of Migratory Birds; Final Rule. 50 FR 13708 (April 5, 1985).
- Washington Department of Fish and Wildlife. 1994. Species of Special Concern in Washington. (April 1994).
- Washington Department of Fish and Wildlife. 1996. Priority Habitats and Species List. (January 1996).
- Washington Department of Natural Resources. 1997. Endangered, Threatened & Sensitive Vascular Plants of Washington (August 1997).



Department of Energy
 Richland Operations Office
 P.O. Box 550
 Richland, Washington 99352

APR 01 1999

99-EAP-234

Mr. Kurt R. Campbell
 Supervisor, Moses Lake Field Office
 U.S. Fish and Wildlife Service
 517 South Buchanan
 P.O. Box 1157
 Moses Lake, Washington 98837

Dear Mr. Campbell:

PROPOSED NATURAL AND ACCELERATED BIO-REMEDIATION RESEARCH PROGRAM - FIELD RESEARCH CENTER ENVIRONMENTAL ASSESSMENT

The U.S. Department of Energy, Richland Operations Office (RL), is preparing an Environmental Assessment (EA), for a proposed Field Research Center under the Natural and Accelerated Bioremediation Research (NABIR) Program, to be located within the 100-H Area of the Hanford Site near Richland, Washington. In compliance with the Endangered Species Act (ESA), the EA will contain an analysis of the proposed action as it relates to species that are either listed or proposed as threatened or endangered under the ESA.

In support of the preparation of this EA, RL requests U.S. Fish and Wildlife Service provide a current list of species that may be affected by the proposed action. Activities covered by this EA will occur in Benton County, Washington, in the following areas:

Township	Range	Section
14N	26E	12, 13, 24
14N	27E	7, 18, 19

If you have any questions, please contact Dana C. Ward of my staff, on (509) 372-1261.

Sincerely,

Paul F. X. Deming, Jr.
 James E. Rasmussen, Director
 Environmental Assurance, Permits
 and Policy Division

EAP:DCW

cc: Mike Sackschewsky, PNNL



Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APR 01 1999

99-EAP-233

Mr. Dennis Carlson
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
510 Desmond Drive SE
Suite 103
Lacey, Washington 98503

Dear Mr. Carlson:

**PROPOSED NATURAL AND ACCELERATED BIO-REMEDIATION RESEARCH
PROGRAM - FIELD RESEARCH CENTER ENVIRONMENTAL ASSESSMENT**

The U.S. Department of Energy, Richland Operations Office (RL), is preparing an Environmental Assessment (EA), for a proposed Field Research Center under the Natural and Accelerated Bioremediation Research (NABIR) Program, to be located within the 100-H Area of the Hanford Site near Richland, Washington. In compliance with the Endangered Species Act (ESA), the EA will contain an analysis of the proposed action as it relates to species that are either listed or proposed as threatened or endangered under the ESA.

In support of the preparation of this EA, RL requests the National Marine Fisheries Service provide a current list of species that may be affected by the proposed action. Activities covered by the EA may impact areas near the Columbia River between River Mile 370 and River Mile 374. If you have any questions, please contact Dana C. Ward of my staff, on (509) 372-1261.

Sincerely,

for James E. Rasmussen, Director
Environmental Assurance, Permits,
and Policy Division

EAP:DCW

cc: Mike Sackschewsky, PNNL

*Environmental Assessment
for the Selection and Operation of the Proposed Field Research Centers for the NABIR Program*

The National Marine Fisheries Service had no comment or response to requested information.



Battelle

Pacific Northwest Laboratories

Project Number _____

Internal Distribution

file/LB

Date March 12, 1999

To Mr. Tyler J. Gilmore, Applied Geology and Geochemistry

From Ms. Natalie A. Cadoret, Cultural Resources Project. Concurrence: 

Subject Cultural Resources Review for the Natural and Accelerated Bioremediation Research (NABIR) Program. HCRC #99-100-005.

In response to your request received March 4, 1999, staff of the Hanford Cultural Resources Laboratory (HCRL) conducted a cultural resources review of the subject project located in the 100 and 600 Areas of the Hanford Site. According to the information that you supplied, a proposal to DOE for hosting a Field Research Center (FRC) at Hanford for the Natural and Accelerated Bioremediation Research (NABIR) program is being prepared. The proposed location is in the 100-H Area and vicinity. A FRC Test Site and 2 control sites, one to the southwest (SWCS) and the other to the southeast (SECS) of the FRC Test Site have been identified. Cultural information on these sites is needed to support an Environmental Assessment effort at DOE Headquarters.

Our records review indicates that approximately half of the FRC Test Site has been intensively surveyed for cultural resources (HCRC #91-100-CERCLA). No archaeological sites or isolated artifacts were identified in the survey area. The FRC Test Site is primarily within areas where the ground surface has been disturbed by prior Hanford Site construction activities. All but a very small part of the remainder of the FRC Test Site not intensively surveyed is identified as original ground surface (Action Plan for Managing Hanford Cultural Resources, 100-H Reactor Area (1995 draft, BHI-00709)). Part of the FRC Test Site area is within 400 m of the Columbia River, which is considered culturally sensitive. Generally, monitoring of excavations by a cultural resource specialist is required within this sensitive zone. There are no known historic properties within the FRC Test Site.

The SWCS and the SECS have also been previously surveyed for cultural resources. No archaeological sites or isolated artifacts were located within the control sites. Review of 1941 aerial photographs indicates that the SWCS was undeveloped range land, while the SECS was a combination of undeveloped and agricultural land. There are no known historic properties within the SWCS or the SECS.

If the 100H Area is selected for the NABIR FRC Project, cultural resource reviews will be necessary for individual tests associated with the project.

A copy of this memo will be sent to D. W. Lloyd, DOE, Richland Operations Office, as official documentation. If you have any questions, please call me at 376-8107. Please use the HCRC# above for any future correspondence concerning this project.

cc: D. W. Lloyd, RL (2)

APPENDIX F

EXISTING NEPA AND RELATED DOCUMENTATION

- I. Representative NEPA Documentation for the Activities Similar to NABIR Proposed Research
 1. NEPA Determination for Proposed Flow-Cell Installations and Tracer Experiments, South Oyster Field Site, Northampton County, Virginia
 - a. Environmental Evaluation Notification Form for Flow-Cell Installations and Tracer Experiments, South Oyster Field Site, Northampton County, VA
 2. Environmental Assessment Executive Summary for Dover Air Base, Dover Delaware

- II. Representative NEPA Documentation for Oak Ridge National Laboratory
 1. Categorical Exclusion for Small-Scale Research and Development Projects and Pilot Studies conducted by ORNL Environmental Sciences Division
 2.
 - a. NEPA Review Report for *In Situ* Permeable Reactive Barriers for Metals and Radioactivity: Sampling and Dye Tracer Study
 - b. Categorical Exclusion for *In Situ* Permeable Reactive Barriers for Metals and Radioactivity: Sampling and Dye Tracer Study
 - c. Tracer Test Workplan for *In Situ* Permeable Reactive Barriers for Metals and Radioactivity: Sampling and Dye Tracer Study
 3.
 - a. NEPA Review for Y-12 Plant Multiple Tracer Injection Test
 - b. Work Plan for Y-12 Plant Multiple Tracer Injection Test
 - c. Voluntary Tennessee Department of Environment and Conservation Dye Tracer Registration Form for Y-12 Plant Multiple Tracer Injection Test

- III. Representative NEPA Documentation for the Hanford Site, Richland, Washington
 1. Categorical Exclusion for Determination for Site Characterization and Environmental Monitoring, Hanford Site, Richland, Washington
 2. Categorical Exclusion Determination for Microbiological and Biomedical Research Projects, and Diagnostic and Treatment Activities, Hanford Site, Richland, Washington
 3. Categorical Exclusion Determination for Palouse Drilling Project Located Near Winona and Washtucna, Washington.

I. Representative NEPA Documentation for Activities Similar to NABIR Proposed Research



Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

OCT 1 1998

Paul E. Bayer
NABIR Field Research Center
Manager, HQ
ER-74/GTN

SUBJECT: NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DETERMINATION FOR PROPOSED FLOW-CELL INSTALLATIONS AND TRACER EXPERIMENTS, SOUTH OYSTER FIELD SITE, NORTHAMPTON COUNTY, VIRGINIA

The activities for the proposed flow-cell installations and tracer experiments located at the South Oyster Field Site, Northampton County, Virginia, have been evaluated for potential environmental impacts.

NEPA review for characterization studies (Gold-0020, Gold-0020-Modification 1, and Gold-0020-Modification 2) were conducted prior to the selection of the South Oyster Field Site. Consequently, general environmental issues have already been addressed for this Site. The proposed action submitted for the current determination is to conduct a research study of bacterial transport in a subsurface aquifer under both aerobic and hypoxic conditions. The property on which the proposed research will take place belongs to the Nature Conservancy and is part of the Virginia Coast Reserve. The proposed field work will be conducted on the edges of actively cultivated fields. Prior to conducting any research on this Site, the Nature Conservancy has required that a Research Permit Application be submitted and approved. The project managers have met all the rigorous requirements and environmental constraints, consequently, a research permit to conduct the studies has been issued.

No environmental impacts would occur to (or result from): threatened/endangered species and/or critical habitats; archaeological/historical resources; prime, unique, or important farmland; special sources of groundwater; coastal zones; the floodplain; noise; and hazardous, toxic, or criteria pollutant air emissions. There is no threatened violation of Environment, Safety & Health regulations/permit requirements at the South Oyster Field Site.



Paul E. Bayer

- 2 -

OCT 1 1998

Based upon my review of the data presented in the Environmental Evaluation Notification Form, I have determined that the proposed action is covered by Categorical Exclusion B3.6 (Siting/construction/operation/decommissioning of facilities for bench-scale research, conventional laboratory operations, small-scale research and development and pilot projects) and B3.8 (Outdoor ecological/environmental research in a small area). No further NEPA review nor documentation is required for the proposed actions at the South Oyster Field Site, Northampton County, Virginia.

Signature:

W. Sedgefield White
Chicago Operations Office NEPA Compliance Officer

Date: October 1, 1998

cc: C. Hickey, HQ, ER-8.2/GTN
W. Timothy Griffin, Golder Associates, Inc.
F. Wobber, HQ, ER-74/GTN
M. Broido, HQ, ER-74/GTN
J. Houghton, HQ, ER-74/GTN

ENVIRONMENTAL EVALUATION NOTIFICATION FORM

Grantee/Contractor Laboratory: Golder Associates Inc.: South Oyster Field Site, Northampton County, VA

Project/Activity Title: Flow-Cell Installations and Tracer Experiments, South Oyster Field Site, VA

CH NEPA Tracking No.:

Type of Funding: Energy Research

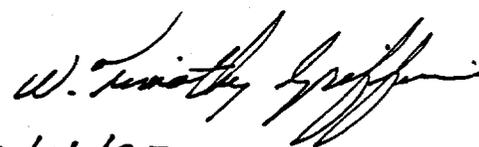
B&R Code:

Total Estimated Cost: \$150,000 (field work alone)

DOE Cognizant Secretarial Officer (CSO):

Contractor Project Manager: W. Timothy Griffin

Signature:

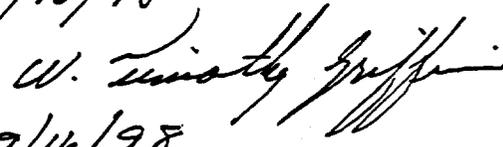


Date:

9/16/98

Contractor NEPA Reviewer: W. Timothy Griffin

Signature:



Date:

9/16/98

I. Description of Proposed Action:

Introduction

This Environmental Evaluation Notification Form (EENF) is being submitted in support of a bioremediation field research project funded by the U.S. Dept. of Energy, Office of Biological and Environmental Research. The purpose of the proposed research project is to study bacterial transport in a subsurface aquifer under both aerobic and hypoxic conditions. A site with these conditions has been identified and characterized on the Delmarva Peninsula near the small fishing village of Oyster, Virginia (Figures 1 and 2). The work to date that has been performed to select and characterize this site was described in EENF's Gold-0020, Gold-0020-Modification 1, and Gold-0020-Modification 2. The property on which the site is located is owned by The Nature Conservancy (TNC), and is part of the Virginia Coast Reserve. The site is herein referred to as South Oyster.

The proposed research is funded by DOE's Natural and Accelerated Bioremediation Research (NABIR) Program. The factors controlling transport of bacteria are important for the field scale application of bioremediation technologies, however, research on microbial transport in the presence of complex subsurface heterogeneity is limited. The purpose of this research program is to focus on the physical and chemical factors which control microbial transport in the subsurface.

An interdisciplinary research team has been assembled to conduct this research. Principal Investigators (PIs) on this team include:

Dr. T.C. Onstott, Princeton University
Dr. Mary F. DeFlaun, Envirogen, Inc
Dr. Donald Swift, Old Dominion University
Dr. William Holben, University of Montana
Dr. Timothy Scheibe, Pacific Northwest National Laboratory
Mr. Timothy Griffin, Golder Associates
Dr. Timothy Ginn, University of California, Davis
Dr. David Balkwill, University of Florida
Dr. Jim Fredrickson, Pacific Northwest National Laboratory
Dr. Tommy Phelps, Oak Ridge National Laboratory
Dr. Chris Murray, Pacific Northwest National Laboratory
Dr. Phil Long, Pacific Northwest National Laboratory
Dr. Ernie Majer, Lawrence Berkeley Laboratory
Dr. Susan Hubbard, University of California - Berkeley

Princeton University, under a grant to Dr. T.C. Onstott, is serving as the lead institution for the research program, and represents the multi-disciplinary team in all issues requiring regulatory input or approval.

In addition to the list of collaborators provided above, there are other PIs in the NABIR program that are interested in obtaining samples from the South Oyster site, and additional PIs may be added to the team as research proposals to the NABIR Program are submitted and approved. The activities of all of these researchers will be coordinated by Dr. T.C. Onstott of Princeton University and Dr. Mary F. DeFlaun of Envirogen, Inc. This research is currently funded through FY 2001.

Generally, the environmental issues to be addressed in this EENF for the work proposed at South Oyster have been addressed previously in EENF's Gold-0020, Gold-0020-Modification 1, and Gold-0020-Modification 2. The proposed activities that require additional documentation include the installation of flow-cells, the extraction and re-injection of unconfined groundwater in flow-cells, the re-injection of indigenous microorganisms into the unconfined aquifer, and the injection of chemical (bromide) tracers into the same aquifer. These activities required a Research Permit from The Nature Conservancy, and a Variance to Virginia Groundwater Quality Standards from the Virginia Department of Environmental Quality (VaDEQ). These documents are included as Attachments 18 and 21 respectively, with additional explanatory text.

Work To Be Performed

The field work that is to be conducted at the South Oyster site over the course of the field research program can be grouped into five categories. Descriptions of these five categories of activities are provided below.

Category 1: Flow Cell Installations

Two flow-cell installations are currently planned for the South Oyster site over the duration of the project (Figure 2). The first will be installed in the northeastern-most corner of the field near Narrow Channel where groundwater is aerobic. The second will be in the northeastern region of South Oyster Focus Area, within 100 meters of the street that runs along the southern perimeter of the village of Oyster. Groundwater in this region is hypoxic. Flow cell installations will take place on separate occasions, each with a duration of approximately 1 to 2 weeks. The first is planned for September of 1998, and the second is projected for some time in early 1999.

The principal framework of each flow-cell is a 20 m x 30 m grid of nine injection/extraction wells arranged in a 3 well x 3 well pattern (Figure 3). These wells will be installed in the uppermost unconfined aquifer at a depth of approximately 10 m below ground surface (bgs). Downgradient from the central injection wells is an array of multi-level samplers (MLSs), as illustrated in Figure 4. Each MLS will have ten to fifteen downhole sampling ports set at even spacing between approximately 6 to 9 m bgs. Precise depth settings for the MLSs will be determined based on field data collected during the installation of the nine injection/extraction wells. Additional details on the MLS installation are provided in the description of the Category 5 activities. In addition to the injection/extraction wells and the MLSs, 4 monitoring wells will be installed within the boundaries of the flow-cells (Figure 3), and at least 4 boreholes will be installed for borehole tomography (Figure 4).

None of these installations will be any deeper than 10 m bgs. Each well-head will extend approximately 2.5 ft above ground surface and will be encased in protective, locking casing (probably PVC tubing) approximately 8 to 10 inches in diameter.

Each hole that is drilled for wells and borehole geophysics will be continuously cored. Core samples will be contained in lexan liners, from which subsamples will be selected and distributed to the various laboratories and PIs identified previously. In addition, groundwater samples will be collected periodically from the wells and the MLSs for chemical and microbial analyses, and for monitoring the groundwater quality as required by TNC and VaDEQ.

Equipment that will be required on site during installation will include one (1) roto-sonic drilling/coring rig and a support truck, a personnel truck, and 2 to 3 vehicles for participating program investigators. There will also be a small temporary "lay-down area"

of no more than 10 meters x 10 meters on the perimeter of the site for storage of drilling and sampling equipment and well construction materials during the field program.

Activities will only be conducted during daylight hours. Noise levels, while requiring hearing protection adjacent to the drilling rig, should not create any concern for the nearby residences.

Access to each flow cell will be from the Village of Oyster. The Narrow Channel Focus Area will be accessed by a path that extends through the field from the old homestead property in the center of the field just south of Oyster. This will avoid traffic across private property at the western margin of the field along Seaside Road. Access to the South Oyster Focus Area will be from the road on the south side of town.

Category 2: Excavation at the Narrow Channel Focus Area

Additional excavations along the bank of Narrow Channel Branch are currently anticipated over the course of the project. The first of these excavations was addressed in Modification 2 to EENF Gold-0020, and was conducted in August of 1998. This same excavation site may be reopened from time to time during the course of the project, depending on the research needs of the program. The purpose of these excavations is to provide a 3-dimensional exposure of the sedimentary facies that comprise the nearby flow-cells, and to provide an opportunity for detailed sampling of these facies.

