DOE/OR/01-2921&D2/R1 January 2023

U.S. Department of Energy
Environmental Management Program DOE/OR/01-2921&D2/R1

Proposed Plan for an Interim Record of Decision for Groundwater in the Main Plant Area at the East Tennessee Technology Park, Oak Ridge, Tennessee

January 2023

This Proposed Plan:

- Describes the initiation of groundwater restoration at the East Tennessee Technology Park in Oak Ridge, Tennessee, through the use of an Interim Record of Decision, with the goal of working towards future final remedial action decisions.
- Describes the preferred alternative evaluated in the *East Tennessee Technology Park Main Plant Groundwater Focused Feasibility Study Oak Ridge, Tennessee* (DOE/OR/01-2894&D2):
  - The preferred alternative initiates contaminant mass reduction at chlorinated volatile organic compound groundwater plumes through the preferred technology of enhanced in situ bioremediation.
- Explains how to participate in selecting or modifying the preferred alternative and where to get more information.

YOUR OPINION IS INVITED

The U.S. Department of Energy (DOE) invites you to express your opinion of the presented remedial alternatives and the preferred alternative for the interim Main Plant Area groundwater decision at the East Tennessee Technology Park. You are encouraged to read the information in the Administrative Record, including the *East Tennessee Technology Park Main Plant Groundwater Focused Feasibility Study, Oak Ridge, Tennessee* (DOE/OR/01-2894&D2), for background and more detailed technical information. A comment form is attached to this fact sheet, but you are not restricted to this form. Decision makers will consider any comments received before the end of the public comment period.

Community involvement is critical to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, cleanup process. DOE has established a 45-day public comment period, during which time local residents and interested parties can express their views and concerns on all aspects of this plan. DOE has scheduled a public meeting to discuss cleanup alternatives and to address questions and concerns the public may have.

1 INTRODUCTION

This Proposed Plan presents the U.S. Department of Energy's (DOE's) preferred alternative for interim remedial actions in the Main Plant Area (MPA) groundwater at the East Tennessee Technology Park (ETTP), located on the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee (Figures 1.1 and 1.2). The purposes of this Proposed Plan are to solicit public involvement, describe the alternatives analyzed, identify the preferred alternative, and explain the rationale for the preferred alternative.

This Proposed Plan is issued to solicit public involvement, as required under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 117(a), as amended by the Superfund Amendments and Reauthorization Act of 1986 (42 United States Code Section 9601, et seq.) and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] 300.430[f][2]). Additional information on the description and evaluation of the alternatives is contained in the *East Tennessee Technology Park Main Plant Groundwater Focused Feasibility Study, Oak Ridge, Tennessee* (DOE/OR/01-2894&D2; Focused Feasibility Study [FFS]).

Remediation efforts on the ORR are governed by the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014). DOE is the lead agency for this Proposed Plan. The U.S. Environmental Protection Agency (EPA) Region 4 and the State of Tennessee Department of Environment and Conservation (TDEC) support the issuance of this Proposed Plan. In accordance with the *DOE Secretarial Policy Statement on the National Environmental Policy Act* (DOE 1994), National Environmental Policy Act of 1969 (NEPA) values have been incorporated into the CERCLA documentation prepared for this project.

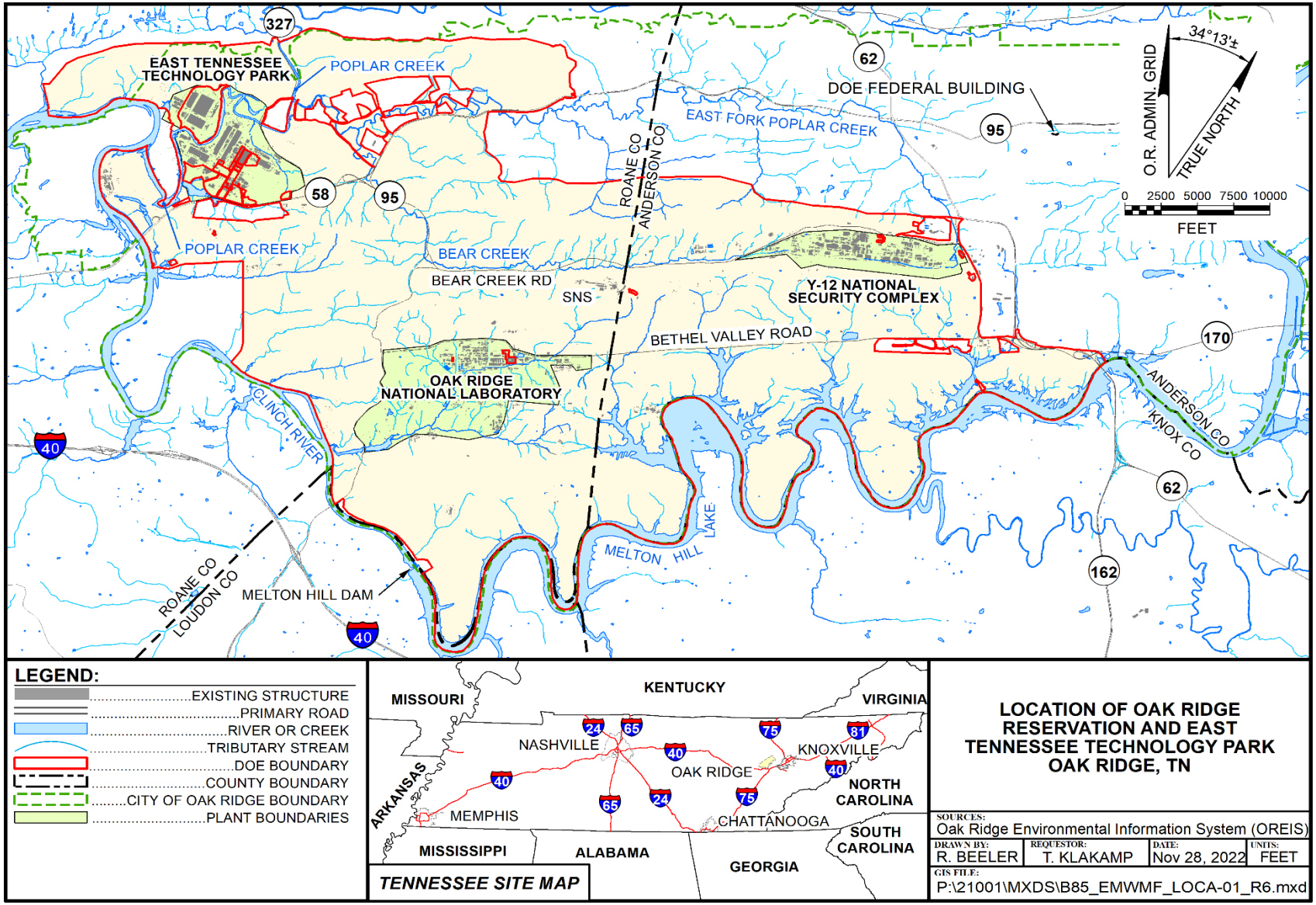

Figure 1.1. Location of ORR and ETTP.

