DOE/OR/01-2585
FINAL

Implementation of Mitigation Action Plan for Parcel ED-1 on the Oak Ridge Reservation Oak Ridge, Tennessee

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12-031(E)/051613

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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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Implementation of Mitigation Action Plan for Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee

Date Issued—May 2013

Prepared by
Science Applications International Corporation
Oak Ridge, Tennessee
under subcontract 30492-BA-RR011
under work release 0014

Prepared for the
U.S. Department of Energy
Reservation Management Branch

12-031(E)/051613

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ACRONYMS

BCK	Bear Creek kilometer
BMAP	Biological Monitoring and Abatement Program
BMP	best management practice
BORCE	Black Oak Ridge Conservation Easement
CROET	Community Reuse Organization of East Tennessee
DA	Development Area
DBK	Dace Branch kilometer
DOE	U.S. Department of Energy
EFK	East Fork kilometer
EFPC	East Fork Poplar Creek
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera and Trichoptera
IDB	Industrial Development Board
LEFPC	Lower East Fork Poplar Creek
MAP	Mitigation Action Plan
MIK	Mitchell Branch kilometer
NA	Natural Area
ND	no data available
NGO	non-governmental organization
NL	not listed
OREIS	Oak Ridge Environmental Information System
ORR	Oak Ridge Reservation
ORUD	Oak Ridge Utility District
PIF	Partners in Flight
ROW	right-of-way
S-CE	special concern species due to commercial exploitation
SR	State Route
T	threatened
T&E	threatened and endangered
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
TPGF	Tennessee Parks and Greenways Foundation
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
WRS	Wilcoxon Rank-Sum
Y-12 Complex	Y-12 National Security Complex

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EXECUTIVE SUMMARY

Parcel ED-1 is an approximately 1000-acre parcel of land located in the western portion of the Oak Ridge Reservation (ORR). In 1996, the U.S. Department of Energy (DOE) leased Parcel ED-1 to the Community Reuse Organization of East Tennessee (CROET) [*Environmental Assessment – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*, DOE/EA-1113 (DOE 1996a)]. In 2003, the DOE transferred ownership of approximately 490 acres of Parcel ED-1 to CROET for development of an industrial/business park now known as the Horizon Center [*Environmental Assessment Addendum for the Proposed Transfer of Parcel ED-1*, DOE/EA-1113-A (DOE 2003a)]. The remaining portion of the parcel (510 acres), referred to as the Parcel ED-1 Natural Area (NA), was retained as DOE property. From 1996 to 2003, CROET leased all of Parcel ED-1, including the NA, from DOE. Following the transfer of Horizon Center in 2003, CROET continued to lease the NA until 2011. CROET transferred title of Horizon Center to the Oak Ridge Industrial Development Board (IDB) in 2010.

The *Mitigation Action Plan – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council* (MAP), DOE/EA-1113 (DOE 1996b), prescribed measures to be implemented to mitigate potentially significant adverse impacts from industrial development on Parcel ED-1. The 1996 MAP specified that mitigation would be accomplished by: (1) excluding areas on Parcel ED-1 from disturbance and development, and (2) conducting surveys and monitoring of industrial development areas prior to disturbance (predevelopment) and during industrial operations (post-development). The objectives of these measures included: (1) protection of wildlife habitat, plant communities, threatened and endangered (T&E) species, water resources, wetlands, and historical and archaeological resources; (2) maintenance of habitat connections to reduce the ecological effects of fragmentation; (3) pre- and post-construction assessment of natural succession and impacts of development by collection of data during monitoring of natural communities and populations; and (4) identification of additional mitigation, as needed, to remediate the actual effects of development.

Following the transfer of title to CROET in 2003, the objectives of the 1996 MAP were reaffirmed and restated in the revised MAP as "...to detect and characterize changes from the baseline (pre-development) conditions" [*Mitigation Action Plan for the Protection of the Natural Area on Parcel ED-1*, DOE/EA-1113-A (DOE 2003b)]. The revised 2003 MAP covers the transfer of Parcel ED-1 to CROET and specifies monitoring of birds, benthic invertebrates, and fish to evaluate changes from the pre-development conditions, potentially associated with development of the site as an industrial park (DOE 2003b).