The excavation site is approximately 20 meters by 15 meters, and reaches a depth of approximately 3 meters. The excavated face was tiered such that no vertical face exceeded 1.5 m in height. All slopes met or exceeded OSHA requirements of 1.5:1 (horizontal:vertical) for the soil type in this area.

Samples collected from the vertical face will include a variety of grab samples, including 70 cm long x 7.6 cm diameter cores, grab samples, and syringe samples.

Future excavations will require either one (1) excavator or backhoe, which will be delivered to the site on a flatbed truck/trailer. Support equipment at the site will include vehicles for field personnel. Proper erosion control procedures (silt fencing, hay bales, re-seeding) were employed previously at the site, and will again be implemented during future excavations.

Excavation sampling programs will last an average of 1 week. Immediately upon completion of the excavation sampling activities, the site will be backfilled, compacted, and re-seeded. Silt fencing and hay bales will remain in place for erosion control until native and seeded grasses are re-established.

Category 3: Additional Selective Sampling and Characterization

Some additional sampling and characterization may be required at the site for detailed correlation between the two flow-cell areas. This work will likely be performed in a similar manner to previous work done at the site by cone penetrometer testing (CPT), which requires a CPT truck, as well as a support truck and trailer. Additional support vehicles include two to three automobiles for participating investigators. Some limited roto-sonic drilling and coring may also be employed. In both cases, boreholes will either be backfilled or shallow monitoring wells will be installed, both in accordance with Virginia Department of Health guidelines.

One or two campaigns are anticipated over the course of the project of approximately 1 week duration; however, no additional CPT or roto-sonic field work has been specifically scheduled at this time.

Category 4: Tracer/Microbial Injections and Sampling

Three to four injection/sampling events are currently anticipated over the course of the project, the first anticipated some time before the end of 1998 at the Narrow Channel Focus Area. Equipment required on site for these activities include a diesel or gas powered generator (provided power is not made available), two pumps to simultaneously inject and extract groundwater, and two large volume (300-500 gallon) carboy tanks for water storage and injection preparation. This equipment will likely be stationed on two small flatbed trailers of 15 to 20 ft in length. During microbial and tracer injection experiments, up to 10 peristaltic pumps will be used to extract groundwater from the MLSs. Extracted volumes will be relatively small - approximately 1 liter per sampling port.

Additional support equipment will include vehicles for participating investigators.

The injection/sampling experiments will be conducted around the clock for a period of 1 to 2 weeks. Personnel will be required on site during the night, so some minimal lighting will be required (lanterns, etc.). Every effort will be made to minimize traffic, noise, and light pollution during these experiments.

Note: Due to the considerable number of samples that must be collected during these experiments (estimated 21 MLSs x 10 samples per MLS), an automated sample collection system is being considered for each flow cell. In the event the automated system is employed, the equipment will be housed in a small (est. 8 ft x 8 ft) temporary building constructed near the center of each flow cell. This building would be constructed in accordance with environmentally sensitive guidelines provided by TNC.

Category 5: Multi-level Sampler Installations

An array of approximately 21 multi-level samplers (MLS's) will be installed just downgradient of the central injection well inside each flow-cell (Figure 4). The surface expression of each MLS will be a bundle of 10 to 15, 3/8-inch diameter poly tubes with swage-lock fittings and caps on each end. Each bundle will be attached to a central, 1/2-inch diameter PVC pipe, which will all be encased inside locking protective casing (PVC), approximately 8 to 10 inches in diameter, that extends no more than 3 ft above ground surface.

Installation of the MLSs will require either a standard rotary drill rig or CPT rig, with one support truck and vehicles for participating investigators. Installation will take no more than 4 days to 1 week.

Note: The MLS installations may actually occur during Category 3 sampling and characterization activities, provided CPT technology can be utilized.

Once each flow-cell is installed, fencing will be constructed around the perimeter of each site in accordance with TNC guidelines. Informational descriptions of the research program and the site will be placed at the entrance of each flow cell for purposes of educating the local citizens and visitors on the objectives of the research program.

All site activities require laboratory space. In the past TNC has provided us the use of a house within the town of Oyster. This house provided adequate accommodations for our field laboratory, however, the future use of this house by TNC is uncertain. Therefore, it may be necessary to provide a laboratory trailer for use during field campaigns. The location of this trailer would be at the discretion of TNC.

Site Monitoring and Contingency

As stipulated by TNC's Research Permit (Attachment 18), a draft Monitoring and Contingency Plan was prepared that describes the short- and long-term monitoring protocols that will be implemented at the site. The draft Monitoring and Contingency Plan is included as Appendix A of Attachment 17, the draft Research Application submitted to TNC.

The focus of this monitoring program will be the microorganisms and tracers that are injected during the tracer injection experiments. In the event that levels of tracers or injected microorganisms exceed background at any time, VaDEQ and TNC will be contacted immediately and a contingency action will be determined at that time. IT IS IMPORTANT TO NOTE THAT NEITHER THE TRACER OR MICROORGANISMS THAT ARE TO BE INJECTED ARE LISTED CONTAMINANTS EITHER WITH VADEQ OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA).

Monitoring will continue for one year after the final injection experiment. Upon approval of TNC and VaDEQ, site closure will be conducted soon thereafter, which will include pulling and/or abandonment of all wells and restoration of the site to its condition prior to research program.

Benefits to Virginia's Eastern Shore Communities

General Benefits

In a general sense, this project will significantly enhance the understanding of the groundwater hydrogeological system that is a fundamental underpinning of the Eastern Shore ecosystem(s). The results of this multi-disciplinary research, both independently and when combined with that of others at Old Dominion University, the University of Virginia's Long-Term Ecological Research Program, and elsewhere, will form one of the most comprehensive studies of a groundwater system in a region this size anywhere.

Specific Benefits

With respect to specific contributions, TNC has expressed a particular interest in the impact of self-sustaining agricultural practices on groundwater quality and biodiversity in the region. In particular, nitrate and other chemical constituent levels in the Eastern Shore groundwater are of particular concern with respect to their potential impact on flora and fauna in low-lying areas. We believe that we can make a significant contribution to the understanding of this problem, and that the South Oyster site offers a unique opportunity to study the problem in both anoxic and aerobic environments. This is important, since models developed by the U.S. Geological Survey, and corroborated by our field work, indicate that anoxic and low DO groundwater conditions may be widely distributed at least in the southern portion of the Eastern Shore, particularly in the critical fringe areas of lowlands and wetlands that border creeks and marshes.

To begin to understand why nitrate is present in the groundwater it is necessary to understand the overall nitrogen cycle in the system. Microorganisms play a critical role in this cycle, both in anoxic and hypoxic environments. Depending on the environmental conditions (aerobic vs. hypoxic), nitrate is either produced or converted to nitrogen by microorganisms (nitrifiers and denitrifiers). Understanding the presence and interactions of the microbial community that produces these reactions is fundamental to assessing the naturally varying baseline concentrations of nitrate in the system. Comparison of data from both the aerobic and hypoxic environments will determine the limitations that exist on hypoxic nitrate reduction. Coupled with studies of how effective nitrate uptake is in plants such as warm season grasses, a more realistic picture can be developed as to the mechanisms of overall nitrate production/uptake in the groundwater.

Dr. David Balkwill of Florida State University and other program PI's will be determining the presence and relative abundance of nitrifiers and denitrifiers in both the aerobic and

hypoxic groundwater systems, and will assess the degree of nitrate production and/or reduction in these respective environments.

Plots of warm season grasses have already been planted in wide borders around the proposed flow-cell sites. These plots will not only serve as natural "blinds" for the flow-cells, but will also provide an opportunity to assess the potential for nitrate uptake by these grasses. Monitoring wells installed down-gradient from these plots will be monitored regularly for nitrate levels, as well as other chemical and microbial constituents. We will also work with the farmer, Ray Newman, to determine the spatial and temporal patterns of nitrogen data derived from the monitoring wells.

It is anticipated that nitrate transport at South Oyster should be more limited under the hypoxic conditions near the proposed site for South Oyster Focus Area flow-cell relative to the aerobic site adjacent to Narrow Channel. A determination of the effect of hypoxic groundwater on nitrate concentrations in surface water and groundwater could have tremendous implications for large scale ecosystem management in the region.

The groundwater chemistry in areas proximal to tidal marshes can be highly variable, reflecting the impacts of agriculture, marine precipitation events, and saline water encroachment. To better understand this complex "mixing" zone, water samples from monitoring wells on the perimeter of the hypoxic flow cell will be analyzed for inorganic and organic chemical constituents at regular intervals over a three year period. We also propose to collect precipitation samples for compositional analyses. This data set will yield a record of salinity fluctuations at this mixing interface, as well as the nutrients entering the marshes and creeks. Ultimately, these temporal and spatial variations can be correlated with changes in precipitation events, cultivation practices, water circulation during bacterial injections, and natural vegetation. These measurements could ultimately help define the geochemical factors that mitigate the expansion of Phragmites.

Other Initiatives

Program PI's will continue to look for opportunities where their scientific objectives can be integrated with the programmatic objectives of TNC. Dr. Mary DeFlaun of Envirogen, Inc. will continue to work with Ms. Terry Thompson, Director of Research and Education for the Virginia Coast Reserve (VCR), to identify such opportunities. Program PI's are also available for educational seminars and other community outreach programs.

Flow-cells will be constructed with sensitivity to the surrounding environment, and instructive plaques will be placed at the sites for the benefit of students, the community, and other TNC visitors.

Public Information

In cooperation with TNC information about this project has been presented to public officials and citizens in Northampton County. Specifically, the project has received the support of the Northampton County Board of Supervisors and the County Office of

Planning and Zoning, the Water Quality Consortium of Northampton County, and the Joint Industrial Development Authority of Northampton County. In addition to TNC, Mr. John Humphrey, the Director of Planning and Zoning for the County of Northampton will be informed of all activities at the site related to this project.

II. Description of Affected Environment:

The South Oyster Site is located on the Eastern Shore of Virginia, near the southern end of the Delmarva Peninsula (Figure 1). It is identified on the USGS 7.5 minute Cheriton Quadrangle just to the south of the small village of Oyster (Figure 2). The property is owned by TNC, which leases the fields to a local farmer. In order to conduct any investigative or research related work on this site, TNC requires that a Research Permit Application be submitted that describes the project in detail (Attachment 17). If the project meets all the rigorous requirements and constraints of TNC, they issue a research permit to conduct the work (Attachment 18).

The proposed field characterization initiative described herein is fully funded by the U.S. Dept. of Energy, Office of Health and Environmental Research, through Grant # DE-FG06-92ER61507. Golder Associates will subcontract all field support necessary to conduct this project (i.e., roto-sonic drilling and coring), and will supervise the field operations. Laboratory analyses and future research initiatives are funded through other individual research grants.

The first of the flow-cells is scheduled for installation in early October, 1998, and the second in early 1999. Flow-cell installations are expected to take one to two weeks. MLS installations will be scheduled for approximately 1 month following the installation of the flow-cells, and tracer injection experiments will take place in 1 to 2 months following MLS installation. Additional characterization work (i.e., CPTs) and excavations have not been scheduled at this time.

Those categorical exclusions that are applicable to the proposed field program, in accordance with Appendix B to Subpart D to 10 CFR Part 1021, are as follows:

B3 Categorical exclusions applicable to site characterization, monitoring, and general research.

B3.1 Site characterization/environmental monitoring.

B3.6 Siting/construction/operation/decommissioning of facilities for bench-scale research, conventional laboratory operations, small-scale research and development and pilot projects.

B3.8 Outdoor ecological/environmental research in a small area.

III. Potential Environmental Effects: (Attach explanation for each "yes" response, and "no" responses if additional information is available and could be significant in the decision making process).

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?

	<u>Yes/No</u>	<u>Attmnt</u>
1. Threatened/Endangered Species and/or Critical Habitats	<u> </u> <u>x</u>	<u>1,2,3</u>
2. Other Protected Species (e.g., Burros, Migratory Birds)	<u> </u> <u>x</u>	<u> </u>
3. Wetlands	<u> </u> <u>x</u>	<u> </u>
4. Archaeological/Historic Resources	<u> </u> <u>x</u>	<u>4,5</u>
5. Prime, Unique, or Important Farmland	<u>x</u> <u> </u>	<u>6</u>
6. Non-Attainment Areas	<u> </u> <u>x</u>	<u> </u>
7. Class I Air Quality Control Region	<u> </u> <u>x</u>	<u> </u>
8. Special Sources of Groundwater (e.g. Sole Source Aquifer)	<u>x</u> <u> </u>	<u>7,8,9</u>
9. Navigable Air Space	<u> </u> <u>x</u>	<u> </u>
10. Coastal Zones	<u> </u> <u>x</u>	<u>10,11</u>
11. Areas w/Special National Designation (e.g. National Forests, Parks, Trails)	<u> </u> <u>x</u>	<u> </u>
12. Floodplain	<u>x</u> <u> </u>	<u>12,13</u>

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated substances or activities?

	<u>Yes/No</u>	<u>Attmnt</u>
13. Clearing or Excavation (indicate if greater than 5 acres)	<u> </u> <u>x</u>	<u> </u>
14. Dredge or Fill (under Clean Water Act section 404; indicate if greater than 10 acres)	<u> </u> <u>x</u>	<u> </u>
15. Noise (in excess of regulations)	<u>x</u> <u> </u>	<u>14</u>
16. Asbestos Removal	<u> </u> <u>x</u>	<u> </u>
17. PCBs	<u> </u> <u>x</u>	<u> </u>
18. Import, Manufacture or Processing of Toxic Substances	<u> </u> <u>x</u>	<u> </u>
19. Chemical Storage/Use	<u> </u> <u>x</u>	<u> </u>
20. Pesticide Use	<u> </u> <u>x</u>	<u> </u>
21. Hazardous, Toxic, or Criteria Pollutant Air Emissions	<u>x</u> <u> </u>	<u>15</u>
22. Liquid Effluent	<u> </u> <u>x</u>	<u> </u>
23. Underground Injection	<u> </u> <u>x</u>	<u> </u>
24. Hazardous Waste	<u> </u> <u>x</u>	<u> </u>
25. Underground Storage Tanks	<u> </u> <u>x</u>	<u> </u>
26. Radioactive (AEA) Mixed Waste	<u> </u> <u>x</u>	<u> </u>
27. Radioactive Waste	<u> </u> <u>x</u>	<u> </u>
28. Radiation Exposures	<u> </u> <u>x</u>	<u> </u>

September 14, 1998

DOE CH NCO Reviewer: _____

Signature: _____ Date: _____

DOE Recommendation Approvals:

CH PM: _____ Signature: _____

Date: _____

CH NCO: W. S. White _____ Signature: _____

Date: _____

CH GLD: _____ Signature: _____

Date: _____

CH STS: Michael J. Flannigan _____ Signature: _____

Date: _____

CH TAS: John P. Kennedy _____ Signature: _____

Date: _____

Office Manager Subpart D CX Determination and Approval:

The preceding pages are a record of documentation required under DOE Final NEPA Regulation, and 10 CFR Part 1021.400 to establish that an action may be categorically excluded from further NEPA review. I have determined that the proposed action meets the requirements for the Categorical Exclusion referenced above. Therefore, by my signature below, I have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

(Proper Authority): _____ Signature: _____

Date: _____

cc: Appropriate Program Office NCO
TAS
Appropriate Area Office
CH NCO

Environmental Assessment
Groundwater Remediation Field Laboratory
at Dover AFB

Department of the Air Force
Armstrong Laboratory Environics Directorate

October 1995

Executive Summary

The proposed action establishes a Groundwater Remediation Field Laboratory (GRFL) at Dover Air Force Base (AFB), Delaware to demonstrate and compare in-situ detection, monitoring, and remediation technologies designed for dense non-aqueous phase liquid (DNAPL) contamination. This environmental assessment (EA) evaluates the potential impacts to the environment that may result from constructing and operating the GRFL.

DNAPL contamination poses one of the most challenging problems facing the Department of Defense (DOD) in its attempt to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). DNAPL is a term used to describe a number of materials which are relatively immiscible with, and denser than, water. As a result of these properties, they migrate downward when spilled on the ground, and can migrate below the water table. Especially once below the water table, they are difficult to locate and remove. For the Air Force, the term DNAPL is virtually synonymous with chlorinated solvents, used for years as industrial cleaners and degreasers, and responsible for the dissolved phase and DNAPL contamination at approximately one third of all Air Force contaminated sites. Currently there are no acceptable, cost effective methods for removing or treating the bulk solvent material that sinks into aquifers or is trapped within the soil interstices. These technologies must be developed to protect the public from any health risks associated with DNAPLs and the associated dissolved phase which are found in the subsurface at a large number of Air Force bases as well as hundreds of other public and private contaminated waste sites.

The Air Force, through the Armstrong Laboratory Environics Directorate (AL/EQ), Tyndall AFB, Florida, proposes to develop the GRFL as part of the joint DOD/National Environmental Technology Demonstration Program [D/NETDP] which is funded through the Congressionally-established, Tri-Service Strategic Environmental Research and Development Program (SERDP). SERDP was begun in 1990 by Sen. Sam Nunn, former Sen. Al Gore and others through Public Law 101-510 (10U.S.C.2901-2904). The purpose of the program is to "harness some of the resources of the defense establishment...to confront the massive environmental problems facing our nation and the world today," (Sam Nunn: Senate Floor Speech, June 28, 1990). It is a multi-agency program funded through DoD and designed to respond to the environmental requirements of the military and those problems that the DoD shares with Department of Energy and Environmental Protection Agency. If developed, the GRFL will become one of the D/NETDP's National Test Sites for field demonstration of innovative remediation technologies.