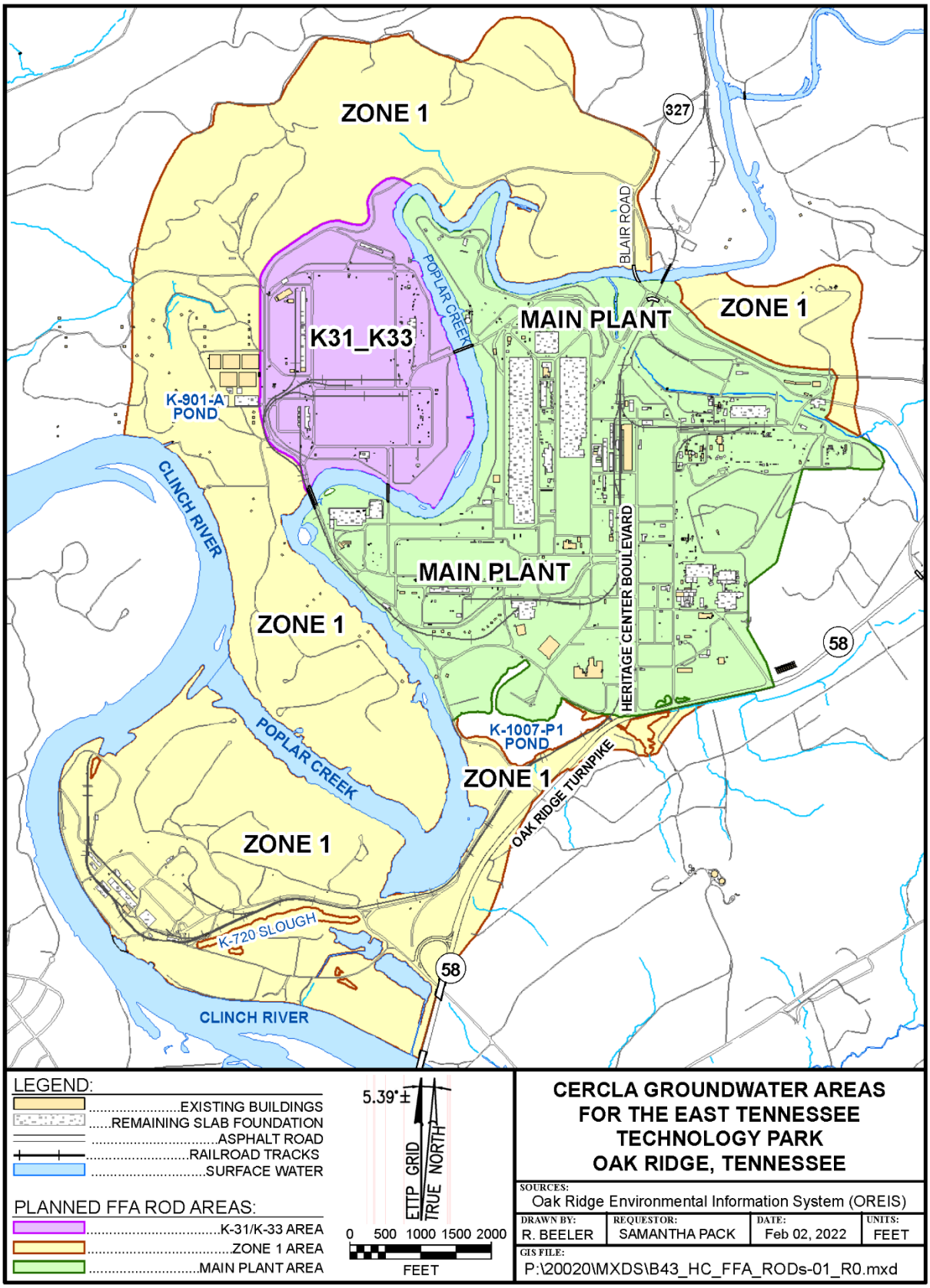

Figure 1.2. ETTP groundwater areas.

2 SCOPE OF PROPOSED REMEDIAL ACTION

The scope covered by the proposed interim action is groundwater within the MPA of ETTP. The specific scope covered in the predecessor FFS includes:

- Six specific areas of groundwater contamination (i.e., groundwater plumes) within the MPA located below the water table in the unconsolidated weathered soil/rock and bedrock zones.

The specific six areas generally are named for former buildings in the area of the contamination and include (Figure 2.1) six chlorinated volatile organic compound (CVOC) groundwater plume areas where contaminant concentrations exceed 1000 µg/L are considered for active remediation:

- Mitchell Branch Comingled Plume/ K-1407-B
- K-1401
- K-25/K-1024
- K-1035
- K-27/K-1232
- K-1239

Additional groundwater CVOC areas of concern have been identified in the ETTP MPA, as shown in Figure 2.1. Some of these additional areas require additional data-collection activities prior to proposing an action. In a few cases, it has yet to be determined if a dense, non-aqueous-phase liquid (DNAPL) form of contamination is present that could require different remedial approaches. Additional data-gathering activities will be initiated as part of a Remedial Investigation Work Plan (RIWP) aimed at obtaining data for final decisions on MPA groundwater.

For the six sites covered by this Proposed Plan, the primary soil sources associated with the groundwater plumes have been or are being excavated above the water table under the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161&D2; Zone 2 Soil Record of Decision [ROD]), as shown in Table 2.1. Completion of the soil work sets the stage for this next phase of work below the water table. The Zone 2 Soil ROD has been responsible for:

> "Soil or buried material that contains sufficiently high levels of soluble contaminants can be a source of contamination to groundwater. The intent of cleanup is to remediate subsurface soil or buried material above the water table or bedrock that poses a threat of causing continued or further spread of groundwater contamination (*Remedial Design Report/Remedial Action Work Plan for Zone 2 Soils, Slabs, and Subsurface Structures East Tennessee Technology Park, Oak Ridge, Tennessee*; DOE/OR/01-2224&D5)."

The large amount of contaminated soil source mass removal that has been or will be excavated as part of the Zone 2 work should result in decreasing trends in groundwater contaminant concentrations. Monitoring for this will be a key component of the work under the RIWP.

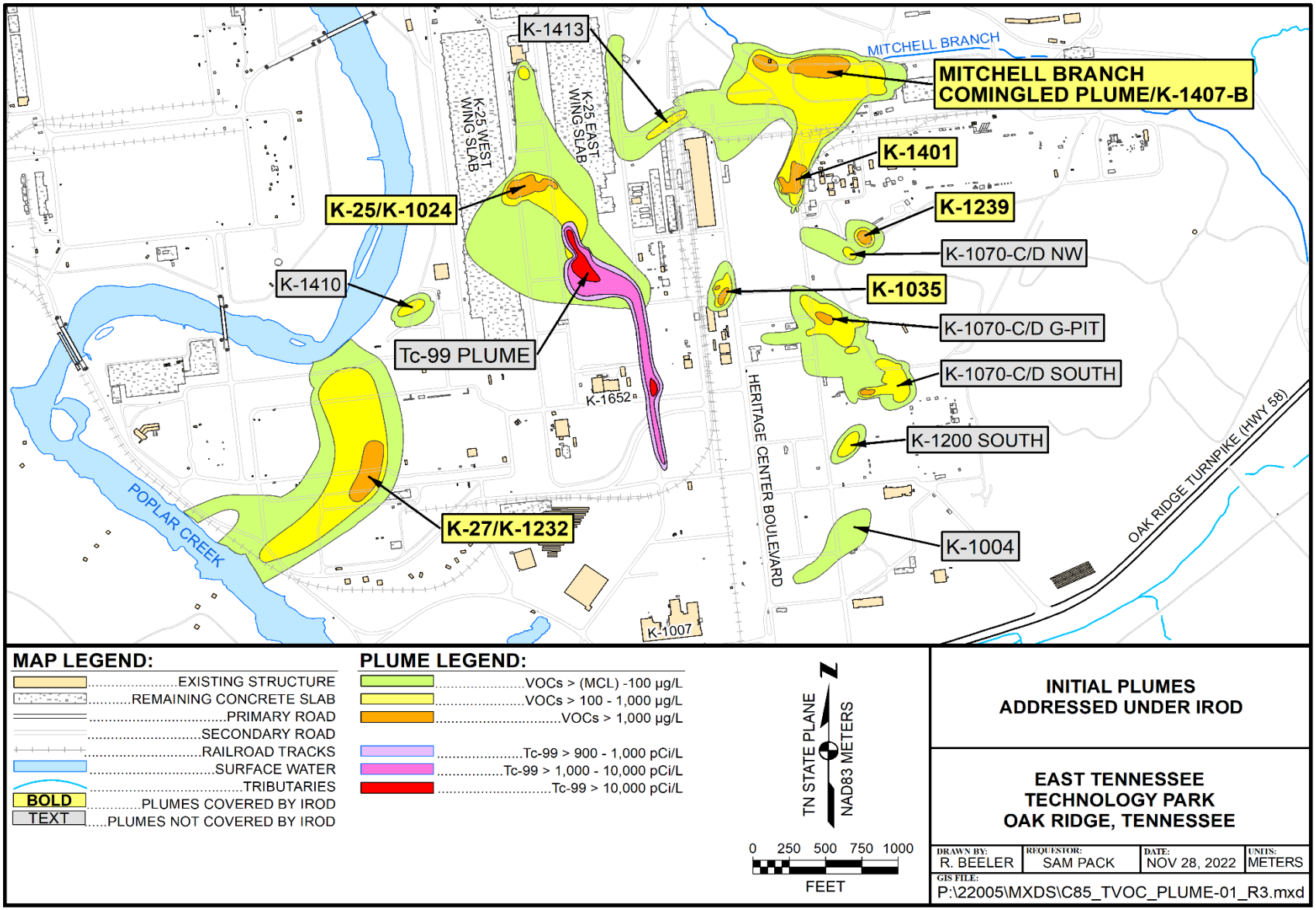

Figure 2.1. Scope of proposed remedial action.

Table 2.1. MPA locations where contaminated soil excavation actions have or will be occurring

Groundwater area of contamination	Zone 2 source action	Excavation volume (yd^3)
Areas included in proposed IROD		
Mitchell Branch Comingled Plume/K-1407-B	EU Z2-35 Area 2 (tetrachloroethene)	850
	K-1407-B Pond	1000
K-1401	Degreasers, acid baths and dip tanks, and other degreasing infrastructure removed during demolition of K-1401	--
K-25/K-1024	EU Z2-21	70,000[a]
K-1035	Pits, drain lines, and soil removed (2009)	2540
K-27/K-1232	K-631 North TCE	19,000[a]
	K-131 North TCE	
	Tank Farm Area TCE	
	K-413 Southeast TCE	
K-1239	No CVOCs identified in Zone 2 soils; further evaluation in progress	--
Areas not included in proposed IROD		
K-1004	Suspect source (dilution pits) removed (2007)	50
Tc-99 dig	EU Z2-21 and EU Z2-22	93,000
K-1413	EU Z2-25 North soil	10,080
	EU Z2-25 K-1413 soil	13,000
K-1410	No CVOC source identified; radiological soil >SSL removed	14,200
K-1420	Contaminated soils and slabs	9000
K-1070-C/D North	Further evaluation in progress	TBD
K-1070-C/D G-Pit	G-Pit removed under separate action	--
K-1070-C/D South	Further evaluation in progress	TBD
K-1200 South	No CVOCs identified in Zone 2 soils	--

[a]Estimated future volumes.

CVOC = chlorinated volatile organic compound
EU = exposure unit
IROD = Interim Record of Decision
MPA = Main Plant Area
SSL = soil screening level
TBD = to be determined
TCE = trichloroethene

3 SITE BACKGROUND

3.1 OVERVIEW OF THE SITE

The 34,465-acre DOE ORR is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee, in Roane and Anderson Counties (Figure 1.1). The ORR is bounded to the east, south, and west by the Clinch River and on the north by the developed portion of the city of Oak Ridge. Three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project—ETTP, formerly the K-25 Site and Oak Ridge Gaseous Diffusion Plant; Oak Ridge National Laboratory (ORNL), formerly X-10; and the Y-12 National Security Complex (Y-12)—are located on the ORR.