The primary mitigative action identified in the original 1996 MAP, and reaffirmed in the 2003 MAP, was to "exclude areas on Parcel ED-1 from disturbance and development." The establishment of the Parcel ED-1 NA was the principal mitigative action that fulfilled this first goal of the original MAP. The MAP identified 510 acres that would be excluded from development, and the originally identified 510 acres have remained mostly undisturbed with the exception of 4 acres that were cleared for infrastructure improvements. Additionally, the total acreage of the NA has been increased by about 53 acres with the addition of Development Area 4, which CROET donated (via title transfer) to Tennessee Parks and Greenways Foundation in 2010 for perpetual conservation. Therefore, the purpose of the MAP to exclude the NA from development has been achieved and enhanced.

The second identified purpose of the MAP was to "conduct surveys and monitoring of industrial development areas prior to disturbance (predevelopment) and during industrial operations (post-development)." This monitoring was conducted primarily to ensure that the NA remained undeveloped and to evaluate if excluding this area from development was sufficient to protect the

resources found within it. To achieve this second stated purpose of the MAP, intensive ecological monitoring was conducted for the periods of 1997 to 2000 and 2002 to 2004. Regular ecological monitoring ceased in 2004, but limited ecological monitoring was conducted after 2004 at Parcel ED-1. Partners in Flight (a partnership of state, local non-governmental organizations, and individuals) has conducted annual bird surveys in late May or June along the original Periphery route since 1996 (except for 2004 and 2007). In 2008, DOE conducted a stream-habitat characterization of East Fork Poplar Creek (EFPC) and a herpetofaunal assessment in the EFPC floodplain. In 2012, DOE conducted additional ecological monitoring including habitat surveys of wetlands, rare plant locations, and other sensitive ecological resources previously documented at Parcel ED-1. Therefore, this purpose of the MAP has also been fulfilled.

The original mitigations identified in the MAP have been demonstrated to be effective. Over 500 acres of NA have been excluded from development and protected from encroachment. Monitoring activities over 16 years have shown that the sensitive resources within the NA have been protected, including state-listed T&E plants, and that monitored plant and animal populations are stable. Implementation of best management practices during construction activities (e.g., silt fences) has largely been effective at preventing sedimentation/siltation of surface water due to erosion. Fragmentation impacts appear to have been minimized, and no need for additional mitigation has been identified. With the goals of the MAP successfully achieved over a long duration, additional ecological monitoring is not warranted for the future, and therefore DOE plans to discontinue ecological monitoring of the NA. The NA will continue to be managed by DOE, or a conservation agency, to ensure that the resources continue to be protected.

1. INTRODUCTION

Parcel ED-1 is an approximately 1000-acre parcel of land located in the western portion of the Oak Ridge Reservation (ORR) [Fig. 1]. In 1996, the U.S. Department of Energy (DOE) leased Parcel ED-1 to the Community Reuse Organization of East Tennessee (CROET) [*Environmental Assessment – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*, DOE/EA-1113 (DOE 1996a)]. In 2003, the DOE transferred ownership of approximately 490 acres of Parcel ED-1 to CROET for development of an industrial/business park now known as the Horizon Center (*Environmental Assessment Addendum for the Proposed Transfer of Parcel ED-1*, DOE/EA-1113-A (DOE 2003a)]. The remaining portion of the parcel, referred to as the Parcel ED-1 Natural Area (NA), was retained as DOE property. From 1996 to 2003, CROET leased all of Parcel ED-1, including the NA, from DOE. Following the transfer of Horizon Center in 2003, CROET continued to lease the NA until 2011. CROET transferred title of Horizon Center to the Oak Ridge Industrial Development Board (IDB) in 2011. DOE has since assumed full responsibility for management of the NA.

This report has multiple purposes, including:

- Assessing the effectiveness of mitigations identified in the 1996 Mitigation Action Plan (MAP) [*Mitigation Action Plan – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*, DOE/EA-1113 (DOE 1996b)] and 2003 MAP [*Mitigation Action Plan for the Protection of the Natural Area on Parcel ED-1*, DOE/EA-1113-A (DOE 2003b)].
- Analyzing and summarizing ecological data collected during the time frame between 1996 and 2012.
- Determining if mitigation goals are being met based on the ecological data evaluation.
- Reporting and evaluating the results of ecological monitoring conducted in 2012.
- Making recommendations regarding the appropriate path forward for stewardship of the NA and the need for future ecological monitoring at Parcel ED-1.