The GRFL differs from other technology demonstration programs in its use of a mass balance design. This design allows for a known, experimental quantity of DNAPL to be emplaced in a test cell prior to a technology demonstration. The test cells are constructed of two concentric rectangles made of steel sheet piling sections. Remedial, or monitoring/detection technologies can be demonstrated side-by-side in the same soil matrix and be evaluated for their effectiveness in removing the emplaced DNAPL.

The proposed action consists of a series of construction and operations activities. Construction involves installing tests cells and monitoring wells, temporary buildings, and fencing. Operations will consist of emplacing the DNAPL, demonstrating and evaluating innovative technologies, monitoring for DNAPL containment integrity, and properly treating and disposing of wastes.

The most common DNAPLs encountered as environmental contaminants throughout the Air Force are tetrachloroethylene (PCE), trichloroethylene (TCE) and other chlorinated compounds. The compound of most concern, due to its pervasiveness and high toxicity, is TCE. For this reason, this E.A. was prepared using TCE as the DNAPL to evaluate a worst case scenario.

The worst case scenario estimates the possible environmental impacts for activities during the test cell construction and for release of 15 liters of TCE in each of five test cells. Overall, this environmental assessment indicates that emplacement of DNAPL in the subsurface would have insignificant impacts to human health and the environment even if one wall of proposed containment were eliminated, the primary containment layer were ruptured by a catastrophic event, a proposed vapor barrier were not in place, proposed monitoring were not conducted, and proposed remediation of plume and source were not carried out as planned. The following sections provide a summary of these worst case impacts, and Chapter 4 discusses them in more detail.

Air Resources

The GRFL will not significantly impact ambient air quality (i.e., particulate or volatiles). Insignificant particulate air quality impacts could result from the movement of approximately three construction vehicles on the site for a maximum period of 6 months. This activity could result in the equivalent emission of approximately 0.142 tons of particulate matter with particle diameter less than 10 micrometers in size (PM_{10}). PM_{10} generated by the GRFL construction would increase the annual PM_{10} from Dover AFB stationary sources (11.3 tons in 1993) by less than one-tenth of 1 percent (USAF, 1994).

As part of the environmental assessment, volatilization of TCE at the surface of the GRFL was calculated after a shallow release. To make this scenario as conservative as possible we artificially assumed no vapor cover on the surface, release of TCE 1 foot below the surface, and subsequent steady diffusion of TCE to the surface. The threshold limit value published by the American Conference of Governmental Industrial Hygienists for exposure to TCE in a normal 8-hour workday and 40-hour workweek is 50 ppm. Using a box model on the surface, with a less-than-average local wind speed, yields a surface air concentration of 0.047 g/m^3 or 8.4 parts per million (ppm) per test cell. This conservative estimate is well below the 50 ppm threshold limit. Operations at the GRFL will use a polyethylene vapor cover to control vapor emissions, so design exposures will be near zero.

Water Resources

Three engineered barriers will be employed to contain the TCE, so the GRFL is not expected to impact groundwater resources outside of the test site under any proposed circumstances. The risk assessment was performed to estimate the most severe groundwater impacts that could result from a catastrophic breach in one containment system with no redundant containment and no remediation of plume or source. The assessment considers two hazards: vertical infiltration of TCE into the confining aquitard, and failure of the test cell joints with flow through the cell and horizontal propagation of a dissolved TCE plume in groundwater.

Two release scenarios were considered for analysing the risks of subsurface migration after release. In one, soil that has been carefully mixed, but not saturated with TCE is carefully placed in the soil below the water table. Under these conditions the soil holds solvent much like a sponge, so that no further migration of the liquid will occur. (See Exhibit 3-3, page 3-5).

The horizontal worst case scenario estimates the dissolved TCE concentration in the uppermost waterbearing strata one mile from the GRFL site would be no more than 0.0033mg/L. This is the of potential concentration at the nearest existing water wells, assuming catastrophic failure of two levels of containment, failure of a backup pump-and-treat system, and failure of the responsible party to excavate the source of the contamination. It also neglects the fact that the contamination would be fully captured by the St Jones river, located one half mile away. The modeled concentration is well below the MCL of 0.005mg/L for groundwater, in any event.

Similar risk analysis shows the GRFL will have no significant impacts to surface water resources. In the most extreme scenario, the peak concentration of contaminated groundwater mixing completely with the river at its lowest recorded flow rate, resulted in a peak TCE concentration of 0.001 mg/L. This is below the TCE surface water limit for Delaware, 0.016mg/L.

Surface Resources

Insignificant impacts to the many biological resources will result from the construction and operation of the GRFL. There are no Federally listed threatened or endangered plant or animal species on Dover AFB. Several species of plant or animal that are of State Special Concern exist on Dover AFB, but none are in or near the GRFL site. The proposed GRFL site is a frequently mowed field providing minimal existing wildlife habitat to be impacted by construction or operation of the GRFL.

Similarly, the Delaware State Historic Preservation Office has concluded that there are no cultural resources on the proposed GRFL site. See Appendix F for a copy of the letter of approval from the Delaware State Historic Preservation Office.

Best management practices will be followed during construction, including periodic watering of disturbed soils. No wetlands or floodplains will be affected during construction and operation associated with the proposed action.

Noise Resources

Neither the construction (normally limited to daylight hours) nor the operation of the GRFL will generate noise greater than 70 dBA (noise of a face-to-face conversation) at any sensitive receptor. Thus, noise impacts associated with the construction and the operation of the GRFL will be insignificant.

Visual Resources

The visual impacts to Dover AFB and community associated with the GRFL will be insignificant. The proposed GRFL construction and operation will be consistent with base appearance standards and the site chosen has a row of trees between the proposed GRFL and Highway 113.

Socioeconomic Resources

Money spent on construction payrolls and for purchase of construction material will generate a slight local cycle of induced commercial and industrial activity. Construction will be intermittent for approximately 6 months necessitating food and lodging for workers. The associated impacts on the hotel and restaurant industry, and the construction supply industry would be positive yet fairly minimal in extent. Similar impacts to the hotel and restaurant industries will result from the operation of the GRFL. Because of the

minimal extent of the construction and operation activities, there will be no negative impacts to the population or employment in the vicinity of Dover due to fluctuations in demand for materials or services.

Health, Safety, and Waste Management

Because the proposed GRFL design minimizes any adverse effects to the health and safety of workers on Dover AFB, the construction or operation of the proposed GRFL will have insignificant impacts to the health and safety of workers. Any wastes generated during operation of the GRFL will be disposed of in the same manner as required for all investigation derived wastes at Dover AFB.

Further, additional measures will be taken to minimize any potential impacts to the GRFL environs including developing a spill control and countermeasures plan (SCCP) to be consistent with and appended to the existing base-wide SCCP, a groundwater monitoring plan to be in place and approved by the Delaware Department of Natural Resources and Environmental Control (DNREC) prior to any proposed experiment. Similarly, the basic design of the GRFL minimizes the potential of adverse effects to human health and safety. It consists of engineered barriers, an inward hydraulic gradient between the outer and inner test cell, and monitoring wells which can be converted to capture (pump and treat) wells in the unlikely event of a release.

Construction and operation of the GRFL will fully comply with the occupational safety and health program in force at Dover AFB. OSHA compliance is assured under such a program.

II. Representative NEPA Documentation for Oak Ridge National Laboratory

Date: March 31, 1998
To: D. R. Allen, DOE-ORO
From: W. M. Belvin, DOE-ORO

Log No. B 0473
Date Received APR 07 1998
File Code 2/30.2

Subject: **Contract DE-AC05-96OR22464, National Environmental Policy Act (NEPA) Categorical Exclusion (CX) for *Small-Scale Research and Development Projects and Pilot Studies Conducted by ORNL Environmental Sciences Division (265TX)***

The DOE Oak Ridge Operations Office (ORO) proposes to conduct small-scale research and development activities that would include but not be limited to (1) outdoor ecological and other environmental research studies and (2) inventory and information collection activities, as well as small-scale pilot projects conducted to verify a concept before demonstration actions. These activities would take place inside existing laboratories in the Environmental Sciences Division at ORNL, at existing structures and facilities on the DOE Oak Ridge Reservation, and at selected geological and ecological sites.

Research and development activities would include but be not limited to (1) studying the distribution and cycling of natural chemicals and environmental contaminants in various ecosystems; (2) exploring and developing methods to expand the monitoring range for contaminants; (3) exploring the use of nonpathogenic bacteria in the removal of contaminants from various media (water, soil, waste, etc.); (4) studying the use of natural autotrophic biofilms in the removal of contaminants from soil, water, waste materials, etc.; (5) developing systems for measuring toxic metal in various media; (6) fabricating and testing components for various ecosystems and facilities; (7) studying the effects of man-made objects and contaminants on the aquatic biosphere; (8) collecting field data and conducting analyses of the factors relating plant and animal ecosystems; (9) conducting research to verify a known technology; (10) conducting cycling studies of nutrient-cycling pathways in various ecosystems; (11) conducting research that would lead to development of hardware and software; (12) studying the effects of altered atmospheric conditions on ecosystems; (13) developing new capabilities for fabricating instrumentation relevant to environmental monitoring; and (14) using theoretical and computational capabilities to model environmental problems of industrial and scientific interest.

Wastes generated during research and development activities would be appropriately characterized and disposed of at existing permitted/approved waste storage, treatment, or disposal facilities. The proposed actions would be evaluated by Pollution Prevention or other responsible personnel for action options to reduce or eliminate generation of waste materials.

Proposed actions that would take place on the ORR have been reviewed in accordance with the *Programmatic Agreement Among the Department of Energy Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation Concerning Management of Historical and Cultural Properties at the Oak Ridge Reservation* (PA) and found to be addressed in Section III.A.1 of the PA. Should the proposed ORR actions have an adverse effect on properties constructed before 1960 or properties included or eligible for inclusion in the National Register of Historic Places, DOE-ORO would consult with the State Historic Preservation Officer and initiate actions specified in procedures set forth in the Council's regulations beginning at 36 CFR 800.5(e)-800.6.

Ensure that sensitive resources are protected, existing maps and surveys/studies on threatened and/or endangered species, wetlands and floodplains, and historically sensitive areas would be used to locate these

areas. In addition, personnel responsible for identifying these resources would be consulted; if warranted, additional surveys and walkovers would be conducted to confirm or update available information.

No known extraordinary circumstances would be associated with these actions, and they would not be connected to other actions with potentially significant impacts or be related to other proposed actions with cumulatively significant impacts. These actions would meet the conditions that are integral elements of the classes of actions which may be categorically excluded from further National Environmental Policy Act (NEPA) documentation. Should a specific action not meet the conditions for CX consideration, a separate NEPA document would be prepared and submitted to DOE-ORO for review and approval.

Although these actions may fall under the category of "small-scale indoor and outdoor research, development, and pilot activities," a separate NEPA review would be performed and documented should an action or related/cumulative effect of an action have the potential to result in an unusual or significant impact to the environment.

These actions would pose no threat of significant individual or cumulative environmental effects. The described actions would not be part of an ongoing Environmental Assessment or Environmental Impact Statement. No extraordinary circumstances would be related to these actions, and the proposals would not be connected to other actions with potentially significant impacts.

B3.4 and B3.6 are the applicable CXs that covers the proposed actions in DOE NEPA Implementing Procedures, 10 CFR 1021, Subpart D, Appendix B.

The above description accurately describes the proposed actions, which reflects the requirements of the CXs cited above. Therefore, I recommend that the proposed actions be categorically excluded from further NEPA review and documentation.

W. Mark Belvin 4/3/98
W. Mark Belvin Date
DOE-ORO Program Manager

Based on my review and the recommendation of the DOE-ORO Program Manager, I have determined that the proposed actions are categorically excluded from further NEPA review and documentation.

David R. Allen 4/9/98
David R. Allen Date
DOE-ORO Office NEPA Compliance Officer

Notification:
W. M. Belvin, ER-11
J. A. Hall, 1061, MS-6429

Date: Wed, 20 May 1998 13:32:36 -0400
To: gub1
From: watsondb@ornl.gov (David Watson)
Subject: NEPA for Reactive Barriers (3757)
Cc: ea6@ornl.gov (Elizabeth A. Rasor), uvx@ornl.gov (Darlene Allred), hom

— Forwarded Message

Date: Wed, 20 May 1998 12:37:44 -0400
From: ivd@ornl.gov (Iris Darling Shelton)
Subject: NEPA for Reactive Barriers (3757)
To: watsondb@ornl.gov (Dave B. Watson)
Cc: sd2@cosmail3.ctd.ornl.gov, ivd@cosmail3.ctd.ornl.gov,
jen@cosmail3.ctd.ornl.gov, rj7@cosmail3.ctd.ornl.gov,
e4n@cosmail3.ctd.ornl.gov, dga@cosmail3.ctd.ornl.gov,
v22@cosmail3.ctd.ornl.gov, jgr@cosmail3.ctd.ornl.gov

**NEPA REVIEW REPORT
Y-12 File 3757**

Project Title: In Situ Permeable Reactive Barriers for Metals & Rad:
Sampling and Dye Tracer Study

Project Engineer/Manager: Dave Watson

Project/Charge No.: 3380-5529

Work Location: Trench area at S-3 Pond site, Oak Ridge Y-12 Plant

Brief Description: This project proposes to sample wells, monitor groundwater levels, and conduct dye tracer studies in support of the technology demonstration for In Situ Permeable Reactive Barrier project.

Comments: Use of micropurge was noted as test technizue that produces less wastewater (from Pollution Prevention).

References: DOE Document CX-GEN-004, "Categorical Exclusion for Site Characterization, Investigation, and Environmental Monitoring Activities," approved October 7, 1997.

Section III.A.1 and III.D.3 of the DOE Programmatic Agreement titled, *Programmatic Agreement Among the Department of Energy Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation Concerning Management of Historical and Cultural Properties at the Oak Ridge Reservation*, approved May 6, 1994.

In accordance with the above references the described work is approved. No further NEPA documentation is required, and Section 106 requirements of the National Historic Preservation Act have been satisfied. Please retain a copy of this report in the project files. A field review or surveillance of this action may be conducted in the future to verify that activities comply with the project description.

Questions or comments should refer to NEPA File # 3757.

I. D. Shelton, NEPA Coordinator (574-2936)
J. L. Webb, NHPA Coordinator (576-5715)
Environmental Compliance, Y-12 Plant
Lockheed Martin Energy Systems, Inc.

**CATEGORICAL EXCLUSION (CX) FOR
SITE CHARACTERIZATION, INVESTIGATION, AND
ENVIRONMENTAL MONITORING ACTIVITIES
CX-GEN-004**

The DOE Oak Ridge Operations Office (ORO) proposes to conduct site characterization and monitoring, air and stack effluent monitoring, plant and animal sampling, surface water sampling, and actions that would include but not be limited to geological, geophysical, geochemical, engineering surveys, and mapping. Also, the proposed actions would be used to assess the soil and subsurface conditions in proposed construction projects, monitor and characterize groundwater flow, obtain data on aquifers, assess active and inactive waste management areas, and assess subsurface contaminated facilities that are potential sources of release to the environment.

The proposed actions would take place at DOE-owned facilities on the DOE Oak Ridge Reservation (ORR) at Oak Ridge, Tennessee; the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio; the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; the Weldon Spring Remedial Action Project near Weldon Spring, Missouri; and the Thomas Jefferson National Accelerator Facility at Newport News, Virginia. In addition, these actions might take place at other DOE-ORO-operated facilities (e.g., Formerly Utilized Site Remedial Action Program sites) and ancillary areas associated with these sites, programs, and projects.

As required by agreements among DOE, the Environmental Protection Agency, and the affected states, a variety of characterization actions would be performed to determine the presence or nature and extent of environmental contamination at the referenced locations. Characterization under these agreements would be done in accordance with applicable regulatory drivers, such as the Resource Conservation Recovery Act (RCRA), the Atomic Energy Act, and/or state laws. These laws require monitoring and investigation of all environmental media that might have been affected by waste that was either treated, stored, or disposed of at the sites.

A variety of investigation/characterization actions would be performed to obtain geological, geophysical, and geochemical data and to determine the presence or nature and extent of environmental contamination. Actions would include collection and analysis of samples and interpretation of the data. Samples would be analyzed for site-specific parameters including (but not limited to) pH, conductivity, dissolved oxygen, metals, mercury, lead, volatile organics, semivolatile organics, polychlorinated biphenyls, asbestos, uranium, and various other radiological analyses of concern. Specific actions might include (but would not be limited to) the following:

1. Drilling of boreholes to obtain subsurface core samples. Core materials might be characterized in the field, archived for later analysis, or sampled for contamination.
2. Collection and analysis of surface soil samples.
3. Installation and development of long-term or short-term groundwater monitoring wells. Groundwater wells and temporary piezometers would be installed to monitor and characterize groundwater flow. Well installation would include soil and bedrock coring and sampling, well drilling, construction, and development of groundwater investigation and monitoring of wells (including vadose zone wells and installation). Construction and development would include (1) emplacement of well casings, screens, and annular seals and (2) construction of the concrete pad of the well, protective posts, and access road, if needed. Groundwater monitoring wells would be constructed in accordance with RCRA-quality requirements and would include seals to prevent

**CATEGORICAL EXCLUSION (CX) FOR
SITE CHARACTERIZATION, INVESTIGATION, AND
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CX-GEN-004**

infiltration of surface water and mixing of groundwater. Temporary piezometers (simple well screens without filter packs and seals) could be used for some characterization. Piezometers would be used only in shallow formations where mixing of groundwater due to penetration of the borehole would be of no concern. Wells and piezometers would be periodically purged and sampled for groundwater contamination. Aquifer testing would be conducted at some wells.