ETTP's principal mission was uranium enrichment. Enrichment activities ceased in 1987 and demolition of all buildings covered under CERCLA was completed in 2020. ETTP currently is being cleaned up to allow beneficial reuse of the land, infrastructure, and groundwater. ORNL historically performed a variety of research and development activities, including the use of research nuclear reactors for DOE. Y-12 has served several missions, including uranium enrichment, lithium refining, nuclear weapons component manufacturing, and weapons disassembly, and has a continuing mission in some of these areas. Historic operations resulted in waste disposal areas as well as soil, surface water, sediment, groundwater, and buildings contamination. Consequently, the ORR, including all of ETTP, was placed on the CERCLA National Priorities List in 1989.

3.2 SITE HISTORY AND STATUS

ETTP occupies approximately 5000 acres of the ORR. Areas potentially impacted by site activities account for roughly 2200 of the 5000 acres. ETTP's original mission was to supply enriched uranium material for nuclear weapons. From 1945–1964, gaseous diffusion technology was used to enrich uranium for use in nuclear weapons. There were five primary process buildings (K-25, K-27, K-29, K-31, and K-33) where highly enriched uranium (HEU) and low enriched uranium (LEU) were produced. In 1964, HEU production was discontinued and the K-25 and K-27 process buildings were shut down.

Over the next 20 years, ETTP's primary mission was LEU production for fabrication into fuel elements for commercial and research nuclear reactors. Secondary missions in the mid-1980s included research on new technologies for uranium enrichment, such as gas centrifuge and laser isotope separation. In 1985, because of a decline in the demand for enriched uranium, DOE placed ETTP in standby mode. ETTP was shut down permanently in 1987. Currently, DOE activities at ETTP include environmental cleanup and reindustrialization efforts. Portions of ETTP are used for non-DOE industrial activities.

ETTP operations resulted in a legacy of inactive and contaminated facilities, waste disposal areas, and contaminated media, including the following:

- Buildings
- Buried wastes
- Buried tanks
- Underground waste lines
- Scrap and debris
- Surface and subsurface soils
- Surface water and sediment
- Groundwater

Early investigations of hazardous releases from contaminant source areas at ETTP were initiated to meet the requirements of the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 and CERCLA. The first set of key decisions addressed single-project, higher risk early actions to remove primary sources of contamination or address primary release mechanisms. In addition, buildings have been demolished under CERCLA removal authority. The early actions and facility demolition are complete.

The second set of key decisions at ETTP addressed soil, buried waste, and subsurface structures. For the purposes of these decisions, ETTP was divided into two geographical areas: Zone 1, consisting of approximately 1400 acres outside the original fence line of the main processing/industrial area; and Zone 2, the processing/industrial area inside the original fence line. Historically, Zone 1 was mostly undeveloped, but portions were used for industrial purposes (e.g., power generation) and limited waste disposal. Zone 2 is the main plant production area associated with heavy industrial use as well as waste treatment and disposal.

Characterization and remedial actions for soil, buried waste, and subsurface structures in Zone 1 were implemented under the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2; Zone 1 Soil Interim ROD [IROD]), as amended. The approved *Amendment to the Record of Decision for Interim Actions in Zone 1 for Final Soil Actions, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2817&D3) added protection of ecological receptors in the terrestrial environment, given that much of Zone 1 is undeveloped and is viable ecological habitat.

All the Zone 1 Soil IROD remedial actions are complete. Remedial actions in Zone 2 are in progress, and all required soil excavations are anticipated to be completed by September 2025. Actions under the Zone 1 Soil IROD and Zone 2 Soil ROD are based on the protection of both human health and the environment, including requirements to remove soil that could continue to leach contaminants to groundwater. Neither ROD includes actions that extend below the water table (or below the top of bedrock).

The remaining CERCLA decisions at ETTP will address contamination in groundwater, soil vapor, surface water, and sediment in the ponds, wetlands, and perennial streams. The groundwater scope at ETTP has been divided into three geographical areas for CERCLA decisions (Figure 1.2):

- MPA groundwater
- K-31/K-33 Area groundwater
- Zone 1 groundwater

The proposed MPA Groundwater IROD that is the subject of this Proposed Plan is the result of a two-step process that has occurred starting in 2018 when the Federal Facility Agreement (FFA) parties agreed to divide the groundwater scope. In November 2019, DOE submitted to the regulators the *East Tennessee Technology Park Main Plant Groundwater Feasibility Study, Oak Ridge, Tennessee* (DOE/OR/01-2835&D1; Feasibility Study [FS]). This FS covered all groundwater scope in the MPA. Comments resulting from regulatory review pointed to issues that would need to be addressed prior to obtaining a Final ROD, including but not limited to:

- Incomplete characterization of the entire plume areas downgradient of the >1000-µg/L area (both depth and lateral spread).
- Incomplete characterization of radiological and metal contaminants in groundwater.
- Incomplete understanding of the weathered rock and bedrock flow zones.

Based on the comments, the FFA parties altered the path to focus on a subset of the MPA groundwater contamination for which sufficient data were available to evaluate remedial technologies and to proceed with an FFS and an IROD on these areas. The FFA parties agreed that comments on the original FS would need to be addressed as part of future efforts toward a final ROD for MPA groundwater.

3.3 SITE CHARACTERISTICS

The MPA is bounded on the north and west by Poplar Creek, Highway 58 on the south, and unindustrialized wooded areas to the east (Figure 1.1). Bedrock geology within the MPA is complex, reflecting lithologic diversity (carbonate and clastics) and structural complexity at different scales. Bedrock is mantled largely by a veneer of unconsolidated overburden ranging up to 70 ft thick. The overburden is made up of a combination of soil and weathered bedrock. These conditions have created a complex hydrogeologic environment, in which groundwater flow patterns reflect a variety of subsurface influences, including bedrock weathering profiles, relict drainage features, historical cut and fill activities, structural geology (e.g., strike and dip and fracturing), subsurface utilities, and karst features.

The K-25 Fault transects the eastern portion of the MPA and is a northeast-dipping thrust fault that places Rockwood Formation clastics over Chickamauga carbonates. The K-25 Fault also separates the groundwater areas addressed in this Proposed Plan into those underlain by clastic rocks (K-1401, K-1407-B, and K-1239) and those underlain by carbonates (K-1024, K-1035, and K-27/K-1232).

The water table in the MPA occurs at depths ranging from approximately 2 to 50 ft below land surface and generally occurs within the unconsolidated zone above bedrock. However, in the southeastern portion of the MPA, bedrock is shallow enough that the water table lies completely within bedrock.

Contaminated groundwater containing CVOCs occurs in both the unconsolidated materials and in

the underlying bedrock resulting from historical use of these compounds as cleaning solvents. Historical releases of CVOCs occurred from equipment cleaning and maintenance, leaking process piping, degreasing pits, and other surface/near-surface releases. The contamination migrated downward to the water table where it dispersed in the unconsolidated zone and also reached the underlying bedrock. Groundwater has continued to migrate in response to natural hydraulic gradients and buried infrastructure and relict drainage features. In addition to CVOCs, other contaminants have entered the groundwater at ETTP, particularly Tc-99 in the area of the former K-25 building. This Proposed Plan addresses specific groundwater areas of contamination within the MPA, including K-27/K-1232, K-1024, K-1401, K-1035, Mitchell Branch Comingled Plume/K-1407-B, and K-1239, as shown in Figure 2.1.

The CVOC groundwater treatment areas were defined on the basis of concentrations of 1000 µg/L for at least one of the CVOCs identified for that particular source, typically trichloroethene (TCE). For areas with high concentrations of vinyl chloride (VC), a more toxic compound, a concentration limit of 400 µg/L is used along with a 1000-µg/L limit for other CVOCs.

The CVOC high-concentration areas are within the larger plume area, as shown on Figure 2.1. These plumes range in concentrations from <1000 µg/L to levels near the EPA maximum contaminant levels (MCLs). Although not the focus of the actions aimed at reducing contaminant mass in the groundwater plumes described in this Proposed Plan, the actions are also expected to have a beneficial effect on these larger plume areas. If the proposed remedy proves effective, remediation efforts may extend into these dissolved-phase areas.

There are additional areas of groundwater contamination at ETTP that are not currently included in the scope of this Proposed Plan, as well as potential unknown areas of contamination that may be discovered as additional characterization work is implemented under the new RIWP. They include but are not limited to:

- The Tc-99 plume
- K-1004
- K-1413
- K-1410
- K-1420
- K-1064 Peninsula
- K-1070-C/D burial grounds (both in the northerly G-Pit and southerly K-1200 flow directions)
- Several DNAPL areas of concern in bedrock
- Other sites identified by further MPA groundwater-characterization activities

These remaining areas of contamination will be included in the final ROD.

3.4 SITE TRANSFER STATUS

Portions of the ETTP MPA have been or will be leased or transferred for reindustrialization. In all cases, the transfer deeds transfer the property but prevent use of groundwater at the site. The transfer status of the sites addressed in this Proposed Plan is listed below:

- The K-1407-B area has not been transferred.
- The K-1401 and K-1035 groundwater plumes areas are located in parcel ED-11, which transferred in May 2014.
- The K-1024 area will be retained by the federal government as part of the K-25 National Historic Preservation/National Park Service footprint.
- The K-1239 groundwater plume lies within parcel ED-10, which transferred in February 2012, but additional pre-design investigations (PDIs) could show it may encroach on other areas.
- Most of the K-27/K-1232 area has not been transferred, but the southern portion is in a “pending transfer” area.