1.1 MITIGATION

The 1996 MAP (DOE 1996b) prescribed measures to be implemented to mitigate potentially significant adverse impacts from industrial development on Parcel ED-1. The MAP specified that mitigation would be accomplished by: (1) excluding areas on Parcel ED-1 from disturbance and development, and (2) conducting surveys and monitoring of industrial development areas prior to disturbance (pre-development) and during industrial operations (post-development). The objectives of these measures included: (1) protection of wildlife habitat, plant communities, threatened and endangered (T&E) species, water resources, wetlands, and historic and archaeological resources; (2) maintenance of habitat connections to reduce the ecological effects of fragmentation; (3) pre- and post-construction assessment of natural succession and impacts of development by collection of data during monitoring of natural communities and populations; and (4) identification of additional mitigation, as needed, to remediate the actual effects of development. For purposes of this report, the post-development phase includes discrete development activities (e.g., clearing vegetation, excavating for utilities, building roads, bridges, buildings, and other infrastructure, and ongoing industrial operations). The potential impacts of development identified in the MAP were habitat alteration or loss, disruptions to reproductive or migratory behaviors, and community changes following local extinctions or species invasions.

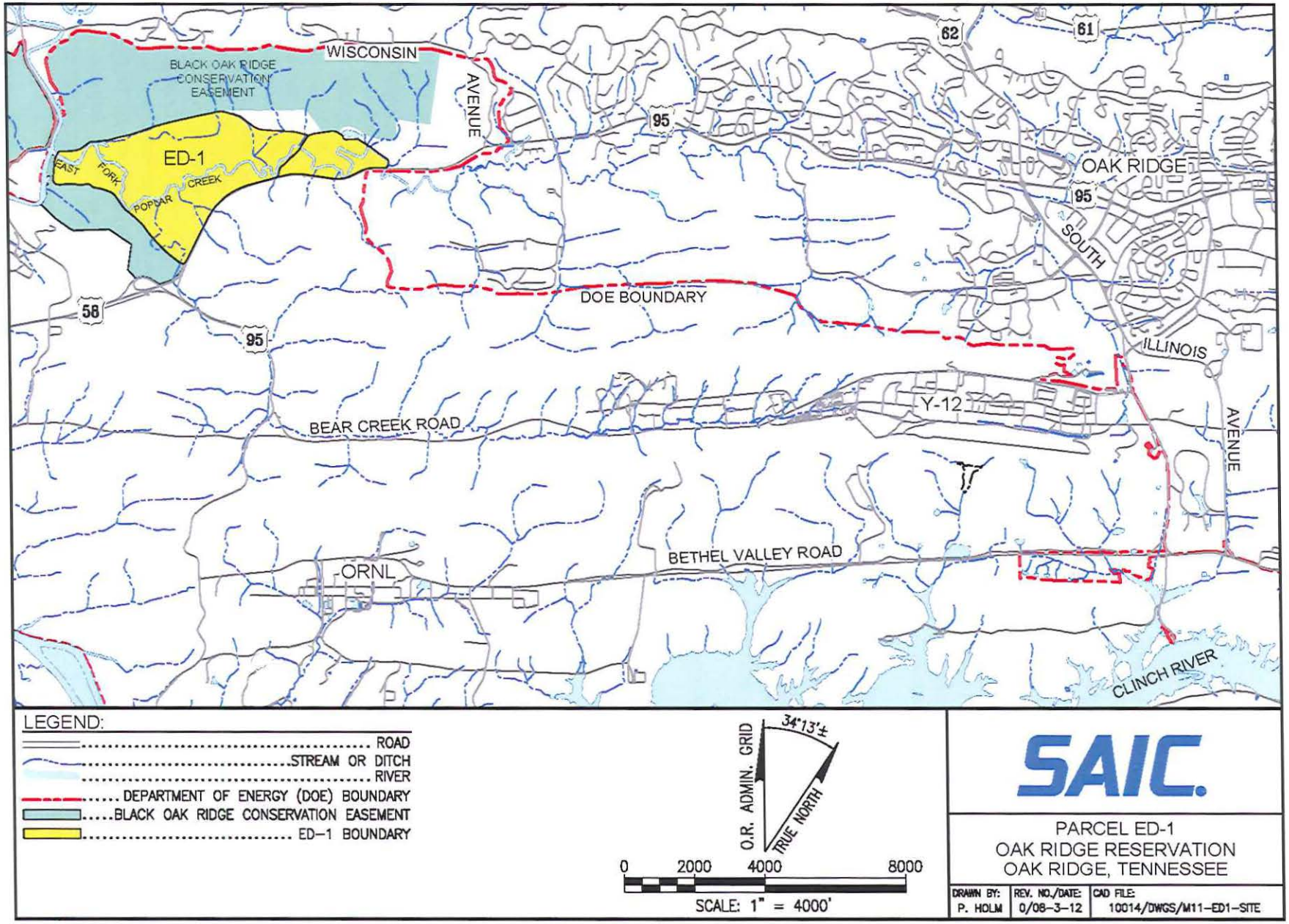

Fig. 1. Location of Parcel ED-1.

Following the transfer of title to CROET in 2003, the objectives of the 1996 MAP were reaffirmed and restated in the revised MAP as "...to detect and characterize changes from the baseline (pre-development) conditions". The 2003 MAP covers the transfer of Parcel ED-1 to CROET and specifies monitoring of birds, benthic invertebrates, and fish to evaluate changes from the pre-development conditions, potentially associated with development of the site as an industrial park (DOE 2003b).

1.2 MONITORING