4. Well plugging and abandonment (including inspection and sampling of wells to verify location, method of construction, and current conditions) and purging water, as required. Well plugging and abandonment would take place using a variety of methods such as casing removal, overdrilling, grout filling, etc. Minor excavation around wellheads might be required prior to commencement of plugging and abandonment actions.
5. Well plugging and abandonment that would include (1) decommissioning groundwater investigation or monitoring wells that have been damaged or destroyed or (2) wells that are a hindrance to construction activities or environmental restoration projects.
6. Installation of water-level monitoring equipment at wells and surface water stations. The latter might require construction of flumes/gaging stations within stream channels.
7. Surface and groundwater sampling and analysis. Some surface water sampling sites would require installation of temporary, removable devices for measurement of surface water flow rates. Actions would include dye tracer studies.
8. Aquifer testing that would include slug, hydraulic packer, and pump testing to characterize hydraulic properties of aquifers. This would include installation of water-level recording devices into characterization, monitoring, and/or piezometric wells to determine vertical and horizontal groundwater flow directions.
9. Installation/relocation of Surface Water Hydrological Information Support Systems houses to surface water monitoring locations.
10. Geophysical exploration including electromagnetic profiling, seismic reflection/refraction, wireline geophysics, and ground penetrating radar.
11. Installation of shallow (< 1-foot-deep) soil gas monitors or insertion of soil gas withdrawal tubes.
12. Installation of rain gauges, evaporative pans, anemometers, or other meteorological monitoring equipment.
13. Construction and use of air monitoring stations to determine ambient air quality or potential air quality impacts during assessment actions.
14. Routine decontamination of equipment.

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15. Sampling of solid waste streams including soil cuttings, personal protective equipment, and process equipment and process waste streams.
16. Sampling of nonendangered plant and animal species.
17. Sampling of stack effluent emissions.
18. Establishment of staging areas for purposes of conducting characterization work. Staging areas would be used for material and equipment laydown and as temporary satellite accumulation areas for wastes (in drums, tanks, or other containers) generated by characterization actions (e.g., drill cuttings and decontamination wastes). Staging areas would be operated and maintained in compliance with site waste management procedures for the duration of their operation and during setup of decontamination trailers/change houses. Staging areas would be established in previously disturbed areas (or in areas that would require minimal grading) and would be covered with gravel or gravel and geotextile material. Temporary access roadways (or temporary extensions of existing roadways) might also be constructed, as necessary. Clearing of low brush or removal of trees and shrubs with the goal of minimization of clearing might also occur.
19. Installation and operation of field instruments, such as flow-measuring devices.
20. Maintenance and modification of existing wells and structures (i.e., painting, minor surface grading/sloping, cleaning, tagging, etc.).

The proposed action would be evaluated by Pollution Prevention personnel for action options to reduce or eliminate generation of waste materials. Environmental samples would be analyzed in on-site or off-site laboratories. The analysis procedures often consume the sample. Should the sample not be consumed, the remaining sample would be acceptable for disposal in existing permitted/approved facilities in accordance with laboratory operating procedures. Any wastes generated would be acceptable for disposal in existing permitted/approved or exempt facilities.

The proposed actions that would take place on the ORR have been reviewed in accordance with the *Programmatic Agreement Among the Department of Energy Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation Concerning Management of Historical and Cultural Properties at the Oak Ridge Reservation (PA)* and found to be addressed in the PA under Section IV, Item R, Environmental Monitoring. If the proposed ORR actions would have an adverse effect on properties constructed before 1960 or properties included or eligible for inclusion in the National Register of Historic Places, DOE-ORO would consult with the State Historic Preservation Officer (SHPO) and initiate actions specified in procedures set forth in the Council's regulations beginning at 36 CFR Part 800.5(e)-800.6.

For sites other than the ORR, DOE-ORO would complete Section 106 reviews consistent with the ORR PA, as discussed above, until PAs are ratified for the respective sites. At such time, the sites would conduct Section 106 reviews under provisions of the site-specific PA.

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Should the proposed site characterization, investigation, and environmental monitoring actions involve ground disturbances at locations where an archeological survey had not been conducted or take place at previously disturbed locations where the potential exists to exceed the depth of previous ground disturbances, DOE-ORO would consult with the SHPO to determine whether an archeological survey would be warranted prior to initiating the proposed actions.

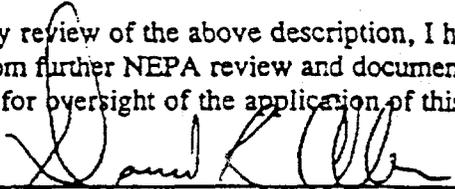
To ensure that sensitive resources are protected, existing maps, surveys and studies on threatened and/or endangered (T/E) species, wetlands and floodplains, and historically sensitive areas would be used to locate these areas. In addition, personnel responsible for identifying these resources would be consulted and, if warranted, additional surveys and walkovers would be conducted to confirm or update available information.

No known extraordinary circumstances would be associated with these actions that might affect the significance of the environmental effects of the proposed action based on past similar actions. These actions would not be connected to other actions with potentially significant impacts or related to other proposed actions with cumulatively significant impacts; they would meet the conditions that are integral elements of the classes of actions which may be categorically excluded from further National Environmental Policy Act (NEPA) documentation. Should the action not meet the conditions for CX consideration, a separate NEPA document would be prepared and submitted to DOE-ORO for review and approval.

Although an action might fall under the category of "site characterization, investigation, and environmental monitoring," a separate NEPA review would be performed and documented should the action or relocation/cumulative effect of the action have the potential to result in an unusual or significant impact to the environment.

B3.1 is the applicable CX that covers the proposed action in DOE NEPA Implementing Procedures, 10 CFR 1021, Subpart D, Appendix B.

Based on my review of the above description, I have determined that the above actions are categorically excluded from further NEPA review and documentation. The DOE Contracting Officer Representative is responsible for oversight of the application of this determination.



David R. Allen
Oak Ridge Operations Office (ORO) Acting NEPA Compliance Officer

10-2-97

Date

Tracer Test Workplan - Pathway 2 S-3 Ponds, Permeable Reactive Barrier Trench Project

1.0 Introduction

The purpose of this workplan is to describe the objectives and procedures for conducting a tracer injection test at the S-3 Ponds, pathway 2, permeable reactive barriers trench site located at the Y-12 Plant. A 225 foot long trench has been excavated at pathway 2 and backfilled with gravel and iron filings. The zero valent iron was installed in a 26 foot long section in the middle of the trench (Figure 1). The trench was constructed to demonstrate the hydraulic capture and treatment of uranium, nitrate, and technetium in a permeable reactive trench configuration. The trench was designed so that contaminated groundwater is collected on the upgradient end of the trench, treated as it passes through the iron filings, and discharges on the downgradient end of the trench. Under certain hydraulic conditions contaminated groundwater may migrate across the trench instead of down the trench. A bromide tracer will be injected in TMW-11 and rhodamine WT dye tracer will be injected in DP-13 to assess flow paths and transport rates through the iron.

2.0 Objectives

The primary objectives of the tracer testing include the following:

- 1) Determine the groundwater velocity, treatment volume, and groundwater residence time in the iron.
- 2) Determine the predominant flow paths through the iron. Tracers will be injected in 2 locations to determine if the predominant groundwater flow direction through the iron is parallel to the trench or across the trench.

3.0 Scope

Bromide and a fluorescent dye tracer will be injected simultaneously in wells TMW-11 and DP-13, respectively. TMW-11 is located in the gravel portion of the trench just upgradient and east of the iron. DP-13 is located upgradient but north of the iron and out of the trench. Sixteen piezometers and 4 seeps (seeps 1, 2, 3, and 4) suspected to be in the flow path of the iron will be monitored approximately 12 times over a 1 to 2 week period for break through of the tracers. Samples will be collected at a frequency of approximately 2 times a day for the first 2 days to determine the approximate rate of tracer movement. The subsequent monitoring schedule will be adjusted if the tracer is migrating faster or slower than anticipated. Up to 42 piezometers and 4 seeps will be monitored twice during the tracer test to obtain a snap shot of tracer distribution. One snap shot will be conducted after initial breakthrough has occurred at the seeps and a second snap shot sampling round will be conducted several days later. The target date for injection is the week of May 18th. If possible one of the snap shot sampling

rounds will take place at the same time as the analytical sampling round planned for the first week of June.

The 16 piezometers that will be monitored on a more frequent basis include:

Routine Sampling Locations - TMW-06, TMW-07, TMW-09, TMW-11, DP-07, DP-08, DP-09, DP-10, DP-11, DP-13, DP-14D, DP-15D, DP-16D, DP-17D, DP-22D, and DP-23D

Additional piezometers besides the ones listed above that will be sampled as part of the 2 snap shot sampling rounds include the following piezometers:

Snap Shot Sampling Locations - DP-14S, DP-15S, DP-16S, DP-17S, DP-18S, I and D, DP-19S, I and D, DP-20S, I and D, DP-21S, I and D, DP-22S and I, DP-23S and I, EW-01, GW-836, TMW-07, TMW-12, TMW-13, TMW-14, TPB-07, and TPB-08

Tasks that will be completed as part of the tracer testing include the following.

Task 1: *Workplan Preparation* - The workplan, NEPA documentation, voluntary TDEC Dye Trace Registration form will be completed prior to tracer injection.

Task 2: *Conduct Background Screen* - At least 1 set of background samples will be collected from the 16 piezometers and 4 seeps listed above. This information will be used to determine background concentrations of bromide and potential dye tracers and finalize the tracer selection and injection concentration. The background samples will be collected during the May 11th analytical sampling round.

Task 3: *Finalize Tracer Selection and Equipment Preparation* - Based on the results of task 2 the selection of tracers will be finalized and any equipment modifications made.

Task 4: *Conduct Tracer Test* - The tracers will be injected the week of May 18th.

Task 5: *Sampling and Analysis* - Sampling and analytical methods that will be used to analyze for individual tracers are discussed in greater detail below. At least 1 in 15 of all samples will have duplicate analyses performed to ensure repeatability. A blank sample will be included in each sampling round.

Task 6: *Data Management* - Analytical results and field notes will be recorded in project logbooks and digital data will be kept on diskettes. Information described in the field notebooks will include project name, date and time, weather conditions, sample location, sample identification number, sample type, if a duplicate or blank sample was collected, and special conditions or changes in procedures.

4.0 Injection Setup and Tracer Concentrations

Carboys containing the concentrated tracers mixed with distilled water will be used as the reservoir for the injection of the tracers. A peristaltic pump will be used to inject the slug of tracer into the well. A plunger will be used to mix the tracer in the piezometer during injection. Approximately, 10 gallons (37 liters) of bromide tracer will be created by the addition of 135.2 g $MgBr_2 \cdot 6H_2O$ to bring the bromide concentration to 2,000 ppm. Ten gallons is approximately equal to one saturated pore volume in the bromide injection well TMW-11. Approximately, 200 g of a fluorescent dye will be added to 5 gallons (20 liters) of water to produce a concentration of 10,000 ppm dye tracer. Five gallons is equal to approximately 2 pore volumes of the saturated water column in the dye injection piezometer DP-13.

5.0 Field and Analytical Methods

5.1 Bromide Analysis

Bromide is a nonreactive, anionic tracer that is present in natural groundwater at low to undetectable concentrations. It is available as a monovalent or divalent simple salt, and is a commonly used groundwater tracer because of its nonhazardous characteristics and the ease of analysis. Two analytical methods are available for this project: ion-specific probe, and ion chromatography (IC). The ion-specific probe measures a concentration based on electrical conductivity of the solution relative to a reference electrode. The advantages of the probe method are that analytical setup is compact and can be taken to the field for instantaneous measurement, it requires only 5 ml of sample, and the sample is not consumed by the analysis and is, therefore, available for other analyses. The disadvantages are that the detection limit is higher (\sim 3-5 ppm) and the accuracy of the measurements is lower than IC.

The second method, ion chromatography (IC), uses chromatographic separation and conductivity to measure concentration compared to a standardized curve. The instrument is highly sensitive, particularly when anion auto-suppression is added, allowing detection at ppb levels. Approximately 20 ml of filtered sample is required and is consumed in the analysis, so that replicate analysis of the same aliquot is not possible. The analyses must be performed in the laboratory and takes somewhat longer than the probe analysis, but numerous samples can be analyzed automatically using an autosampler, thus minimizing technician time. Because we are interested in capturing the earliest possible arrival, the IC analytical method will be used. If conditions warrant, however, IC measurements may be augmented with probe measurements conducted in the field. Analyses will be conducted in ESD laboratories using a Dionex DX-120 ion chromatograph equipped with a conductivity detector and auto-suppression. The system is computerized for automatic data analysis and digital data recording.

5.5 Fluorescent Dye (rhodamine WT, fluorescein, or acid red #92) Analysis

The dyes under consideration for injection at the S-3 Ponds trench site are commonly used as groundwater tracers and give no indication of significant toxicity in the concentrations used

during tracer studies. The final selection criteria for which dye to use will depend on background levels detected in the pre-test screening. The fluorescent dyes can be detected using a spectrofluorophotometer with synchronous scanning. A good description of dye tracing procedures is provided in the Workplan for the K-25 site groundwater tracer test at the K-1070-A Burial Ground for the K-901 Operable Unit.

Dye concentration can be assessed through grab sample analysis or recovered on activated coconut charcoal and unbleached cotton dye receptors commonly referred to as "bugs". Only grab samples will be collected for this project. Approximately 200 g of dye will be used in the the tracer test.

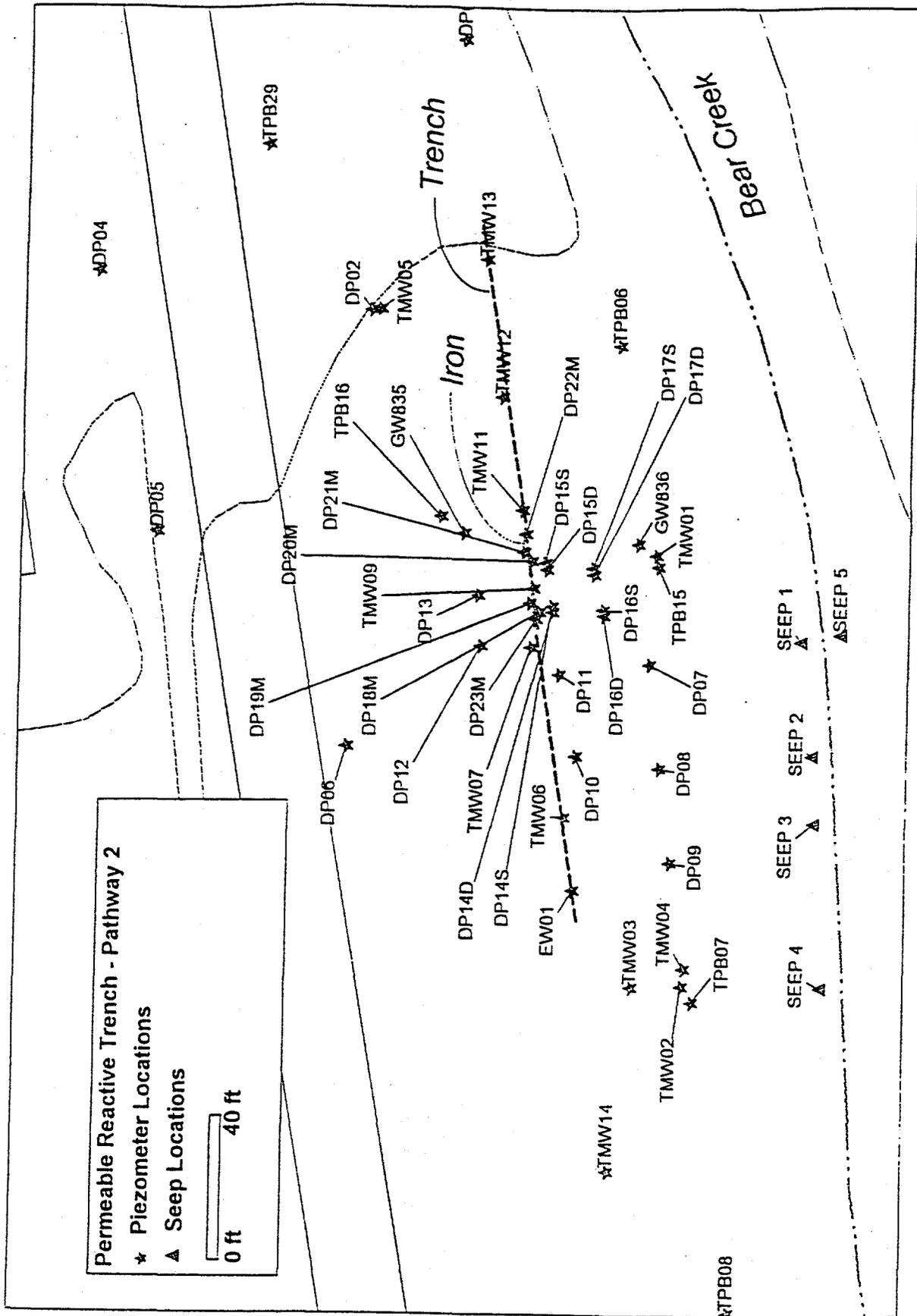
5.3 Sampling Methods

Background samples will be collected and analyzed for bromide and dye tracers prior to the start of the injections. Initially, sampling will be conducted twice a day, however, sampling frequency will be adjusted throughout the tests, depending on analytical results. Once breakthrough has occurred, the sampling frequency can be reduced to capture the main characteristics of the breakthrough curves. Samples can be prepared and stored in a refrigerator until several sampling rounds have been accumulated in order to minimize analytical time. Samples from the piezometers will be collected by pumping with a peristaltic pump. Samples will be filtered with an in-line 40 micron filter prior to collection in 80 ml glass containers. Seep samples will be collected by dipping a glass or stainless steel dipper into the seep, filtering a portion of the sample and collecting the filtered sample in the 80 ml glass containers.