Despite having transferred the land for reuse at the MPA, the deeds all contain language that ensures DOE retains unrestricted access to the groundwater plumes at ETTP for the purpose of investigations, remedial action, and monitoring. Coordination with existing tenants may need to be accounted for in planning and implementing work.

3.5 INTEGRATION WITH OAK RIDGE RESERVATION GROUNDWATER STRATEGY

From 2013–2014, the FFA parties met to develop a strategy for addressing the complex CERCLA groundwater cleanup challenges on the ORR. These meetings culminated in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2628&D2/V1; Groundwater Strategy report). The report identified six key recommendations that were considered in the development of this plan:

- Perform an Off-site Groundwater Quality Assessment, including monitoring residential wells and springs downgradient of ETTP, to address the potential for off-site public health threats, as addressed in Section 4.1.2.
- Continue with ORR conceptual site model investigations.
- Enhance groundwater flow modeling.
- Coordinate with the FFA parties to support technology development toward final groundwater decisions.
- Identify groundwater early actions/remedial actions, as portrayed by this IROD Proposed Plan.
- Include some remediation elements related to MNA.

Components of the strategy not directly addressed by this interim action will be incorporated into the development of the RIWP for the MPA Final ROD.

4 SUMMARY OF SITE RISKS

Historical groundwater monitoring at ETTP has identified areas of groundwater contamination throughout the site. Baseline human health risk assessments have been performed for most of the CVOC plumes addressed under this Proposed Plan to identify current and hypothetical future industrial and residential health risks. Risks associated with current land use and hypothetical future land use are summarized below. A full baseline human health risk assessment will be included in the remedial investigation report for the MPA Final ROD.

4.1 CURRENT LAND USE

4.1.1 Onsite

Current land use for the ETTP MPA is commercial/industrial. The State of Tennessee designates groundwater at ETTP as general use, per State of Tennessee Water Quality Criteria General Use Ground Water (0400-40-03-.07(4)(b)) requirements; however, currently, there are prohibitions against groundwater use at ETTP. Because of groundwater use restrictions, no current direct exposure risk to industrial workers via use of potable water exists.

A potential for indirect exposure to groundwater CVOC contaminants via migration of vapors through subsurface soils into buildings exists. Characterization work performed as part of the CERCLA 120(h) land transfer process (*Evaluating the Potential for Vapor Intrusion at the East Tennessee Technology Park, Oak Ridge, Tennessee* [DOE/OR/01-2572]) indicated there are no unacceptable exposures associated with vapor intrusion of chlorinated solvents in the footprints of buildings that were being transferred at that time. Additionally, the property deeds for transferred properties in the MPA require any new buildings constructed on the property that are intended to be occupied by workers 8 hr or more per scheduled workday or by public visitors follow Office of Solid Waste and Emergency Response 9200.2-154, Section 8.2.3, *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, which requires evaluation and design/construction requirements to prevent exposure to CVOC vapors. Recent Zone 2 CERCLA soil completion efforts have included a vapor screening evaluation as part of the Phased Construction Completion Reports.

4.1.2 Offsite

In addition to on-site industrial receptors, residents currently are located offsite to the north and west of ETTP. DOE conducted the *Offsite Groundwater Assessment Remedial Site Evaluation* (DOE/OR/01-2715&D2) from fiscal year 2014 through fiscal year 2016 to investigate groundwater quality and potential off-site migration of contaminants from the ORR. The study included sampling 15 wells and springs downgradient of ETTP. That study concluded cancer risks at all off-site monitoring locations are within the EPA acceptable risk range. Non-cancer risks were

above a hazard index (HI) of 1 at five locations; however, these HI values for non-cancer toxic effects are associated with three inorganic chemicals—lithium, fluoride, and manganese. The study concluded the inorganics contributing to the non-cancer HI >1 are not likely an ORR-related issue for one or more of the following reasons:

- The inorganics may be naturally occurring.
- The total HI is the sum of inorganics with different toxic endpoints.
- The inorganic chemicals did not exceed any primary drinking water standards (i.e., MCL), or there is no access to springs for drinking water.

These three inorganics are not chemicals of concern identified in the ETTP soil RODs or the previous groundwater remedial investigations.

4.2 FUTURE LAND USE

Future land use assumptions for the MPA are based on input from the Oak Ridge Site-Specific Advisory Board and the End Use Working Group and discussion with regulatory agencies. The designated future land use for the MPA is commercial/industrial. As established in the Zone 2 Soil ROD, industrial use is restricted to a depth of 10 ft below ground surface, and in some areas, to a 2-ft-below-ground-surface depth. Land use around the former K-25 building footprint will be historic preservation in support of the Manhattan Project National Historical Park. DOE will retain three classified burial grounds within the MPA at ETTP. Areas within the MPA may be changed to recreational use; however, these areas likely would be limited to a narrow strip of land bordering Poplar Creek.

Under these future land uses, the *East Tennessee Technology Park Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2477&D4; ETTP Remedial Action Report [RAR] Comprehensive Monitoring Plan [CMP]) institutional controls on groundwater usage will remain in place through deed restrictions filed in the transfer deeds. The ETTP RAR CMP states, "In the event of property transfer, DOE will ensure that DOE's property disposal agent incorporates the Land Use Control (LUC) objectives into restrictive covenant languages in the deeds transferring the property… The deeds will contain appropriate provisions to ensure the restrictions continue to run with the land and are enforceable by DOE." (Refer to Table 6.2 [Section 6.2] for the ETTP RAR CMP land use control [LUC] requirements for transferred properties.)

Despite these land use designations and restrictions, and in accordance with CERCLA baseline risk assessment practices, the past risk assessments have evaluated future hypothetical residential land use, including the use of groundwater as a potable water source. This residential use evaluation is used to help evaluate the potential to return the groundwater resource to unrestricted uses and to determine the need for ongoing use controls.

The 2007 risk assessment (*Final Sitewide Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee* [DOE/OR/01-2279&D3]) evaluated a hypothetical resident who lived above the high-concentration portion of a groundwater plume and obtained water for all household uses from groundwater within that source area. Potential exposure routes assessed for the adult and child residents included ingestion of drinking water, dermal contact with household water, and inhalation of CVOCs. In addition, inhalation of CVOCs migrating from groundwater through soil and into a home (i.e., vapor intrusion) was assessed. The evaluation followed the guidance for assessing a reasonable maximum exposed individual. This assessment was used as a starting point for the FFS assessment.

The risk assessment in the FFS identified groundwater underlying ETTP as contaminated with CVOCs that could result in unacceptable human health risks if used as a potable water source. Incremental lifetime cancer risk for a future hypothetical resident ranges from 1.7×10^{-2} to 7.5×10^{-5}, depending on the specific groundwater plume. These estimated risks are above the CERCLA acceptable risk range of 1×10^{-4} to 1×10^{-6}. The estimated HI ranged from 12 to 340, well above the acceptable HI of 1. The predominant CVOC and greatest risk driver present in groundwater is TCE, with 1,1,1-trichloroethane and tetrachloroethene also contributing risk but being less widespread throughout the area. Degradation products of these parent compounds, primarily cis-1,2-dichloroethene; 1,1-dichloroethene; and VC, are also present in some areas. Although additional chemicals of potential concern were identified, CVOCs were identified as the principal concern with regard to protection of human health.

5 REMEDIAL ACTION OBJECTIVES

The purpose of the interim action is to initiate remedial actions while additional information is collected to better assess the practicability of aquifer restoration prior to determining final cleanup goals.

Interim remedial action objectives (IRAOs) establish goals for the interim action to provide the basis for evaluating alternatives and to help identify a target for determining the action has been successful. IRAOs are sometimes referred to as functional objectives, technology-specific goals/performance metrics, and near-term remediation goals. They describe intermediary goals that guide progress towards achieving final remedial action objectives (RAOs) in a Final ROD.

In the ETTP MPA, CVOCs present the greatest human health risks in groundwater and exceed MCLs by several orders of magnitude. The MPA groundwater plume areas addressed in this Proposed Plan are the areas where the greatest CVOC contaminant mass has been observed. These areas act as sources of continued releases to the associated groundwater plumes. The IRAO for the IROD is to substantially reduce CVOC contaminant mass in these areas. Reducing groundwater plume source material will facilitate long-term restoration of groundwater at the site.

A target performance metric identified for the IROD is to reduce contaminant concentrations below 1000 µg/L for individual CVOCs (or 400 µg/L for VC). This 1000-µg/L threshold was selected because it is a practical goal to achieve contaminant mass removal and is similar to values selected for several other CERCLA sites for this purpose, including two EPA Region 4 National Aeronautics and Space Administration sites and DOE's Santa Susana site. It also represents a contaminant level that is less than values suggesting the presence of DNAPL, or less than 1% of the solubility of TCE and other priority CVOCs. Treatment to these levels contributes to DOE's strategy to substantially reduce further contribution of contaminant mass to the aquifer.