Figure 2 presents a timeline showing various activities at or near Parcel ED-1 including environmental monitoring and development activities or site operations for the period from 1996 to 2012. Monitoring was initiated for birds, benthic invertebrates, and fish at Parcel ED-1 in 1996 to define their pre-development baseline conditions. Monitoring continued in 1997. During late 1998, development activities began on the parcel, and the initial clearing, road and bridge construction, and utility installations were complete by the end of 2000. Monitoring also continued during the first few years of the post-development period. The monitoring data were compiled by DOE in the following Annual Reports:

- *Annual Report – Implementation of Mitigation Action Plan for DOE/EA-1113: Lease of Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee, Pre-Development Ecological Surveys*, DOE/EA-1113/MAP-97 (DOE 1997);
- *Annual Report – Implementation of Mitigation Action Plan for DOE/EA-1113: Lease of Parcel ED-1 on the Oak Ridge Reservation Oak Ridge, Tennessee*, DOE/EA-1113/MAP-98 (DOE 1998)];
- *Annual Report – Implementation of Mitigation Action Plan for DOE/EA-1113: Lease of Parcel ED-1 of the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/EA-1113/MAP-99 (DOE 1999); and
- *Annual Report – Implementation of Mitigation Action Plan for Lease of Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/EA-1113/MAP-00 (DOE 2000).

No monitoring data per the 1996 MAP were collected at Parcel ED-1 in 2001. Per the requirements stated in the revised 2003 MAP, annual monitoring was resumed in 2002 and continued through 2004. CROET prepared annual reports for three years of monitoring:

- *Annual Report, Calendar Year 2002 – Implementation of Mitigation Action Plan for Lease of Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/EA-1113/MAP-02 (DOE 2003c);
- *Annual Report, Calendar Year 2003 – Implementation of Mitigation Action Plan for Lease of Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/EA-1113/MAP-03 (DOE 2004); and
- *Annual Report, Calendar Year 2004 – Implementation of Mitigation Action Plan for Lease of Parcel ED-1 on the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/EA-1113/MAP-04 (DOE 2005a).