5.4 Quality Control

At least 1 in 15 of all samples will have duplicate analyses performed to ensure repeatability. A blank sample will be included in each sample shipment. In addition, calibration curves will be constructed for each tracer and sample standards will be analyzed periodically during each set of analyses. Sampling teams will protect against the generation of contaminated samples by:

- donning new latex gloves before the start of sample collection at each site;
- working downstream of surface water sample collection points;
- collecting seep samples in order from downstream to upstream;
- refrigerating samples at a temperature of 4 degrees C if stored prior to analysis in the laboratory.



S-3 Ponds

Pathway 2

NITRATE	29 mg/L
URANIUM	1.7 mg/L
GROSS ALPHA	370 pCi/L
GROSS BETA	280 pCi/L
TECHNETIUM	150 pCi/L

Pathway 1

NITRATE	1400 mg/L
URANIUM	2.6 mg/L
GROSS ALPHA	790 pCi/L
GROSS BETA	4300 pCi/L
TECHNETIUM	10,000 pCi/L

Pathway 3a

NITRATE	2300 mg/L
URANIUM	0.0037 mg/L
GROSS ALPHA	210 pCi/L
GROSS BETA	9000 pCi/L
TECHNETIUM	22,000 pCi/L

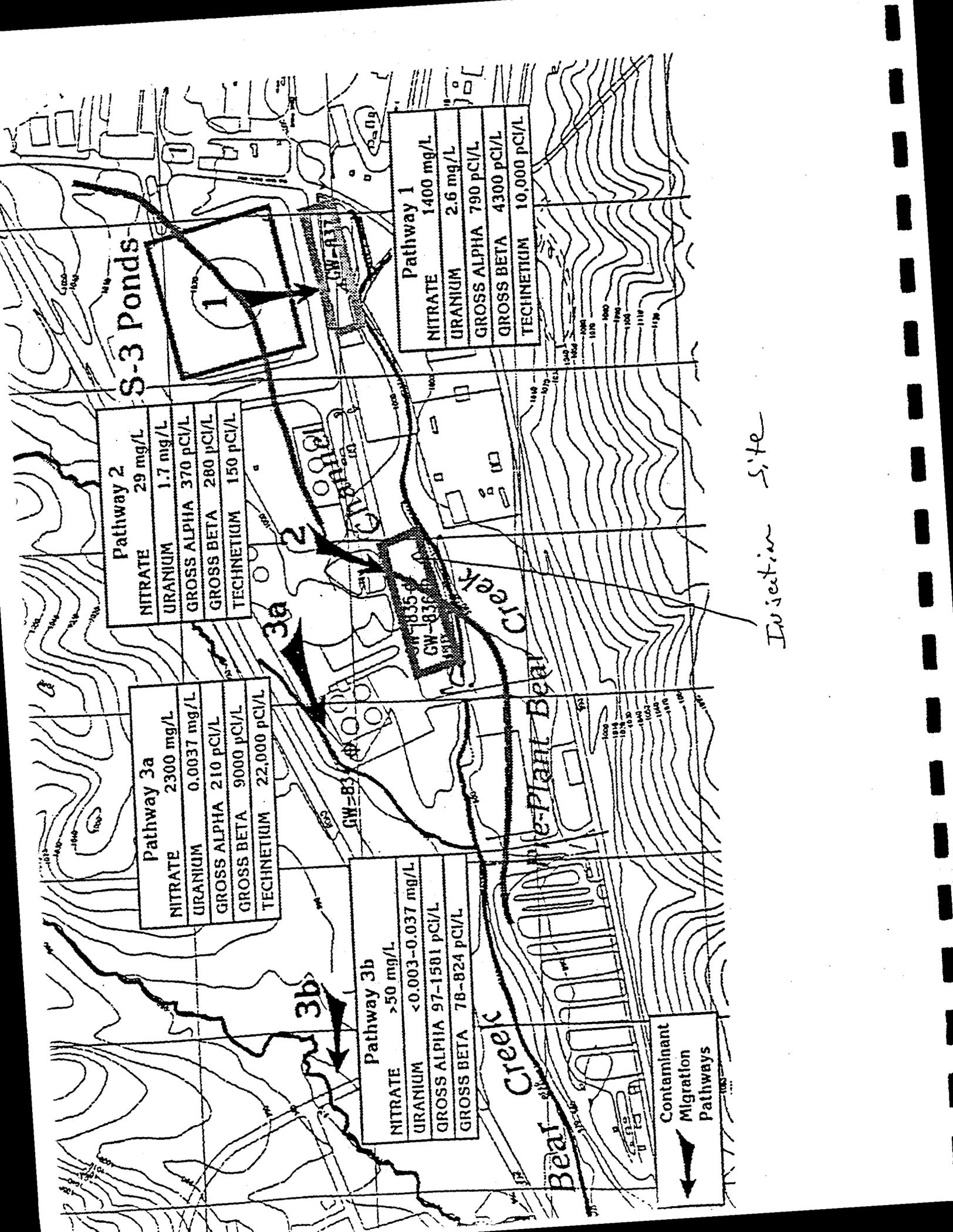
Pathway 3b

NITRATE	>50 mg/L
URANIUM	<0.003-0.037 mg/L
GROSS ALPHA	97-1501 pCi/L
GROSS BETA	78-824 pCi/L

Contaminant Migration Pathways



Insecticide site



Date: Thu, 18 Sep 1997 16:47:15 -0500
 From: ivd@ornl.gov (Iris Darling Shelton)
 Subject: NEPA for Tracer Tests (3705)
 To: watsondb@ornl.gov (Dave B. Watson)
 Cc: sd2@cosmail3.ctd.ornl.gov, ivd@cosmail3.ctd.ornl.gov,
 jen@cosmail3.ctd.ornl.gov, rj7@cosmail3.ctd.ornl.gov,
 e4n@cosmail3.ctd.ornl.gov, dga@cosmail3.ctd.ornl.gov,
 v22@cosmail3.ctd.ornl.gov, jgr@cosmail3.ctd.ornl.gov

Y-12 Plant: Multiple Tracer Injection Test (3705)

The project to inject tracer materials into two wells in Bear Creek Valley has been reviewed in accordance with the National Environmental Policy Act (NEPA) and will require no further NEPA review or documentation, provided that the project scope remains as outlined on the Environmental Checklist. The project is preliminary to a CERCLA action and has been covered by an existing, approved general Categorical Exclusion (CX) for RI/FS/FI Activities, which has received a determination by the Manager of the DOE Oak Ridge Operations Office. Verification of NEPA approval is on file in the NEPA Program Office, Building 9115.

This activity has also been reviewed in accordance with Section 106 of the National Historic Preservation Act (NHPA) and is covered by a Programmatic Exclusion (PX) under Section III.A.1 of the Programmatic Agreement between the DOE-ORO office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation concerning management of historical and cultural properties at the Oak Ridge Reservation. As such, the project may proceed without additional Section 106 documentation. Verification of NHPA approval is also on file in the NEPA Program Office, Building 9115.

Comments from ECO: Project personnel should take precautions not to spill the chemicals on the ground where it might migrate to surfact flow channels.

NOTE: Place a copy of this message in your project files along with a copy of the Environmental Checklist submitted for this action. This serves as verification that the activity, as documented on the Environmental Checklist, has received a NEPA and NHPA review.

The Y-12 NEPA Approval ID number should be used on the ESO as further indication of the NEPA/NHPA review and approval.

Project ID	Contact	Activity Title	NEPA #
PK287U01	D B Watson	Y-12 Plant Multiple Tracer Injection Test	3705

Iris D. Shelton
 LMES NEPA Coordinator
 574-2936

Jennifer L. Webb
 LMES NHPA Coordinator
 576-5715

Appendix F

Y-12 Plant Multiple Tracer Injection Test Work Plan Oak Ridge Y-12 Plant, Oak Ridge, Tennessee

1. Introduction

The purpose of this workplan is to describe the objectives and procedures for conducting multiple tracer injection tests at two locations at the Y-12 Plant. The first tracer injection site (Fig. 1) is located in the Bear Creek Valley (BCV) Watershed picket B exit pathway wells located upgradient of spring SS-4. Wells in picket B (e.g., GW-694 and GW-706) provide monitoring of nitrate, uranium, and other contaminants migrating to the west in the Maynardville Limestone at depths of ~200 ft. The concentration of contaminants detected in the picket B wells and spring SS-4 are similar, suggesting a hydraulic connection. Sources of these contaminants include the S-3 ponds and the Bone Yard/Burn Yard (BY/BY).

The second tracer injection site (Fig. 2) is located near the Y-12 Plant eastern property boundary in the Upper East Fork Poplar Creek (UEFPC) Watershed picket J exit pathway well GW-722 (port 20). GW-722 is a multiport Westbay well that monitors the carbon tetrachloride (CT) plume that has migrated off site to the east of Y-12. The highest concentration of CT is detected in monitoring ports located between the depths of 300 and 500 ft. This is probably the interval that the CT is migrating off site in the Maynardville Limestone. The source of the CT contamination is probably DNAPL that has migrated to depth in the Maynardville Limestone upgradient of the former New Hope Pond (NHP). The installation of an underdrain beneath the UEFPC concrete-lined channel east of NHP has impacted the transport of CT by lowering groundwater levels in the shallow interval and drawing CT contamination into the underdrain. Concentrations of CT in shallow wells adjacent to the underdrain have risen from nondetected prior to its installation in 1987 to a detection of ~600 to 700 ppb during more recent sampling events. However, the degree to which the underdrain has impacted the deep off-site transport pathway is not known.

The rate of migration and impact of matrix diffusion and sorption on the fate and transport of contaminants is not well understood at either site. Therefore, when remedial actions are taken it is not known how fast the aquifer will remediate, and the frequency of monitoring needed to evaluate aquifer restoration is difficult to estimate.

2. Objectives

Primary objectives and benefits of the tracer testing include the following:

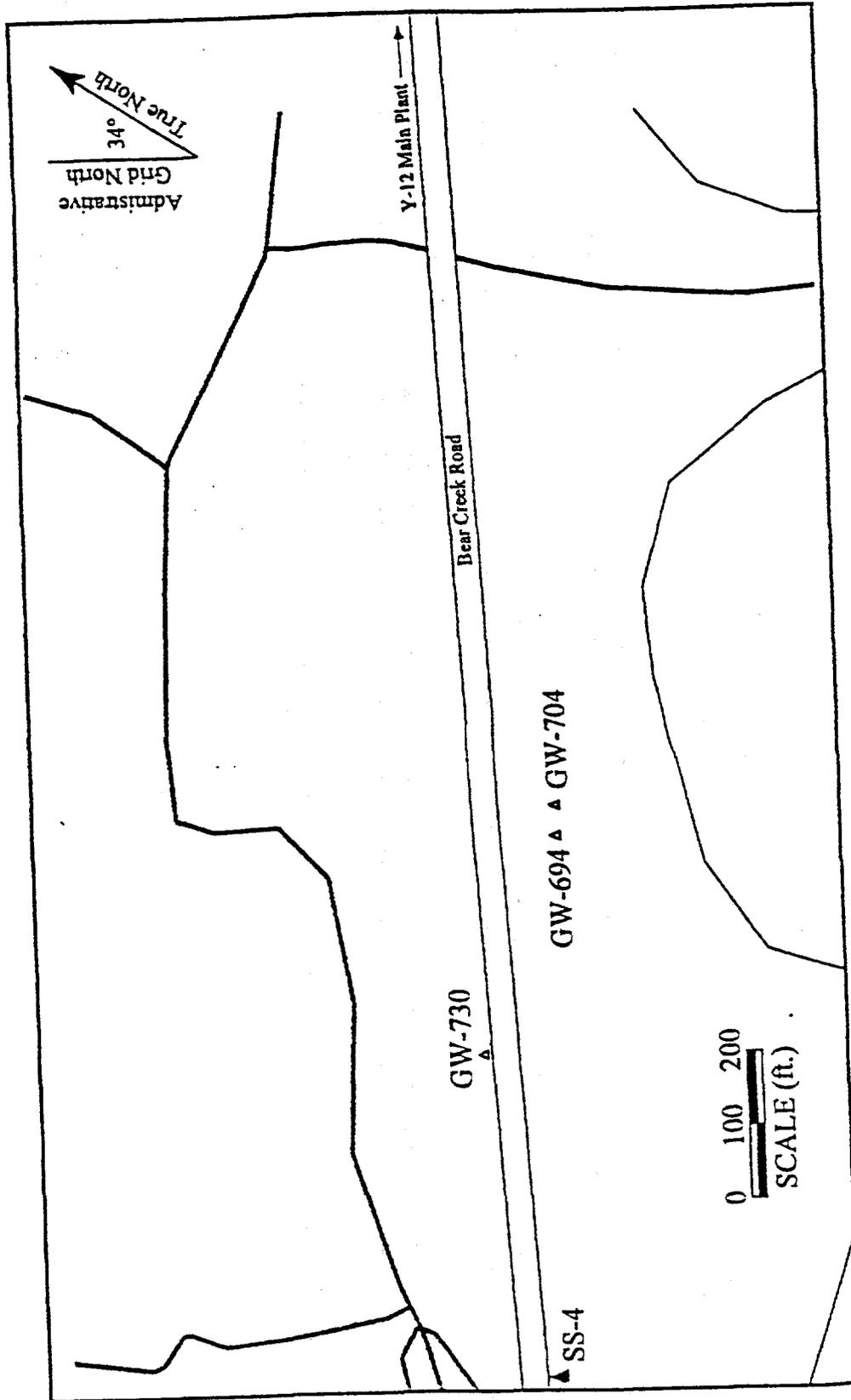


Figure 1. BCV test location map. GW-704 is the source well. GW-694 and spring SS-4 are observation sites.

III. Representative NEPA Documentation for the Hanford Site, Richland, Washington

CATEGORICAL EXCLUSION FOR
SITE CHARACTERIZATION AND ENVIRONMENTAL MONITORING,
HANFORD SITE, RICHLAND, WASHINGTON

Proposed Action: The U.S. Department of Energy (DOE), Richland Operations Office (RL) proposes to perform site characterization and environmental monitoring activities.

Location of Action: On and off the Hanford Site, Richland, Washington

Description of Proposed Action: The proposed action consists of both intrusive and non-intrusive site characterization and environmental monitoring activities on and off the Hanford Site. Intrusive activities include the installation and monitoring of groundwater and vadose zone wells, groundwater tracer tests, and the excavation and sampling of test pits on the Hanford Site. Non-intrusive activities consist primarily of site surveying techniques and collection of environmental media.

Groundwater and vadose zone wells and test pits would be installed as needed, in and near Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) facilities, operable units, and waste management facilities, in compliance with DOE Order 5480.4, Federal Regulations (e.g., Title 40 Code of Federal Regulations [CFR] 264 and 265, Subpart F) and Washington Administrative Code (WAC) 173-160. The monitoring wells and test pits would detect contaminant releases to the groundwater and vadose zone, facilitate the remediation and closure phases of each site, and ensure that remediation is effective.

The proposed activities include well drilling, test pit excavation, construction, development, subsequent sampling and analysis, and final closure. Drilling, constructing, and monitoring would be performed in accordance with approved and appropriate procedures. Drilling methods would primarily be standard cable tool, auger, cone penetrometer, sonic drilling, or rotary drilling technologies. When the wells are determined to be no longer necessary, wells would be abandoned in accordance with WAC 173-160.

Wells and test pits would not be sited on environmentally sensitive areas, such as: 100-year floodplains, jurisdictional wetlands (based in part on the National Wetlands Inventory compiled by the U.S. Department of the Interior), special sources of water, archaeological sites, critical habitats, property listed or eligible for listing on the National Register of Historic Places, or areas having a special environmental designation such as wild and scenic rivers, wildlife refuges, or national natural landmarks without additional National Environmental Policy Act (NEPA) documentation.

Site characterization and environmental monitoring activities that are either non-intrusive or would involve minimal small-scale intrusion would also be included in this action. These activities would include general geophysical, radiological and chemical, meteorological, cultural and biological surveys, sampling, transport of samples, and analytical techniques, including the following:

- Geophysical techniques would include, but not be limited to, methods such as electro-magnetic surveys, site surveying and mapping, soil sampling,

ground penetrating radar surveys, seismic monitoring, telemetry, and borehole spectral gamma logging techniques.

- Radiological and chemical techniques would include, but not be limited to, methods such as gamma scintillation, thermo-luminescent dosimetry, groundwater tracer studies, soil gas surveys, x-ray fluorescence, radiological surveys, and sampling, transport, and laboratory analysis of environmental samples from existing well and borehole networks.
- Meteorological data gathering techniques would include, but not be limited to, air emissions monitoring, installation of weather stations, and other climatological monitoring.
- Site characterization for archaeological and historical resources would be in compliance with 36 CFR part 800, Protection of Historic and Cultural Properties and 43 CFR part 7, Protection of Archaeological Resources or any programmatic agreement. This would include activities such as facility inspections, ground surveys, inventory of archaeological resources, exploratory test pits and trenches, core and auger tests.
- Biological characterization and environmental monitoring would include, but not be limited to, activities such as field surveys and biotic sampling (agricultural products, flora, and fauna). Wildlife and other biotic sampling would be conducted under applicable state and federal permits. Environmental monitoring would include river stage monitoring, transects, flow measurements, surface water and sediment sampling.