If performance data indicate treatment is capable of reducing contaminant concentrations to levels below the target performance metrics (400 µg/L for VC and 1000 µg/L for the other CVOCs), then active remediation will continue to achieve the greatest practicable reduction in contaminant mass. In this situation, the treatment would continue until performance data indicate additional treatment actions do not accomplish any further practicable reduction in contaminant concentrations. Decision rules identified in the Remedial Design Report (RDR)/Remedial Action Work Plan (RAWP) will be used to define the conditions for ceasing active treatment operations for the interim action and in collaboration with TDEC and EPA to determine the next stage of work. The IRAO for this Proposed Plan does not include groundwater restoration to CVOC MCLs; rather, it focuses on plume contaminant mass reduction to identified interim numeric goals. Nonetheless, the action identifies Safe Drinking Water Act MCLs as chemical-specific applicable or relevant and appropriate requirements (ARARs) because they are still well suited to establishing remedial goals for groundwater. However, because this is an interim action, DOE is seeking a waiver from these ARARs under CERCLA Section 121(d)(4)A), 42 United States Code Section 9621(d)(4)(A), which allows for remedial actions to be selected that will not attain ARARs, if the remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed (commonly called the interim action waiver).

6 SUMMARY OF REMEDIAL ALTERNATIVES

The FFS developed and evaluated four alternatives to address CVOC contamination >1000 µg/L in the six groundwater plumes described in Section 2. These remedial alternatives are described below.

6.1 REMEDIAL ALTERNATIVES DEVELOPED FOR CHLORINATED VOLATILE ORGANIC COMPOUND GROUNDWATER PLUMES

The four alternatives evaluated in the FFS for the CVOC groundwater plumes are:

- No action
- In situ thermal treatment (ISTT)
- Enhanced in situ bioremediation (EISB) treatment
- In situ soil mixing (ISSM), along with EISB for deeper zones

Major components of each remedial alternative are summarized in Table 6.1. The remedial alternatives developed are a set of technology combinations that will result in the most promising

alternatives to achieve cleanup objectives. With the exception of the no action alternative, all the remedial alternatives listed in Table 6.1 include common components such as PDIs, performance monitoring, LUCs, and Five-Year Reviews (FYRs). These remedial alternatives are described more fully in the FFS.

The IRAO for the CVOC groundwater plumes is to substantially reduce CVOC mass. The performance metric for accomplishing this IRAO is to reduce concentrations of individual chlorinated organics to less than or equal to 1000 µg/L (or 400 µg/L in the case of VC).

Table 6.1. Summary of alternatives for CVOC groundwater plumes

Alternative	Description	Cost/Timeframe
No action	No actions	Cost: $0 Timeframe: not applicable
ISTT	This alternative involves installing heating elements to increase the subsurface temperature, resulting in volatilization of contaminants, with capture of the resulting vapors using a vacuum extraction system. The vapors will be treated before being discharged to the atmosphere. Process water produced as a result of treatment will be treated onsite and discharged to a permitted NPDES outfall	Capital cost: $123.3 million Total present-worth cost: $133.5 million Timeframe: 5 years
EISB	This alternative involves stimulating existing subsurface bacteria to promote dechlorination and ultimate destruction of the CVOC contaminants. It involves installing injection wells in the unconsolidated and bedrock zones. A carbon substrate, along with other supporting treatment reagents such as supplements and bioaugmentation cultures, will be injected into the wells so they can be distributed in the subsurface. Multiple injections will be completed to recharge the system with treatment reagents	Capital cost: $16.9 million Total present-worth cost: $32.7 million Timeframe: 5 years
ISSM, along with EISB for deeper zones	This alternative involves using a soil mixing technology to deliver zero valent iron and bentonite to the unconsolidated zone. The reagents will treat contaminants and minimize contamination migration from the treatment zone. The soil mixing technology will be completed under a tent with air control to prevent the release of CVOCs to the atmosphere. This alternative also uses EISB treatment in the bedrock zone	Capital cost: $154.1 million Total present-worth cost: $167.2 million Timeframe: 5 years

CVOC = chlorinated volatile organic compound
EISB = enhanced in situ bioremediation
ISSM = in situ soil mixing
ISTT = in situ thermal treatment
NPDES = National Pollutant Discharge Elimination System

6.2 COMMON COMPONENTS OF REMEDIAL ALTERNATIVES

With the exception of the no action alternative, the remedial alternatives include the following common components:

- **PDIs** – Existing data are sufficient to evaluate technologies and remedial alternatives for remediation of MPA groundwater. However, additional data are required to complete the final design and implement the selected remedy. These data will be collected as part of a PDI that will be defined in the Remedial Design Work Plan (RDWP). The PDIs will be intended to address and manage uncertainties and challenges with the selected remedy.
- **Performance Monitoring** – Performance monitoring will be conducted to assess remedy effectiveness. Performance metrics for determining when the remedial action is successful will be established in the RDR/RAWP. For the purposes of this Proposed Plan, the remedies are assumed to be implemented and evaluated for 5 years, a time period considered appropriate for determining if IRAOs can be achieved in a reasonable period of time. As such, present-worth costs are based on a 5-year timeframe. Performance monitoring will include collecting groundwater samples. The details of performance monitoring will be developed in the RDR/RAWP. For the conceptual design of each remedial alternative, the following assumptions were made:
  - A portion of the new wells installed as part of the PDIs is located such that they can be used as the performance monitoring wells for each remedy.
  - Monitoring frequency and target analytes will be defined in the RDR/RAWP. For cost-estimating purposes, frequency is assumed to be semiannual, and target analytes are assumed to be the same as those currently used for semiannual monitoring at the site.
  - Data collected during performance monitoring will be used to optimize specific remedial actions.
  - DOE will incorporate post-IROD remedy optimization as a part of groundwater remedial actions, consistent with EPA guidance on optimization, which DOE has determined may be helpful in ensuring the treatment of these plumes is achieving its remediation goals in a reasonable timeframe.
- **LUCs** – DOE has implemented LUCs to prevent potential exposures to contaminated groundwater at ETTP. These LUCs are included as part of each alternative for this interim action and are part of the selected remedy. LUCs include institutional controls (ICs) and engineering controls. ICs include restricting groundwater use for any purpose and may include additional requirements for constructing buildings until groundwater future final cleanup goals are achieved. LUCs currently are implemented in accordance with the ETTP RAR CMP, which includes the LUC Implementation Plan (LUCIP) and engineered remedies and controls. Applicable LUCs follow:
  - Property record restrictions
  - Property record notices
  - Excavation/Penetration permit program
  - Access controls
  - Vapor intrusion controls

  Guidelines for property transfer and LUC verification and reporting are also included.

  LUCs application will be the same for all remedial alternatives (Table 6.2). These LUCs will remain in effect until they are updated or removed in a future decision document.

  DOE will ensure that any unacceptable risks due to vapor intrusion will be addressed and a final remedy for vapor intrusion will be selected as part of the Final MPA Groundwater ROD. The deeds for property transfer require that any buildings newly constructed on the property that are intended to be occupied by workers 8 hr or more per scheduled workday or by public visitors will be designed and constructed to minimize exposure to volatile organic compound vapors, if determined to be necessary, using Office of Solid Waste and Emergency Response 9200.2-154 or an alternative, more recent EPA guidance document.
- **FYRs** – FYRs are required at sites where contaminant concentrations remain above unlimited use and unrestricted exposure, following guidance provided in EPA's

Comprehensive Five-Year Review Guidance (EPA/540/R-01/007). The objectives of the FYR are to assess remedy performance and determine remedy protectiveness. Each FYR will cover the following six components:

- Community involvement
- Document review
- Data review and analysis
- Site inspection
- Interviews
- Protectiveness determination

  The protectiveness determination is further evaluated by addressing the following:

  - Is the remedy functioning as intended?
  - Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?
  - Has any other information come to light that could call into question the protectiveness of the remedy?

  FYR preparation is part of the Water Resources Restoration Program implemented at ETTP, and costs for completing FYRs are covered under that program.

In addition to the above common components of the various alternatives, DOE performed a comprehensive sustainability analysis of the technologies in the original 2019 FS. This served as a quantitative assessment of the potential environmental and social impact of each alternative. That analysis recommended that, once a technology is selected, it be further evaluated during the design phase to explore opportunities to integrate sustainable remediation best practices in the design, construction, and operation of the alternative.

Table 6.2. LUCs for MPA in place during the preferred alternative

Type of control	Purpose of control	Duration	Implementation	Affected area
1. Property record restrictions: A. Land use	Impose limitations to restrict use of property	Until concentrations of hazardous substances are at such levels to allow for unrestricted use/unlimited exposure	Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office (verified every 5 years)	All WMAs and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions
B. Groundwater	Prohibit groundwater use	Until final groundwater decision is made		
C. Vapor intrusion	Mitigate the vapor intrusion pathway on existing and future enclosed building structures, as needed	Until the concentrations of volatile organic contaminant vapors reach levels to allow for unrestricted use and unlimited exposure	Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office	All of ETTP, consistent with deed covenants
2. Property record notices	Notify anyone searching records about existence and location of contaminated areas and limitations on their use	Until concentrations of hazardous substances are at such levels to allow for unrestricted use and unlimited exposure; groundwater use prohibitions are in place until final groundwater decision is made	Recorded by DOE in accordance with state law at County Register of Deeds office and copied to the appropriate zoning office (verified every 5 years). (1) Tennessee Code Annotated notice of land use restrictions after signing the ROD. (2) Upon transfer of affected areas. (3) Upon completion of a remedial action that leaves hazardous substances in place	All of ETTP
3. Zoning notice	Notify city about existence and location of waste disposal and residual contamination areas for zoning/planning purposes	Until concentrations of hazardous substances are at such levels to allow for unrestricted use and unlimited exposure; groundwater use prohibitions are in place until final groundwater decision is made	Initial zoning notice (same as property record notice) filed with City Planning Commission as soon as practicable after signing the ROD. Final zoning notice and survey plat filed with City Planning Commission upon completion of all remedial actions	All WMAs and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions

Table 6.2. LUCs for MPA in place during the preferred alternative (cont.)