All contaminated materials (e.g., drill rig, equipment and tools, drill cuttings, personal protective equipment, decontamination fluids) would be dispositioned in a manner consistent with applicable regulations. Contaminated materials from well drilling activity either would be stored within a designated onsite storage area until cleanup of the operable unit, or removed from the well site and disposed or decontaminated in accordance with regulatory requirements. Final disposal of waste would likely be in the Hanford Site Central Waste Complex or other appropriate disposal unit. The activities addressed in this CX would not occur on other DOE Complex sites without obtaining appropriate NEPA documentation from the applicable DOE Field Office.

Categorical Exclusion to be Applied:

The following Categorical Exclusion (CX) is listed in 10 CFR 1021, "National Environmental Policy Act Implementing Procedures," Subpart D, Appendix B, published in the Tuesday, July 9, 1996, 61 *Federal Register* 36222:

- B3.1 "Onsite and offsite site characterization and environmental monitoring, including siting, construction (or modification), operation, and dismantlement or closing (abandonment) of characterization and monitoring devices and siting, construction, and associated operation of a small-scale laboratory building or renovation of a room in an existing building for sample analysis. Activities covered include, but are not limited to, site characterization and environmental monitoring under CERCLA and RCRA. Specific activities include, but are not limited to:

- (a) Geological, geophysical (such as gravity, magnetic, electrical, seismic, and radar), geochemical, and engineering surveys and mapping, including the establishment of survey marks;
- (b) Installation and operation of field instruments, such as stream-gauging stations or flow-measuring devices, telemetry systems, geochemical monitoring tools, and geophysical exploration tools;
- (c) Drilling of wells for sampling or monitoring of groundwater or the vadose (unsaturated) zone, well logging, and installation of water-level recording devices in wells;
- (d) Aquifer response testing;
- (e) Installation and operation of ambient air monitoring equipment;
- (f) Sampling and characterization of water, soil, rock, or contaminants;
- (g) Sampling and characterization of water effluents, air emissions, or solid waste streams;
- (h) Installation and operation of meteorological towers and associated activities, including assessment of potential wind energy resources;
- (i) Sampling of flora or fauna; and
- (j) Archeological, historic, and cultural resource identification in compliance with 36 CFR part 800 and 43 CFR part 7."

ELIGIBILITY CRITERIA

Since there are no extraordinary circumstances that may affect the significance of the environmental effects of the proposal, the proposed activity meets the eligibility criteria of 10 CFR 1021.410(b), as shown in the following table. The proposed activity is not "connected" to other actions with potentially significant impacts (40 CFR 1508.25[a][1]), or with cumulatively significant impacts (40 CFR 1508.25[a][2]), and is not precluded by 10 CFR 1021.211.

The "Integral Elements" of 10 CFR 1021 are satisfied as discussed below:

INTEGRAL ELEMENTS 10 CFR 1021, SUBPART D, APPENDIX B	
Would the Proposed Action:	Comment or explanation:
Threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including requirements of DOE and/or Executive Orders?	No applicable laws, regulations, or orders would be violated by the proposed actions.
Require siting and construction or major expansion of waste storage, disposal, recovery or treatment facilities (including incinerators)? The proposal may include categorically excluded waste storage, disposal, recovery or treatment actions.	No, the proposed action would not require the siting construction or major expansion of waste storage, disposal, recovery or treatment facilities.
Disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that preexist in the environment such that there would be uncontrolled or unpermitted releases?	No preexisting hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products would be disturbed in a manner that would result in an uncontrolled or unpermitted release.
<p>Adversely affect environmentally sensitive resources including but not limited to:</p> <p>(i) Property (e.g., sites, buildings, structures, objects) of historic, archeological, or architectural significance designated by Federal, state, or local governments or property eligible for listing on the National Register of Historic Places</p> <p>(ii) Federally-listed threatened or endangered species or their habitat (including critical habitat), Federally-proposed or candidate species or their habitat or state-listed endangered or threatened species or their habitat</p> <p>(iii) Wetlands regulated under the Clean Water Act (33 U.S.C. 1344) and floodplains</p> <p>(iv) Federally- and state-designated wilderness areas, national parks, national natural landmarks, wild and scenic rivers, state and Federal wildlife refuges, and marine sanctuaries</p> <p>(v) Prime agricultural lands</p> <p>(vi) Special sources of water (such as sole-source aquifers, wellhead protection areas, and other water sources that are vital in a region)</p> <p>(vii) Tundra, coral reefs, or rainforests?</p>	No environmentally sensitive resources will be adversely affected. When appropriate, a sensitive resources review would be performed (e.g. cultural, archeological, and biological) to ensure that sensitive resources are not adversely affected.

Compliance Action: I have determined that the proposed action meets the requirements for the CX referenced above. Therefore, using the authority delegated to me by DOE Order 451.1, I have reviewed the documentation and have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

Signature/Date:

Paul F. X. Dunigan, Jr.
Paul F. X. Dunigan, Jr.
RL NEPA Compliance Officer

4/17/87

Attachments:

Checklist Summarizing Environmental Impacts

Distribution w/attach:

B. D. Dixon, DYN
S. Herres, SID
D. W. Lloyd, EAP
L. A. Mihalik, CHI
R. C. Phillips, PNNL
F. A. Ruck, FDH
K. M. Thompson, RP
A. G. Weiner, RUST

Checklist to Attachment 1

The following checklist summarizes environmental impacts that were considered:

IMPACT TO AIR

Would the proposed action:		YES	NO
1	Result in more than minor and temporary gaseous discharges to the environment?		X
2	Release other than nominal and temporary particulates or drops to the atmosphere?		X
3	Result in more than minor thermal discharges?		X
4	Increase offsite radiation dose to >0.1 mrem (40 CFR 61 Subpart H)?		X

IMPACT TO WATER

Would the proposed action:		YES	NO
5	Discharge any liquids to the environment?	X	
6	Discharge heat to surface or subsurface water?		X
7	Release soluble solids to natural waters?		X
8	Provide interconnection between aquifers?	X	
9	Require installation of wells?	X	
10	Require a Spill Prevention Control and Countermeasures Plan? (40 CFR 112.1 & 761)		X
11	Violate water quality standards (WAC-173-200, Table 1)?		X

IMPACT TO LAND

Would the proposed action:		YES	NO
12	Conflict with existing zoning or land use?		X
13	Involve hazardous, radioactive, PCB, or asbestos waste?	X	
14	Cause erosion?		X
15	Require an excavation permit?	X	
16	Disturb an undeveloped area?	X	

GENERAL

Would the proposed action:		YES	NO
17	Cause other than a minor or temporary increase in noise level?		X
18	Make a long-term commitment of large quantities of nonrenewable resources?		X
19	Require new utilities or modifications to utilities?	X	
20	Use pesticides, carcinogens, or toxic chemicals?	X	
21	Require radiation work permit?	X	
22	Occur on Arid Lands Ecology Reserve or Wahluke Slope?		X

The items marked "yes" in the Environmental Impact Checklist located above, are addressed in the following paragraphs:

5. Well development and sampling would require purging of groundwater. Depending upon the location of the well, purgewater would be discharged to the ground or contained in compliance with the Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington.

8. Well development in cased wells drilled deeper than unconfined aquifer has the potential for interconnection.
9. Groundwater and vadose zone wells and test pits might be installed as needed in accordance with state and federal regulations to detect contaminant releases to the environment, facilitate the remediation and closure phases of each site, and ensure that remediation is effective.
13. Small quantities of hazardous and nonhazardous solid waste, radioactive, Polychlorinated Biphenyls, and/or asbestos waste might be created by these actions. All waste would be handled and disposed of in accordance with contractor procedures and standards, federal and state regulations, and DOE orders and guidance. Waste would be dispositioned in existing Hanford Site waste management units, or approved permitted offsite facilities.
15. An excavation permit prior to starting work would be required which addresses biological and cultural resources for each instance in which the ground would be disturbed.
16. Intrusive characterization efforts such as groundwater monitoring wells or test pits might be located in undeveloped areas, if determined necessary for reasons such as to determine regulatory compliance or to confirm modeled groundwater contaminant flows.
19. Laboratory and field operations may require minor alterations of existing utilities.
20. Some characterization, testing, and laboratory actions may involve the use of toxic chemicals. Standard laboratory safety practices would be followed.
21. In the event that work would occur in areas where radiation work permits would be required, workers would be properly trained and would follow all applicable regulations and safety requirements. Work would be governed by the As Low As Reasonably Achievable principles, applicable state and federal regulations, DOE Orders, and contractor guidelines.

SENSITIVE RESOURCES REVIEWS

Cultural, Biological, Historical, Archeological, Wetlands and Floodplains Resource Reviews would be conducted for each use of the CX as appropriate wherever the work might impact such resources. Documentation for each use of the CX would be maintained according to contractor procedures and DOE requirements.

**CATEGORICAL EXCLUSION DETERMINATION FOR MICROBIOLOGICAL AND
BIOMEDICAL RESEARCH PROJECTS, AND DIAGNOSTIC AND TREATMENT
ACTIVITIES, HANFORD SITE RICHLAND, WASHINGTON**

PROPOSED ACTION: The U.S. Department of Energy (DOE), Richland Operations Office (RL) proposes to conduct microbiological and biomedical research projects through the Pacific Northwest National Laboratory (PNNL) and biomedical diagnostic and treatment activities through the Hanford Environmental Health Foundation (HEHF).

LOCATION OF ACTION: Buildings and structures that are owned and leased by both DOE and Battelle on the Hanford site, as well as other offsite buildings and structures that are used to conduct work for RL, PNNL, or HEHF.

DESCRIPTION OF THE PROPOSED ACTION: The proposed action would be to conduct microbiological and biomedical projects to support the following general research areas:

- diagnostic products, which would provide early detection of disorders or measurement of exposures with sensitive, generally non-invasive devices and systems;
- therapeutic products, which would provide targeted delivery of medical therapeutics with minimal adverse effects;
- technology and systems management products, which would improve health care delivery processes and systems through re-engineering and policy reform;
- developing a molecular-level understanding of the physical, chemical, and biological processes that underlie environmental remediation, waste processing and storage, and human health effects; and
- the beneficial use of biomedical ultrasonics, bioelectromagnetics, molecular toxicology, and medical isotopes.

Microbiological and biomedical research would include those activities that are conducted under Biosafety Levels 1 and 2¹, as identified in "Biosafety in Microbiological and Biomedical Laboratories." Actions that involve Biosafety Levels 3 or 4 (or those using inhalable or aerosol agents that may cause serious or potentially life-threatening disease) would not be conducted under this CX.

HEHF supports two missions for DOE that would be addressed by this CX: (1) provide occupational health risk management and (2) provide occupational health services to personnel at Hanford. The health risk management program helps to identify and analyze the hazards that Hanford personnel face in the work environment. The occupational health services provide elements such as occupational medicine and nursing, medical surveillance, ergonomics

¹ Level 1 activities involve well-characterized agents not known to cause disease in healthy adult humans and pose minimal potential hazard to laboratory personnel and the environment. Level 2 activities involve agents of moderate potential hazard to personnel and the environment. It differs from Level 1 activities in that (1) laboratory personnel have specific training in handling pathogenic agents, (2) access to the laboratory is limited when work is being conducted, (3) extreme precautions are taken with contaminated sharp items, and (4) certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

assessment, exercise physiology, psychology and counseling, fitness for duty evaluations, immediate health care, health education, industrial hygiene, and health, safety, and risk assessments.

DOE funds a variety of activities at PNNL that are currently covered under the bench-scale CX, but which are better addressed by this microbiological and biomedical research CX. These research activities include efforts such as the development of real-time ultrasonic visualization of bloodflow, automated lung ventilation diagnosis, ultrasonic measurement of bone density, dissolvable vascular connectors, in-vivo and in-vitro effects of magnetic fields, biological intake and exhalation rate of volatile organic compounds (using rodents), analysis of nuclear magnetic resonance spectroscopy, medical 3D imaging, optical in-vivo blood characterization, portable ultrasensitive biological sensors, and radium-223 immunoconjugates for cancer therapy. PNNL expects growth in the microbiological and biomedical fields over the next several years.

The majority of the PNNL microbiological and biomedical research activities occur in facilities such as 2400 Stevens, 326, 331, Sigma V, PSL, Math, RTL, LSL II, and the Environmental Molecular Sciences Laboratory. Ongoing activities also include collaboration with other laboratories, research hospitals, and other federal agencies. PNNL staff occasionally offer microbiological and biomedical technical assistance to offsite groups and organizations and participate in offsite research and clinical trials. These types of activities would be addressed by this CX determination. The majority of HEHF activities occur in the Hanford Square Buildings and individual health care centers.

The proposed action includes the operation and minor modification (if necessary) of facilities used for microbiological and biomedical projects and the purchase, installation, and eventual removal of research equipment such as laminar flow hoods, biological safety cabinets, gloveboxes, lasers, ultrasonic instrumentation, centrifuges, etc. These research projects would include those actions foreseeably necessary for implementation, such as associated transportation activities, waste disposal activities, small-scale decommissioning of individual rooms and laboratories, and award of grants and contracts. Each proposed activity must meet the CX eligibility criteria (10 Code of Federal Regulations [CFR] 1021.410) and all of the following criteria:

1. Each activity would be conducted within existing or newly modified structures that provide appropriate safety systems, exhaust ventilation, air filtration, and additional confinement or controls appropriate to the nature of the materials and equipment used in the project.
2. Each activity would comply with applicable administrative controls and requirements identified in the Facility Use Agreement or equivalent procedure established for the facility in which the work would be conducted. Facility Use Agreements outline specific requirements for elements such as safety class systems, operating parameters, radiological controls, and entry requirements.

3. Each activity could use hazardous and/or radioactive materials, should the use be necessary to the research project. Inventories would be maintained at the lowest practicable levels while remaining consistent with existing safety or hazards analyses, continuing operations, and research goals.
4. All releases of liquid and/or airborne substances (i.e., chemicals, radionuclides) to the environment would be compliant with existing permits, local, state, and federal regulations, DOE Orders, and PNNL or HEHF guidelines, as applicable.
5. Types of waste generated by each activity would be limited to those with an available treatment, storage, or disposal pathway. Volumes of waste generated by each activity would be reduced as much as possible by pollution prevention measures and waste minimization practices.
6. Wastes generated by each activity would be handled, packaged, transported, stored, and/or disposed of in accordance with applicable local, state, and federal regulations, DOE Orders, and PNNL or HEHF guidelines.
7. If human subjects are involved in any aspect of biomedical research, protocols developed by the PNNL Institutional Review Board for Human Subject Research would be rigorously followed in accordance with 10 CFR 745. If animal subjects are involved, protocols from the "Guide for the Care and Use of Laboratory Animals," as well as regulations from the U.S. Department of Agriculture and Public Health Service would be followed.

Funding for the proposed activities would be obtained on a project-specific basis from DOE Program Secretarial Offices or other sources.

CX TO BE APPLIED: The following CX is listed in the DOE NEPA Implementing Procedures, 10 CFR 1021, Appendix B to Subpart D, published in the Tuesday, July 9, 1996, Federal Register (61 FR 36221):

- B3.12 "Siting, construction (or modification), operation, and decommissioning of microbiological and biomedical diagnostic, treatment and research facilities (excluding Biosafety Level 3 and Biosafety Level 4; reference: Biosafety in Microbiological and Biomedical Laboratories, 3rd Edition, May 1993, U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, and the National Institutes of Health (HHS Publication No. (CDC) 93-8395)) including, but not limited to, laboratories, treatment areas, offices, and storage areas, within or contiguous to an already developed area (where active utilities and currently used roads are readily accessible). Operation may include the purchase, installation and operation of biomedical equipment, such as commercially available cyclotrons that are used to generate radioisotopes and radiopharmaceuticals, and commercially available biomedical imaging and spectroscopy instrumentation."

ELIGIBILITY CRITERIA: The proposed activity meets the eligibility criteria of 10 CFR 1021.410(b), since there are no extraordinary circumstances that might affect the significance of the environmental effects of the proposal. The proposed activity is not connected to other actions with potentially significant impacts (40 CFR 1508.25[a][1]), or with cumulatively significant impacts (40 CFR 1508.25[a][2]), and is not precluded by 10 CFR 1021.211.

The "Integral Elements" of 10 CFR 1021 are satisfied as discussed in the following table:

INTEGRAL ELEMENTS, 10 CFR 1021, APPENDIX B, SUBPART D	
WOULD THE PROPOSED ACTION:	COMMENT OR EXPLANATION:
Threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, or health (ES&H), including requirements of DOE and/or Executive Orders?	The proposed action would not threaten a violation of ES&H regulations or Executive or DOE Orders.
Require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities (including incinerators), but the proposal may include categorically excluded waste storage, disposal, recovery, or treatment actions?	Wastes created by the proposed action would be treated, stored, or disposed of in existing waste facilities.
Disturb hazardous substances, pollutants, contaminants; or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases?	No pre-existing hazardous substances pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products would be disturbed in a manner that would result in uncontrolled releases.
Adversely affect environmentally sensitive resources including but not limited to: (i) Property (e.g., sites, buildings, structures, objects) of historic, archeological, or architectural significance designated by federal, state, or local governments or property eligible for listing on the National Register of Historic Places (ii) Federally-listed threatened or endangered species or their habitat (including critical habitat), Federally-proposed or candidate species or their habitat or state-listed endangered or threatened species or their habitat (iii) Wetlands regulated under the Clean Water Act (33 U.S.C. 1344) and floodplains (iv) Federally- and state-designated wilderness areas, national parks, national natural landmarks, wild and scenic rivers, state and federal wildlife refuges, and marine sanctuaries (v) Prime agricultural lands (vi) Special sources of water (such as sole-source aquifers, wellhead protection areas, and other water sources that are vital in a region) (vii) Tundra, coral reefs, or rainforests?	No environmentally sensitive resources would be adversely affected. When appropriate, cultural and/or biological resources reviews would be performed to ensure that sensitive resources are not adversely affected by the proposed action. The proposed action would not adversely affect floodplains or wetlands regulated under the Clean Water Act; wilderness areas or other specially designated areas; prime agricultural lands; special sources of water; or tundra, coral reefs, or rainforests.

COMPLIANCE ACTION: I have reviewed the documentation and have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

Signature: Paul F. X. Dunigan, Jr. Date: 3/12/97
Paul F. X. Dunigan, Jr.
RL NEPA Compliance Officer

Attachment:
Checklist Summarizing Environmental Impacts

Distribution w/attach:
S. M. McInturff, HEHF
R. C. Phillips, PNNL
K. A. Piper, HEHF
R. S. Weeks, PNNL

Attachment 1

The following checklist summarizes environmental impacts that were considered. Answers to relevant questions are explained in detail in the text following the checklist.

IMPACT TO AIR

Would the proposed action:		YES	NO
1	Result in more than minor and temporary gaseous discharges to the environment?		X
2	Release other than nominal and temporary particulates or drops to the atmosphere?		X
3	Result in more than minor thermal discharges?		X
4	Increase offsite radiation dose to >0.1 mrem (40 CFR 61 Subpart H)?	X	

IMPACT TO WATER

Would the proposed action:		YES	NO
5	Discharge any liquids to the environment?	X	
6	Discharge heat to surface or subsurface water?		X
7	Release soluble solids to natural waters?		X
8	Provide interconnection between aquifers?		X
9	Require installation of wells?		X
10	Require a Spill Control and Prevention and Countermeasures Plan? (40 CFR 112 and 761)		X
11	Violate water quality standards (WAC 173-200; Table 1)?		X

IMPACT TO LAND

Would the proposed action:		YES	NO
12	Conflict with existing zoning or land use?		X
13	Involve hazardous, radioactive, PCB, or asbestos waste?	X	
14	Cause erosion?		X
15	Occur on the Arid Lands Ecology Reserve or Wahluke Slope?		X
16	Require an excavation permit?	X	
17	Disturb an undeveloped area?		X

GENERAL

Would the proposed action:		YES	NO
18	Cause other than a minor or temporary increase in noise level?		X
19	Make a long-term commitment of large quantities of nonrenewable resources?		X
20	Require new utilities or modifications to utilities?	X	
21	Use pesticides, carcinogens, or toxic chemicals?	X	
22	Require a radiation work permit?	X	

4. Research involving biomedical use of radioactive isotopes might result in instances where unabated offsite radiological doses are greater than 0.1 mrem for the maximally exposed offsite individual. In accordance with the National Emission Standards for Hazardous Air Pollutants (40 CFR 61), continuous air sampling is in place for those facilities whose cumulative emissions are likely to be above 0.1 mrem. In addition, high-efficiency particulate air filters are in place to control emissions. Unabated radiological emissions would not be released from microbiological or biomedical research activities.
5. Liquid wastes generated by proposed activities would be discharged into existing treatment systems or in accordance with applicable regulations. For activities conducted at the Hanford Site, liquid wastes would be processed through systems such as the City of Richland publicly-owned treatment works, process sewer, retention process sewer, septic systems, or radioactive liquid waste sewer, whichever is appropriate. Liquid waste treatment and disposal would be compliant with applicable local, state, and federal regulations and permit requirements, DOE Orders, and PNNL or HEHF guidelines.
13. Proposed activities might result in small quantities of hazardous, radioactive, PCB, and/or asbestos wastes. If unrecyclable, such wastes would be characterized, handled, packaged, transported, stored, and/or disposed of in existing Hanford Site or offsite treatment, storage, and disposal facilities in accordance with applicable local, state, and federal regulations, DOE Orders, and PNNL or HEHF guidelines.
16. Facility modification to support microbiological or biomedical research might require an excavation permit if earth-disturbing activity is involved.
20. Proposed activities might require minor modifications to utilities that serve existing facilities.
21. Proposed activities might use small quantities of pesticides, carcinogens, and/or toxic chemicals. Project inventories would be maintained at the lowest practicable levels, and chemicals would be recycled or regenerated if possible.
22. Proposed activities would be performed in compliance with as low as reasonably achievable principles, applicable state and federal regulations, DOE Orders, and PNNL guidelines. The radiation received by workers during the performance of activities would be administratively controlled below DOE limits as defined in 10 CFR 835.202(a). Under normal circumstances, those limits control individual radiation exposure to below an annual effective dose equivalent of five rem.

CULTURAL RESOURCES REVIEW: Minor facility modifications foreseeably necessary to perform microbiological and biomedical research would be conducted under this CX. If the facility is listed in Appendix C, Table 1 of the "Programmatic Agreement for the Maintenance, Deactivation, Alteration, and Demolition of the Built Environment on the Hanford Site," the Hanford Cultural Resources Laboratory would

review the proposed modification activity prior to commencement. This review would evaluate potential impacts to culturally sensitive resources, including consideration of the historical significance of the facilities. In accordance with the PA Section (V) (C), the Project will assess the contents of each affected facility to locate and identify artifacts or museum property prior to activities associated with this CX.

BIOLOGICAL RESOURCES REVIEW: A biological resources review would be completed for facility modification activities with the potential to adversely affect sensitive plant and animal species. This review would not generally be required for those activities that are internal to a building or facility.

**CATEGORICAL EXCLUSION FOR
Palouse Drilling Project Located Near
Winona and Washtucna Washington**

Proposed Action:

Golder Federal Services, Inc. is proposing to do small-scale intrusive drilling (two test holes) in eastern Washington.

Location of Proposed Action:

The two drilling sites are located in the Palouse Region of eastern Washington. The first site is near Winona, located 80 miles northeast of Richland. The second site is near Washtucna, located 60 miles northeast of Richland.

Description of Proposed Action:

The proposed action involves small-scale intrusive drilling activities. Two vertical test holes will be drilled. The first hole near Winona will be drilled to about 190 ft. The second hole near Washtucna will be from 50-100 ft. deep. Both holes will be drilled using standard truck-mounted auger drilling equipment with work slated to begin in early January 1996 and taking approximately one week to complete.

The purpose of the Palouse Drilling Project is to collect aseptic soil samples for microbiological characterization and chloride mass balance analysis. The project is funded under the Subsurface Science Program (SSP), managed by the U.S. Department of Energy's Office of Health and Environmental Research and Pacific Northwest National Laboratory (PNNL), Richland, Washington. One of the major objectives of the SSP is to gain an understanding of the distribution and population dynamics of microorganisms in the subsurface environment, and to better understand their potential application to bioremediation of subsurface contaminants at DOE facilities. The soil samples will be processed at the PNNLs Life Science Laboratory II.

The proposed action will be conducted on privately owned farm properties which have been used for wheat production for decades. The hollow stem auger drilling and associated sampling actions do not produce significant amounts of fugitive dust and the proposed action is expected to generate much less dust than normal farming practices in the site area. No water, mud, or other circulating fluids would be used in drilling the test holes. This is necessary to avoid contaminating the desired subsurface soil samples with naturally occurring surface microorganisms. Once drilling is completed, site restoration activities would be conducted at both drilling sites. The test holes will be backfilled in accordance with state regulations and the soil cuttings at the surface will be distributed around each drill site, such that subsequent farming would readily incorporate them into the fields.

Categorical Exclusion (CX) to be Applied:

The following CXs are listed in 10 *Code of Federal Regulations* (CFR) 1021, "National Environmental Policy Act Implementing Procedures," Subpart D, Appendix B, published in the Friday, April 24, 1992, 57 *Federal Register* 15151:

B3.1 Site characterization and environmental monitoring, including siting, construction, operation, and dismantlement of closing (abandonment) of characterization and monitoring devices and siting, construction, and operation of a small-scale laboratory building or renovation of a room in an existing building for sample analysis. Activities covered include, but are not limited to, site characterization and environmental monitoring under CERCLA and RCRA. Specific activities include, but are not limited to:

(f) Sampling and characterization of water, soil, rock, or contaminants;

3.6 Indoor bench-scale research projects and conventional laboratory operations (for example, preparation of chemical standards and sample analysis) within existing laboratory facilities.

ELIGIBILITY CRITERIA

Since there are no extraordinary circumstances that may affect the significance of the environmental effects of the proposal, the proposed activity meets the eligibility criteria of 10 CFR 1021.410(b), as shown in the following table. The proposed activity is not "connected" to other actions with potentially significant impacts (40 CFR 1508.25[a][1]), or with cumulatively significant impacts (40 CFR 1508.25[a][2]), and is not precluded by 10 CFR 1021.211.

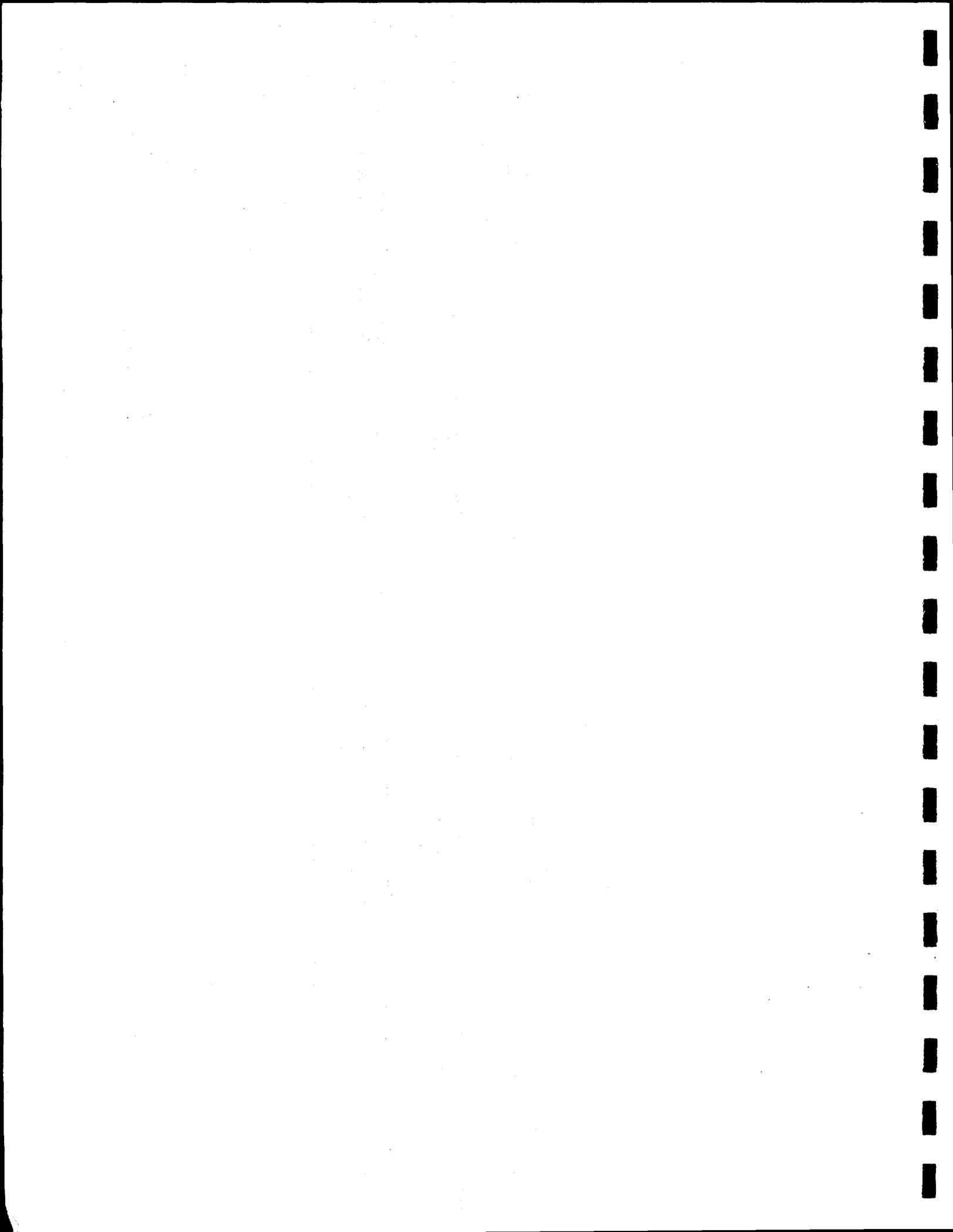
The "Integral Elements" of 10 CFR 1021 are satisfied as discussed in below.

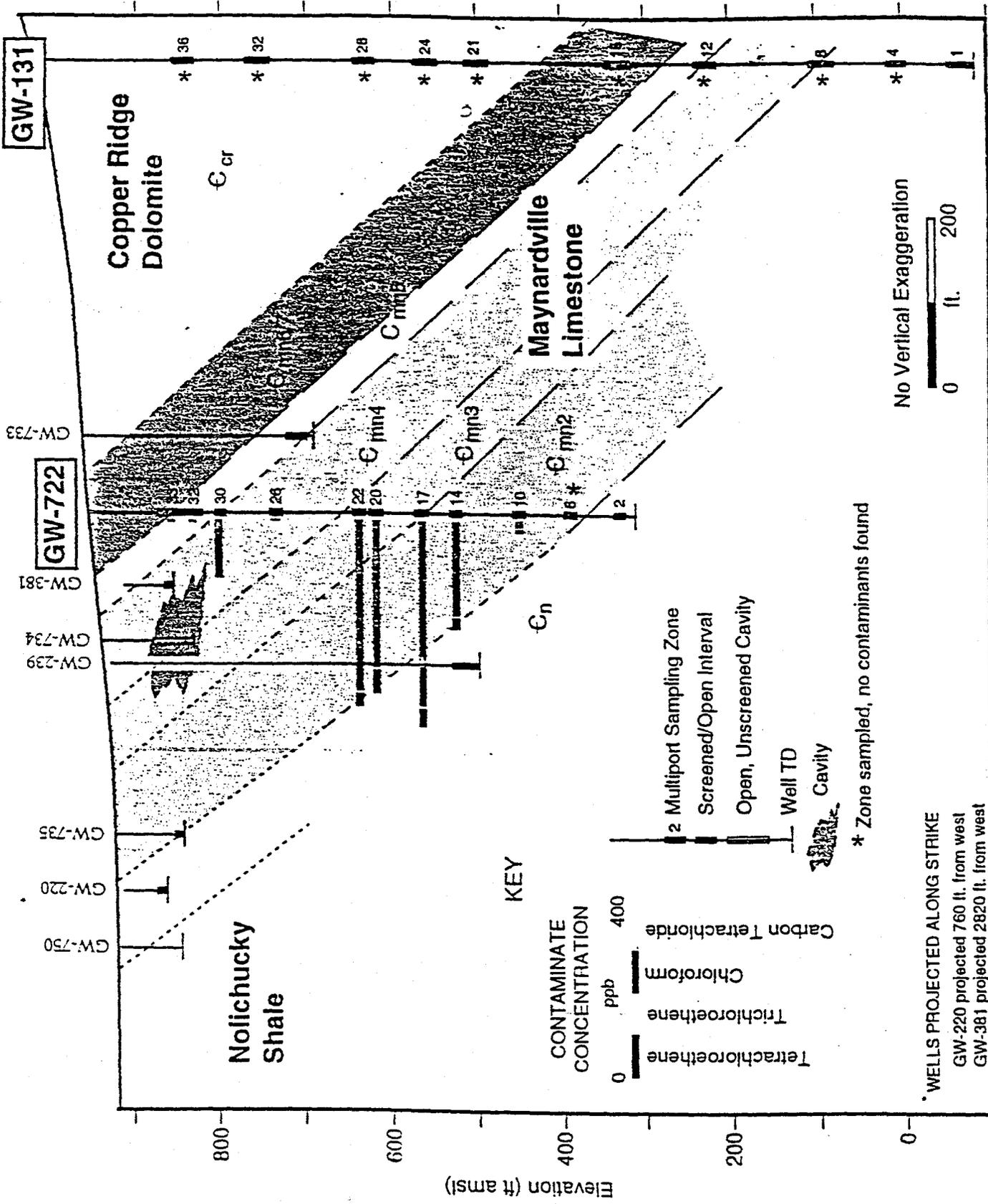
INTEGRAL ELEMENTS 10 CFR 1021, SUBPART D, APPENDIX B	
Would the Proposed Action:	Comment or explanation:
Threaten a violation of environmental, safety or health laws, regulations, or DOE orders?	No laws, regulations, or Orders would be violated by the proposed action.
Require siting, construction or major expansion of waste treatment, storage, or disposal facilities?	Wastes created by the proposed action would be disposed of in existing waste facilities.
Disturb hazardous substances preexisting in the environment, allowing uncontrolled releases?	No liquids would be discharged to the ground by the proposed action.
Adversely affect archaeological or historical property?	Properties of archaeological or historical significance would not be adversely affected.
Adversely affect federally- or state listed, proposed or candidate, threatened or endangered species or habitat?	The proposed action would not adversely affect any federally or state listed, proposed or candidate, threatened or endangered species or habitat.
Adversely affect floodplains or wetlands?	The proposed action would not take place on a floodplain or wetland.
Adversely affect wild and scenic rivers, state or federal wildlife refuges or specially designated areas?	The proposed action would not take place in a specially designated area.
Affect special sources of water?	No special sources of water would be affected.

I have reviewed the attached documentation and have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

Signature/Date: Paul F. X. Dunigan, Jr. 12/22/95
 Paul F. X. Dunigan, Jr.
 RL NEPA Compliance Officer

Attachments





* Zone sampled, no contaminants found

WELLS PROJECTED ALONG STRIKE
 GW-220 projected 760 ft. from west
 GW-381 projected 2820 ft. from west

Northeast

Southwest

Both Locations

- The rate of transport and impact of matrix diffusion over relatively long distances in the Maynardville Limestone deep exit pathways will be determined by using multiple tracer injection tests.
- The results of the tracer tests can be used by the Integrated Water Quality Program (IWQP) to determine meaningful sampling frequencies and the impact of matrix diffusion on the rate of aquifer restoration (i.e., expected change in groundwater concentration) in response to remedial actions. This will become more important, especially at sites where natural attenuation is selected as the remedial option.
- Testing at both sites will provide information the regulators and public have requested regarding the monitoring, and fate and transport within the exit pathway plumes.