Type of control	Purpose of control	Duration	Implementation	Affected area
4. Excavation/ Penetration permit program	Notify worker/ developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/ penetration activity	Until concentrations of hazardous substances are at such levels to allow for unrestricted use and unlimited exposure; groundwater use prohibitions are in place until final groundwater decision is made	Implemented by DOE and its contractors. Initiated by permit request (verified annually)	Remediation systems, all WMAs, and areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions. All of ETTP for groundwater. Remainder of Zone 1 and all of Zone 2 below 10 ft
5. Access controls (e.g., fences, gates, signs, and portals)	Control and restrict access to workers and the public to prevent unauthorized uses	Until concentrations of hazardous substances are at such levels to allow for unrestricted use and unlimited exposure; groundwater use prohibitions are in place until final groundwater decision is made	Maintained by DOE (verified annually)	Remediation systems, all WMAs, and areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions

DOE = U.S. Department of Energy
ETTP = East Tennessee Technology Park
LUC = land use control
MPA = Main Plant Area
ROD = Record of Decision
WMA = waste management area

EXPLANATION OF NINE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 EVALUATION CRITERIA

1. **Overall Protection of Human Health and the Environment** addresses whether a remedial action provides overall protection of human health and the environment. This criterion must be met for a remedial alternative to be eligible for selection.

2. **Compliance with Applicable or Relevant and Appropriate Requirements** addresses whether a remedial action meets all the applicable or relevant and appropriate federal and state environmental requirements or provides grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for selection.

3. **Long-term Effectiveness and Permanence** considers the ability of an alternative to protect human health and the environment over time.

4. **Reduction of Toxicity, Mobility, or Volume Through Treatment** evaluates an alternative's use of treatment to reduce harmful effects of contaminants, their ability to move in the environment, and the amount of contamination present.

5. **Short-term Effectiveness** refers to potential adverse effects on workers, human health, and the environment during the construction and implementation phases of a remedial action.

6. **Implementability** refers to the technical and administrative feasibility of a remedial action alternative, including the availability of materials and services needed to implement the alternative.

7. **Cost** refers to an evaluation of the capital, operation and maintenance, and monitoring costs for each alternative, including present-worth costs.

8. **State Acceptance** indicates whether the state concurs with the preferred alternative.

The following is applied after comments are received on the Proposed Plan.

9. **Community Acceptance** assesses the general public response to the Proposed Plan following a review of public comments received during the public comment period. The remedial action is selected only after consideration of this criterion.

7 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 PROCESS FOR EVALUATION OF ALTERNATIVES

CERCLA Section 121, as amended, specifies statutory requirements for remedial actions. These requirements include protection of human health and the environment, compliance with ARARs, a preference for permanent solutions that incorporate treatment as a principal element to the maximum extent practicable, and cost effectiveness. To assess whether alternatives meet these requirements, the following nine criteria (*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* [EPA/540/G-89/004]) are identified in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300.430(f)(2)) and must be evaluated for each alternative (Section 300.430(e)(9)(iii)).

- Threshold criteria:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Balancing criteria:
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying criteria:
  - State acceptance
  - Community acceptance

The first two criteria are the threshold criteria that relate directly to statutory findings that must be documented in a final ROD. The next five criteria, the balancing criteria, address performance of the alternative and verify the alternative is realistic. The last two modifying criteria are taken into account after public comments are received on the Proposed Plan.

In addition to these evaluation criteria prescribed under CERCLA, DOE policy directs the substantive elements of analysis required under NEPA be incorporated into CERCLA decision documents (DOE 1994). Elements common to both CERCLA and NEPA include protectiveness, compliance with ARARs, long-term effectiveness and permanence, short-term effectiveness, and cost. Additional NEPA values not specifically included in CERCLA criteria include socioeconomic impacts, environmental justice, irreversible and irretrievable commitment of resources, and cumulative impacts.

The following sections summarize the evaluation of alternatives presented in the FFS and how each alternative compares to the other alternatives evaluated. Table 7.1 summarizes the comparative evaluation of alternatives presented in the following sections.

7.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Because LUCs are in place at ETTP, no action during the interim period does not pose a threat to human health. However, the no action alternative does not achieve the IRAO of substantially reducing source mass, which is the first step in overall protection of human health in the long term. The three treatment alternatives are expected to substantially reduce contaminant mass and achieve IRAOs to support a final cleanup decision and final RAOs.

Table 7.1. Summary of CVOC groundwater actions against CERCLA evaluation criteria

CERCLA criteria	No action	ISTT	EISB	ISSM
Threshold criteria				
Protection of human health and the environment	Does not achieve IRAOs	Protective	Protective	Protective
Compliance with ARARs	Does not address contaminants with ARARs	Complies/ seeking waiver	Complies/ seeking waiver	Complies/ seeking waiver
Primary balancing criteria				
Long-term effectiveness and permanence	Lower compared to other alternatives	Comparable to ISTT and EISB	Comparable to ISTT and ISSM	Comparable to ISTT and EISB
Reduction of toxicity, mobility, or volume through treatment	Lower, no active treatment performed	Higher than other alternatives	Comparable to ISSM	Comparable to EISB
Short-term effectiveness	Lower compared to other alternatives	Comparable to ISSM	Higher than other alternatives	Comparable to ISTT
Implementability	No remediation activities implemented	Higher than ISSM and lower than EISB	Higher than other alternatives	Lower than ISTT and EISB
Present-worth cost	$0	$133.5 million	$32.7 million	$167.3 million

ARAR = applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CVOC = chlorinated volatile organic compound
EISB = enhanced in situ bioremediation
IRAO = interim remedial action objective
ISSM = in situ soil mixing
ISTT = in situ thermal treatment

7.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As the goal of the interim action is groundwater plume mass reduction and DOE's use of the interim action waiver, treatment to chemical-specific ARARs is not applicable at this time. For a final ROD, a decision will be made on what appropriate actions are necessary to achieve contaminant-specific ARARs. The three treatment alternatives are capable of complying with identified action- and location-specific ARARs.

7.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

The no action alternative is not considered an effective long-term solution to groundwater contamination problems in the MPA.

The three treatment alternatives are expected to be effective in the long term, aid toward achieving a permanent solution, and have the following attributes in common:

- Treatment will target the most highly contaminated groundwater that represents the greatest risks at the site and where concentrations of specific CVOCs exceed 1000 µg/L.
- Treatment in bedrock represents a challenge that will be addressed incrementally over time, starting with attempts to target contamination in the bedrock zone during the PDI step.
- Treatment will continue until target contaminants are reduced below 1000 µg/L, at which point treatment will continue as long as it is technically and economically feasible.
- Groundwater will be monitored to assess the treatment progress.
- Treatment is expected to substantially reduce contaminant concentrations in the groundwater plumes.

The ISTT alternative is limited in delivering heat to the high-concentration area in a complex geologic environment and capturing the volatilized mass. Some unrecovered volatilized organic mass in the bedrock zone may migrate outside the treatment zone and condense, resulting in moving of contaminant mass rather than achieving full recovery of the volatilized contaminants.

Treatment by EISB has been demonstrated to be effective at removing contaminant mass, including a successful treatability study at ORNL in 2010 that resulted in strong reduction of TCE and daughter product concentrations (DOE/OR/01-2566&D1), and a study of in situ reductive dechlorination of a solvent plume in karst bedrock (Alexander et al. 2003). There are some challenges where soil material has less permeability, which may create challenges to distributing treatment reagents. The remedial design will assess engineering options to improve confidence in distributing treatment reagents.

Both EISB and ISSM rely on liquid injections to deliver treatment reagents to the bedrock zone, which pose challenges due to the network of fractures that are present and the potential to create preferential flow paths for treatment reagents.

Overall, the amount of mass and risk reduction in the unconsolidated zone is expected to be comparable for ISTT and ISSM; the risk reduction for EISB is expected to be slightly less due to potential reagent delivery challenges in the less permeable soils.

While different elements of the three treatment alternatives have different strengths and challenges, overall, the alternatives were considered to be comparable, with EISB scoring slightly less than ISTT and ISSM because less mass reduction is anticipated. However, EISB is still expected to achieve IRAOs.

7.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

The no action alternative does not use treatment to reduce groundwater contaminant mass.

ISTT involves heating the soils or rock, which volatilizes the contaminants. The resulting vapors are collected by vapor extraction wells and passed through an above-ground treatment unit that uses activated carbon to remove the contaminants from the vapors. The carbon media containing the contaminants are ultimately sent offsite to an appropriately permitted disposal facility. Because the contamination is removed from the soil/rock and eventually sent offsite for disposal, thermal treatment is considered an irreversible treatment technology. Treatment residuals from ISTT involve generating spent carbon, which will be managed at an appropriately permitted disposal facility.

EISB involves implementing biological treatment. With this technology, transient intermediate degradation products may have greater toxicity and mobility than parent compounds, but they are expected to be reduced by properly implementing the treatment process.

EISB and ISSM both involve implementing biological treatment in the unconsolidated and bedrock zones. EISB involves injecting either or both microbial populations and a food source to increase aquifer biological populations. ISSM uses stabilizing material that will be left behind in the treated soils. Contaminants will be treated with zero valent iron (ZVI) or will remain immobile in the stabilized material.

Overall, ISTT scored highest for this criterion and EISB and ISSM were considered comparable. The no action alternative scored the lowest.

7.5 SHORT-TERM EFFECTIVENESS

There are no risks to workers with the no action alternative. This alternative does not impact workers or the community, and it does not have an environmental impact. There is no timeframe to operate the no action alternative.

EISB scored the highest in protecting workers because of the limited mechanical components of the alternative. ISSM has the greatest potential to impact workers due to the need to work with a high level of personal protective equipment and mechanical mixing for soil. ISTT rated in the middle because it uses heat to treat contaminated groundwater and includes mechanical treatment components.

The three treatment alternatives were evaluated to have limited and similar impacts on the community.

The environmental impacts of ISTT were considered highest due to the energy demand of the treatment components, followed by ISSM due to energy required for mixing soils and material intensity. EISB has the lowest environmental impacts.

The three treatment alternatives are planned to be operated for 5 years and are expected to achieve the IRAOs in this period of time.

Overall, EISB scored higher than the other treatment alternatives.

7.6 IMPLEMENTABILITY

There are no activities implemented with the no action alternative.

The three treatment alternatives will need to comply with DOE's rigorous on-site requirements for construction and operation of treatment systems. CERCLA considerations related to implementability are discussed below:

- The need to perform all treatment activities in a tent for the unconsolidated zone will be challenging for ISSM.
- EISB has the least potential for schedule delays, while ISTT and ISSM have greater potential for schedule delays.
- ISTT and EISB were considered compatible with the potential for future remedial actions if needed at the treatment sites. The use of stabilizing agents in the unconsolidated zone limits the type of additional remediation that could be implemented if ISSM is selected. This alternative also has limitations on what kind of redevelopment could occur at the treatment sites because of the potential for subsidence of soils as a result of mixing and adding ZVI and stabilization materials.
- The three treatment alternatives were considered comparable in the ability to monitor the remedy.
- Based on availability of services and materials, EISB was evaluated to be best due to its use of common treatment reagent material as well as availability of contractors that can implement the technology. There are few technology vendors that can implement ISTT and ISSM.

Overall, EISB scored higher than ISTT, and ISSM scored the lowest.

7.7 COST

There are no costs for implementing the no action alternative.

EISB is the lowest cost alternative because the technology only uses injection wells and episodic reagent injection events. It is the least expensive alternative being 19.5% of the costs of ISSM and 24.0% of the costs of ISTT on a net present-value basis.

ISTT and ISSM have significantly greater costs than EISB due to their need to use significant groundwater treatment equipment (thermal) or heavy construction equipment, with work being performed in a high level of personal protective equipment in a ventilated tent (soil mixing). The pre-design and performance monitoring components of these two alternatives are comparable.

7.8 STATE ACCEPTANCE

State involvement has been solicited throughout the CERCLA and remedy selection process. TDEC supports the preferred alternative, and its final concurrence will be solicited following review of all comments received during the public comment period.

7.9 COMMUNITY ACCEPTANCE

Community acceptance will be evaluated after the public comment period for this Proposed Plan.

8 SUMMARY OF PREFERRED ALTERNATIVE

8.1 IDENTIFY THE PREFERRED ALTERNATIVE

The preferred alternative for the MPA IROD is active remediation using EISB at six CVOC groundwater plumes.

The preferred alternative includes continuation of LUCs that are currently in place at ETTP as part of the selected remedy.

The preferred alternative is based on current information and could change in response to public comment or new information.

8.2 DESCRIBE THE PREFERRED ALTERNATIVE

Table 8.1 summarizes the preferred alternative for the MPA IROD.

Table 8.1. Summary of preferred alternative

Site	Primary COCs	Initial treatment area (ft^2)	Selected technology[a]	Cost		
				Capital (M$)	5-Year O&M (M$)	Total (M$)
Mitchell Branch Comingled Plume/K-1407-B	CVOC	69,260	EISB	$5.9	$5.5	$11.4
K-1401	CVOC	23,522	EISB	$2.0	$1.9	$3.9
K-25/K-1024	TCE	33,106	EISB	$2.8	$2.6	$5.4
K-1035	CVOC	6098	EISB	$0.52	$0.48	$1.0
K-27/K-1232	TCE	59,677	EISB	$5.1	$4.7	$9.8
K-1239	CVOC	7405	EISB	$0.63	$0.59	$1.2
			TOTAL	**$16.95**	**$15.8**	**$32.7**

[a]Common components to all actions are pre-design investigations, performance monitoring, land use controls, and Five-Year Reviews.

COC = contaminant of concern
CVOC = chlorinated volatile organic compound
EISB = enhanced in situ bioremediation
M$ = millions of dollars
O&M = operation and maintenance
TCE = trichloroethene

The proposed preferred alternative is implementation of EISB to meet the interim goal to "remove contaminant mass (EPA, 1990)" in selected groundwater source areas. EISB refers to remediation systems that are designed to remediate chlorinated solvents by input of an organic source, nutrients, electron acceptors, and/or microbial cultures into a plume to stimulate degradation of the contamination. The precise delivery system for the inputs will be described in the RDR/RAWP. EISB is proposed at the following sites:

- Mitchell Branch Comingled Plume/K-1407-B
- K-1401
- K-25/K-1024
- K-1035
- K-27/K-1232
- K-1239

If successful, EISB likely will be considered for additional CVOC remedial actions in the MPA.

Additional data are required to complete the final design and implement the selected remedy. These data will be collected as part of a PDI outlined in the RDWP. The PDI will be designed to address and manage uncertainties and challenges with the selected remedy. This investigation primarily will consist of installing groundwater wells and piezometers in the unconsolidated and bedrock zones to better characterize the nature and extent of the target CVOC concentrations greater than 1000 µg/L (and VC greater than 400 µg/L) to design the injection network.

Once design is complete, permanent injection wells will be constructed to treat groundwater within the unconsolidated and bedrock zones. Figure 8.1 exemplifies how the injection wells would be configured at an example groundwater plume (K-1401). The unconsolidated wells will be clustered with two separate screen intervals—one in the overburden and one in the weathered bedrock. The EISB injection wells would distribute a carbon substrate to the area. The substrate used for injections is assumed to be commercially available emulsified vegetable oil (EVO). Other substrates could also be used (e.g., EVO with ZVI), and/or the EVO might be amended with other organics (e.g., lactate) plus buffers and bioaugmentation cultures. Sampling and analysis of geochemical and microbial parameters will be performed as part of the PDI to help assess the need for other amendments. The effectiveness of substrate delivery is a key variable in the effectiveness of this alternative. PDI testing (e.g., tracer testing or other strategies) will help identify injection wells placement to optimize substrate distribution and monitoring of the remedy.

Operation and maintenance activities associated with this alternative include initial injections, groundwater monitoring, and potential follow-up injections. Additional optimizations of the injections may be carried out based on monitoring data. These optimizations would be designed to target uncertainties and challenges with delivery and could include additional injections, optimizing the substrate mixture, and possibly recirculating

groundwater to optimize delivery to more challenging locations within the formation. For cost-estimating purposes, a second round of injections is assumed to occur at year 2 and be followed by a 3-year period of post-injection monitoring. Injection well fouling may require routine well maintenance and rehabilitation prior to each injection.

For this interim action, remedies are assumed to be implemented and evaluated for 5 years, a time period considered appropriate for determining if IRAOs can be achieved in a reasonable period of time.