BCV test site

- The likely rate of groundwater restoration in the Maynardville Limestone from source actions taken at the BYBY and S-3 ponds can be better determined. Using the results of the tracer test, the information can be used to determine monitoring frequencies for the uranium, nitrate, and TCE plumes migrating in the Maynardville Limestone exit pathway.
- The BCV site will be used to test the equipment and tracers prior to conducting the UEFPC test (in GW-722, a Westbay well) where transport mechanisms are not as well understood.

UEFPC test site

- The data will be used to determine if the current direction of groundwater flow is east and off site or west toward the UEFPC underdrain, which is on site. This information can be used to determine the monitoring locations the IWQP should be focusing on.
- The information can be used to determine monitoring frequencies for the off-site CT plume in the Maynardville exit pathway. The likely rate of off-site groundwater remediation (concentration change) due to the proposed on-site containment actions can be better determined.

3. Scope

The tracer test will be conducted in a similar manner at both locations. Three tracers—ice nucleating agent (INA), bromide, and sulfur hexafluoride (SF6)—will be injected at both locations using the same Westbay downhole equipment. The purpose of using three tracers is to determine the rate of movement of a colloid (i.e., INA) that is theoretically too large to be subject to matrix diffusion relative to the rate of movement of two other tracers that are impacted by matrix diffusion but to different degrees (i.e., bromide and SF6). At the BCV site, a fluorescent dye tracer will also be injected to assess the impacts of sorption on contaminant transport.

APPENDIX G

**GRAY AND INDIANA BATS: ASSESSMENT AND EVALUATION
OF POTENTIAL ROOSTING AND FORAGING HABITATS,
ANDERSON AND ROANE COUNTIES, TENNESSEE**

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**Gray and Indiana Bats:
Assessment and Evaluation of Potential Roosting and
Foraging Habitats
Anderson and Roane Counties, Tennessee**

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February 2000

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1.0 SUMMARY

This assessment examines potential impacts on federally listed plant and animal species that could result from the construction and operation of the proposed Field Research Center (FRC) by the Department of Energy (DOE) on the preferred site on the Oak Ridge Reservation (ORR). The species considered in this assessment are those listed in the letter from the U.S. Fish and Wildlife Service to the U.S. Department of Energy, dated September 14, 1999 (FWS 1999a) and included in Appendix D of the Draft Environmental Assessment for the proposed project (DOE 1999). These listed species are the endangered gray and Indiana bats.

DOE staff concludes, for the reasons described in the main text of this assessment, that the proposed project is not likely to adversely affect either species. Also, since no proposed or designated critical habitats are present on the site, none would be affected. The FWS expressed concurrence with this conclusion in a letter dated February 10, 2000 (FWS 2000). This assessment is intended to finalize concurrence.

2.0 INTRODUCTION AND PROJECT DESCRIPTION

The proposed FRC would include a 243-acre (98-ha) previously disturbed contaminated area and a 404-acre (163-ha) background area on and adjacent to the Y-12 Site. The proposed contaminated area would be used for conducting experiments on contaminated groundwater and subsurface sediments. The proposed background area would provide for comparison studies in an uncontaminated area. The proposed contaminated area and background areas would be located in Bear Creek Valley (BCV). The BCV is approximately ten miles (16 kilometers [km]) long and extends from the eastern end of the Oak Ridge Y-12 Site to the Clinch River on the west. Bear Creek is a tributary to East Fork Poplar Creek, which drains into the Clinch River at the East Tennessee Technology Park. Except for the extreme eastern end of the contaminated area of the proposed FRC, the area is outside of any security fences, adjacent to public use roads, but protected from unwarranted passersby. There would be no new building construction needed for operation of the FRC; only minor land disturbance would be involved, for the installation of wells.

3.0 ECOLOGICAL DESCRIPTION OF THE SITES

The following brief description is taken from DOE (1999) unless otherwise noted. This description has been verified with field reconnaissance by the author (J.W. Webb, ORNL, personal observations, February, 2000).

Before 1940, most of BCV was cleared and used for agriculture. Currently, about 65 percent of the BCV watershed is wooded, with common vegetation being predominantly oak and oak-hickory associations on the upper slopes and ridgetops and planted pine along the creek and floodplain area. Old field and grassland habitats are also present. Thus, elements of the majority of wildlife habitat types and the expected terrestrial fauna found on the ORR occur in BCV. Hardwood and mixed hardwood/conifer habitats are the most abundant of the habitat types in the

Bear Creek watershed, followed by pine plantation and grassland habitats, with considerable riparian habitat along the length of Bear Creek.

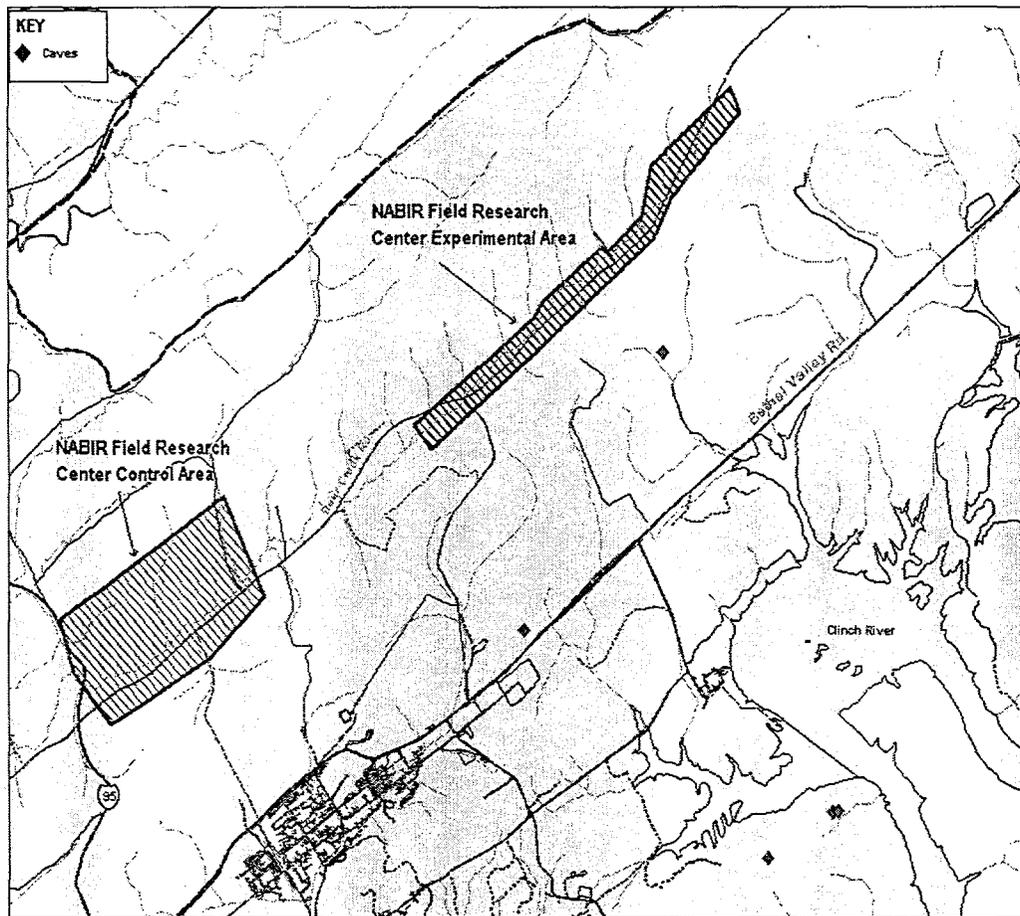


Figure G-1 Existing bat caves in the proposed FRC

The proposed contaminated area is primarily characterized by dense stands of planted pines and smaller areas of densely spaced mixed hardwoods. The creek and riparian zone are narrow and located near the paved Bear Creek Road. Trees in the proposed contaminated area are generally less than 20 cm diameter at breast height (dbh) and do not exhibit exfoliating bark; Indiana bats require larger trees with loose bark as maternity roost sites. Some snags are present, primarily a result of wind activity in these exposed stands.

In contrast, the proposed background area is primarily mixed hardwoods and has larger trees (>70 cm dbh) of a variety of species. Spot checks in the proposed background area (Webb, personal observations) showed the presence of both snags and trees with exfoliating bark, particularly in the riparian zone of Bear Creek; these are potential roost sites for Indiana bats.

Bear Creek completely traverses the length of both the proposed contaminated area and the background area, and thus includes the associated section of 100-year floodplain and associated

riparian habitat. The creek is narrow (i.e., < 1 m) and channelized in its upper reaches, including much of the proposed contaminated area. In the proposed background area, the creek is frequently several meters wide and meandering. Bear Creek has been quantitatively monitored and has been designated as having a degraded fish community especially in headwater locations, where most of the proposed contaminated and background areas are located. Benthic invertebrate fauna collections show a similar pattern with a diverse benthic fauna well established at downstream locations (outside the proposed FRC areas) and a depauperate benthic community within the proposed contaminated and background areas adjacent to Bear Creek. Recent research has indicated an improvement in species diversity within the upper reaches of Bear Creek; however, the fish population is still considered impaired. Neither the FRC field office nor laboratory structures would be located in the BCV floodplain.

3.1 Listed Species and Potential Impacts of the Project

The general ecology of federally listed species that may occur on the site (FWS 1999a) and the expected impacts from the project on them are summarized below. Unless otherwise noted or referenced, general biological information on the species is derived from Harvey (1992).

3.1.1 Gray Bat (*Myotis grisescens*)

The endangered gray bat is concentrated in cave regions of Arkansas, Missouri, Kentucky, Tennessee, and Alabama. Although the population is over 1.5 million and improving, about 95 percent hibernate in only eight known caves, two of which are located in Tennessee. During the summer gray bats are usually found in caves, though frequent different caves than those used for hibernation. Females form maternity colonies of at least several hundred individuals, while males and non-reproductive females form smaller summer bachelor colonies. Summer caves, especially for maternity colonies, are rarely more than three km (two miles) and usually less than 1.6 km (one mile) from the rivers and lakes used as foraging areas. During the spring and autumn transient periods the bats occupy a wider variety of caves. During all seasons males and yearling females seem less restricted to specific caves and roost types. In general, bats enter hibernation in September through October and emerge in late March and April; timing depends on age and gender. Young are born in late May or early June. Bats forage over water, mostly along rivers, large creeks, and lakes, primarily within about five m (15 feet) above the surface. Gray bat populations are on the upswing as a result of improved breeding success due to better protection measures, such as cave gates, fences and informational signs near caves.

The nearest caves to either of the proposed FRC areas are about one, two, and five km from the proposed contaminated area, slightly further from the proposed background area. The latter two of these, Walker Branch cave and Big and Little Turtle caves, were surveyed by Mitchell et al. (1996) and no gray bats were found. There is an unverified report of ten gray bats roosting in Little Turtle cave (located about 5 km from the sites) in September, 1996, as referenced in FWS (2000). These bats were observed roosting and were not further disturbed; thus, a definite, in-the-hand identification was not made (J.W. Webb, ORNL, personal communication with Deborah Awl, JAYCOR, September 18, 1996). If indeed gray bats, they quite likely were bachelor males en route to a hibernation site, although they could also have been entering hibernation in that cave.

In November 1994, a single dead gray bat was found in a display case in a building at the Y-12 plant northeast of the proposed contamination site. This individual was probably an isolated

individual juvenile which became lost, disoriented, and trapped. In August 1995 a live bat was found in a building at Y-12, but it was released before a positive identification was made. Based on the attachment of the wing membrane to the ankle as shown in photographs of this specimen, I do not think it was a gray bat (Webb, personal observations.)

Mist netting, in which I assisted, was conducted by Harvey on the lower portion of East Fork Poplar Creek and its tributaries in May 1992 and again in May - June, 1997 (Harvey 1997). The 1997 survey included portions of lower Bear Creek near its confluence with lower East Fork Poplar Creek; this location is about 4 km from the proposed FRC areas. The creeks in this area provided good gray bat foraging habitat and excellent Indiana bat summer roosting and foraging habitat at the time of the surveys. No gray or Indiana bats were recorded among six species captured.

Although caves less than 5 km from the sites are not known to harbor gray bats, it is still possible that bats could forage on the sites, primarily along the stream corridor of Bear Creek. Within the contaminated area, the creek is narrow and suboptimal for frequent foraging by gray bats. Within the background area, the stream corridor is suitable, although there is better habitat along the Clinch River and the lower reaches of Poplar Creek and East Fork Poplar Creek; these latter three areas are probably also nearer to likely roost caves. As reported above, the aquatic insect fauna of Bear Creek is suboptimal, again suggesting that the creek and its riparian zone may not provide an ideal foraging area. In any case, the only creek-related activities associated with proposed FRC research would involve sampling within the creek and possible well installation within the riparian zone. These activities would involve minimal clearing at most, and would be conducted during the day, so that any foraging by gray bats would therefore not be disrupted. Thus, I conclude that the project is unlikely to adversely affect the gray bat or its habitat.

3.1.2 Indiana bat (*Myotis sodalis*)

The range of the endangered Indiana bat is in the eastern U.S. from Oklahoma, Iowa, and Wisconsin east to Vermont and south to northwestern Florida. Distribution is associated with major cave regions and areas north of cave regions. The present total population is estimated at ca. 352,000, with more than 85 percent hibernating at only nine locations — two caves and a mine in Missouri, three caves in Indiana, and three caves in Kentucky.

Indiana bats usually hibernate in large dense clusters of up to several thousand individuals, in sections of the hibernation cave where temperatures average 38 - 43 F and with relative humidities of 66 to 95 percent. They hibernate from October to April, depending on climatic conditions. Density in tightly packed clusters is usually estimated at 300 - 484 bats per square foot.

Female Indiana bats depart hibernation caves before males and arrive at summer maternity roosts in mid May. A single offspring, born during June, is raised under loose tree bark, primarily in wooded streamside habitat. Maternity colonies use multiple primary roost trees that are used by a majority of the bats most of the summer and a number of secondary roosts that are used intermittently and by fewer bats, especially during periods of precipitation or extreme temperatures. Thus, there may be more than a dozen roosts used by some Indiana bat maternity colonies (FWS 1999b). Kurta et al. (1996) found that female Indiana bats may change roosts about every three days, and a group of these bats may use more than 17 different trees in a single maternity season. During September, they depart for hibernation caves. The summer roost of

adult males is often near maternity roosts, but where most males spend the day is unknown. Other males remain near the hibernaculum. A few males can be found in caves during summer.

Until relatively recently, little was known about the summer habitat and ecology of the Indiana bat. The first maternity colony was discovered in 1974, under the loose bark on a dead butternut hickory tree in east central Indiana. The colony, numbering about 50 individuals, also used an alternate roost under the bark of a living shagbark hickory tree. The total foraging range of the colony consisted of a linear strip along approximately 0.5-mile of creek. Foraging habitat was confined to airspace from 6 feet to ca. 95 feet high near the foliage of streamside and floodplain trees.

Two additional colonies were discovered during subsequent summers, also in east central Indiana. These had estimated populations of 100 and 91 respectively, including females and pups. Habitat and foraging area were similar to the first colony discovered. Additional evidence gathered during recent years indicates that, during summer, Indiana bats are widely dispersed in suitable habitat throughout a large portion of their range.

Using radio telemetry techniques, several additional maternity colonies have recently been discovered and studied at several locations. These studies reinforced the belief that floodplain forest is important habitat for Indiana bat summer populations. However, maternity colonies were also located in more upland habitats. It was also discovered that Indiana bats exhibited fidelity to specific roosting and foraging areas to which they returned annually.

Between early August and mid September, Indiana bats arrive near their hibernation caves and engage in swarming and mating activity. Swarming at cave entrances continues into mid or late October. During this time, fat reserves are built for hibernation. It is thought that Indiana bats feed primarily on moths. A longevity record of 13 years 10 months has been recorded for this species. Hibernating bats leave little evidence of their past numbers; thus, it is difficult to calculate a realistic estimate of the overall population decline for this species. However, population estimates at major hibernacula indicated a 34 percent decline in the total Indiana bat population from 1983 to 1989.

The only record of Indiana bats on the ORR is from a single specimen in the 1950s (FWS 2000). No maternity roosts have been located on the ORR, or indeed yet in Tennessee (FWS 1999b). In general, limited information suggests that the bats roost primarily north of their hibernacula and more often in the northerly parts of their range. During mist netting on lower East Fork Poplar Creek and its tributaries, described above for gray bats and in Harvey (1997), no Indiana bats were captured out of six species recorded. Habitat on the proposed contaminated area of the FRC does not appear to provide suitable roosting habitat, and foraging habitat there is suboptimal as described above for gray bats. The proposed background area, however, does provide apparently suitable roosting and foraging habitat, although the site has not been completely characterized in this regard (Webb, personal observations, February 2000). Because only minor land-disturbance would occur within 100 feet of the stream, roosts, if present in the riparian zone, would not likely be disturbed. Though less likely, a roost also might be present in an upland area. Were a roost to occur near drilling, then noise and other activities might disturb Indiana bats. The severity of any such adverse effects would depend on specific circumstances. Effects on foraging would be unlikely because activities would occur during the day. Thus, current knowledge, including recent surveys on the ORR in optimal habitat, suggests that it is unlikely that Indiana bats would be present on either site; if present, it is unlikely that project activities would adversely affect them.

4.0 REFERENCES

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