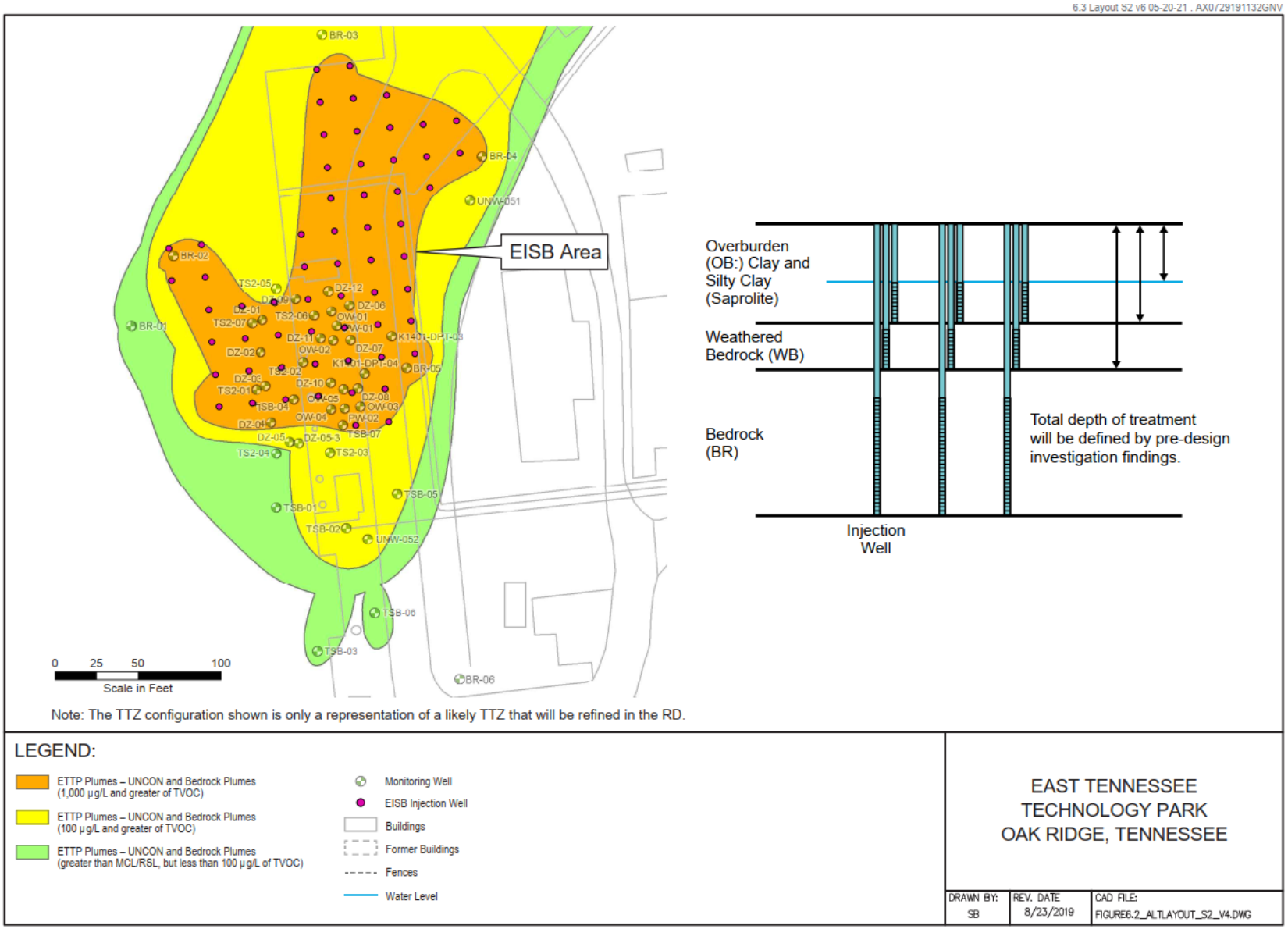

Figure 8.1. Injection wells example.

8.3 STATUTORY DETERMINATION

Based on information currently available, DOE, as the lead agency, believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying CERCLA criteria. DOE expects the preferred alternative to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment, (2) comply with ARARs (or justify a waiver), (3) be cost-effective, (4) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element (or justify not meeting the preference). Should DOE encounter principal threat source material during the pre-design phase, treatment would be applied to the principal waste to the extent practicable.

9 NATURAL RESOURCE DAMAGES

Hazardous substances above health-based levels will remain onsite if this remedy is implemented. Because hazardous substances will remain, DOE, TDEC, and EPA recognize Natural Resource Damage claims, in accordance with CERCLA, may be applicable. This Proposed Plan does not address restoration or rehabilitation of any natural resource injuries that may have occurred, or whether any such injuries have occurred. Neither DOE nor TDEC waives any rights or defenses they may have under CERCLA Section 107(1)4(c).

10 COMMITMENT TO LONG-TERM STEWARDSHIP

Areas within the MPA at ETTP cannot support unrestricted use due to hazardous substances remaining in place after the selected remedy is implemented. Land use restrictions limiting the use and/or exposure to those areas of the property, including water resources, that are contaminated are required as part of earlier CERCLA actions at ETTP. DOE is committed to implementing and maintaining LUCs, including ICs, to ensure the selected interim remedy remains protective of human health and the environment.

DOE, EPA, and TDEC have agreed upon a LUC Assurance Plan (LUCAP) for the ORR to help ensure ongoing effectiveness of LUCs imposed in remedial actions to protect human health and the environment from remaining contamination. The LUCAP establishes regular inspection and reporting procedures designed to ensure each required LUC is properly implemented and maintained for as long as it is needed and it continues to provide the expected level of protection. Any LUCs relied upon as part of the IROD for the ETTP MPA groundwater remedial action will be implemented in accordance with the existing LUCIP and the ORR LUCAP agreement.

11 COMMUNITY PARTICIPATION

DOE, EPA, and TDEC encourage the public to review this document and other relevant documents in the Administrative Record to gain an understanding of the ETTP MPA and the proposed interim remedial action. A copy of this Proposed Plan, as well as the entire Administrative Record, is located at the DOE Information Center, at the Office of Scientific and Technical Information, 1 Science.gov Way, Oak Ridge, Tennessee, 37830. The center is open Monday through Friday, 8 a.m. to 5 p.m.; the telephone number is (865) 241-4780.

DOE will establish a 45-day public comment period and schedule a public meeting to discuss cleanup alternatives and address any questions or concerns from the public. The public meeting will be held at the DOE Information Center (see the previous paragraph for the address).

The public comment period will begin upon regulatory approval of the Proposed Plan, and the dates will be specified in DOE's public notice announcing the availability of the Proposed Plan and the dates for the public comment period. The announcement will include details regarding the public meeting.

DOE also encourages the public to submit comments on the proposed cleanup alternatives. Comments may be provided at the public meeting or via email to OakRidgeEM@orem.doe.gov. Written comments may be addressed to the FFA Project Manager, Oak Ridge Environmental Management, DOE Oak Ridge Operations, Post Office Box 2001, Oak Ridge, Tennessee, 37831. Extensions to the comment period will be granted if requested via email to OakRidgeEM@orem.doe.gov or via written correspondence to the physical address provided above.

DOE will document and respond to comments as part of the ROD that will be issued after the public comment period.

12 REFERENCES

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42 U.S.C. Section 9601, et seq. *Superfund Amendments and Reauthorization Act of 1986*, 1986, U.S. Environmental Protection Agency, Washington, D.C.

Alexander et al. 2003. Pilot Study for In Situ Reductive Dechlorination of a Solvent Plume in Karst Bedrock. A-61, in: R.R. Sirabian and R. Darlington (Chairs), *Bioremediation and Sustainable Environmental Technologies—2013*, Second International Symposium on Bioremediation and Sustainable Environmental Technologies (Jacksonville, FL; June 10–13, 2013). ISBN 978-0-9819730-7-4, Battelle Memorial Institute, Columbus, OH.

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GLOSSARY

Applicable or relevant and appropriate requirement – Those cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal or more stringent state environmental or facility siting laws that are either legally applicable or relevant and appropriate to the hazardous substances, pollutant, contaminant, remedial action, location, or other circumstance found at the CERCLA site.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) – The federal law that establishes, among other requirements, a program for parties (including federal agencies) to identify, investigate, and, if determined necessary, remediate inactive site/facilities contaminated with a hazardous substance, pollutant, or contaminant. It is also known as the Superfund law.

Focused feasibility study – The step in the CERCLA process in which alternatives for interim remediation of a contaminated site or of other remediation decisions are developed and evaluated.

National Environmental Policy Act of 1969 (NEPA) – A federal law that requires federal agencies to consider and evaluate environmental impacts associated with any significant proposed actions or activities. For CERCLA actions undertaken by the U.S. Department of Energy, any impacts to NEPA values associated with the proposed action are considered along with other factors required to be evaluated.

Proposed Plan – The formal document in which the lead agency identifies its preferred alternative for remedial action, explains why this alternative was preferred, and solicits comments from the public.

Interim Record of Decision – The formal document in which the lead agency sets forth the selected interim remedial action and the reasons for its selection.

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CMP	Comprehensive Monitoring Plan
CVOC	chlorinated volatile organic compound
DNAPL	dense, non-aqueous-phase liquid
DOE	U.S. Department of Energy
EISB	enhanced in situ bioremediation
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FFS	focused feasibility study
FS	feasibility study
FYR	Five-Year Review
HEU	highly enriched uranium
HI	hazard index
IC	institutional control
IRAO	interim remedial action objective
IROD	Interim Record of Decision
ISSM	in situ soil mixing
ISTT	in situ thermal treatment
LEU	low enriched uranium
LUC	land use control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
MCL	maximum contaminant level
MPA	Main Plant Area
NEPA	National Environmental Policy Act of 1969
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PDI	pre-design investigation
RAO	remedial action objective
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RDR	Remedial Design Report
RDWP	Remedial Design Work Plan
RIWP	Remedial Investigation Work Plan
ROD	Record of Decision
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
VC	vinyl chloride
Y-12	Y-12 National Security Complex
ZVI	zero valent iron

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PROPOSED PLAN FOR AN INTERIM RECORD OF DECISION FOR GROUNDWATER IN THE MAIN PLANT AREA AT THE EAST TENNESSEE TECHNOLOGY PARK, OAK RIDGE, TENNESSEE
PUBLIC COMMENT SHEET

The U.S. Department of Energy (DOE) is interested in your comments on the alternatives being considered in the *Proposed Plan for an Interim Record of Decision for Groundwater in the Main Plant Area at the East Tennessee Technology Park, Oak Ridge, Tennessee,* including the preferred alternative. The mailing address is preprinted on the back of this form. You may use this form to submit your comments. We must receive your comments on or before the close of the public comment period. If you have questions, please contact Mr. Roger Petrie, FFA Project Manager; Oak Ridge Environmental Management; DOE Oak Ridge Operations; P.O. Box 2001, Oak Ridge, TN 37831; (865) 316-4063.

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Name: _____

Address: _____

City: _____ State/Zip: _____

Phone: _____

MAILING LIST ADDITIONS:

Please add my name to the Environmental Management Program mailing list to receive additional information on the progress at the Oak Ridge Reservation: ☐ Yes ☐ No

Place stamp here

Mr. Roger Petrie, FFA Project Manager
Oak Ridge Environmental Management
DOE Oak Ridge Operations
P.O. Box 2001
Oak Ridge, TN 37831

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