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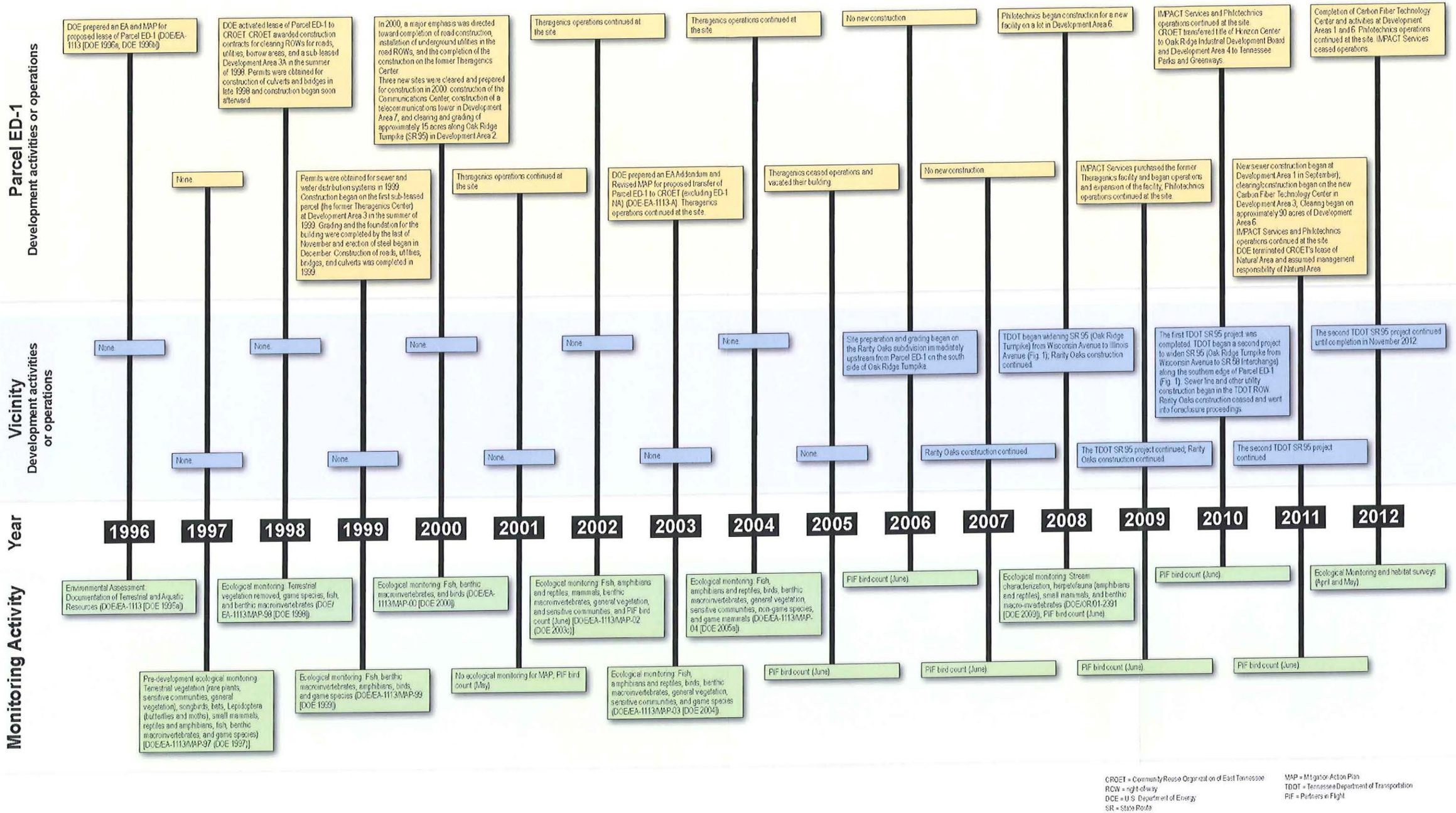

Fig. 2. Development activities or operations and environmental monitoring at or near Parcel ED-1 (1996–2012).

A summary report, including the most recent data collected after preparation of the revised MAP, was published in 2009:

- *Ecological Sampling at Parcel ED-1 (Horizon Center) Oak Ridge, Tennessee – 2008 Stream Characterization and Herpetofaunal Assessment*, DOE/OR/01-2391 (DOE 2009).

In April and May 2012, DOE conducted additional monitoring at Parcel ED-1 specifically to document the condition of existing sensitive resources at the site and to evaluate possible effects to these resources from recent construction activities at Horizon Center and from other projects in the vicinity but not on Horizon Center.

2. SITE ACTIVITIES

Site activities at Parcel ED-1 between 2001 and 2012 include construction and maintenance of infrastructure (roads and utilities) and various buildings, land-clearing and grading, and ongoing operations at the facilities of Horizon Center tenants. There have also been other external activities initiated by entities other than DOE, CROET, and the Oak Ridge IDB that have occurred close enough to affect resources at Parcel ED-1 (e.g., two road construction projects on State Route [SR] 95 initiated by Tennessee Department of Transportation (TDOT) and private commercial development).

2.1 CONSTRUCTION

Development activities at Horizon Center have continued intermittently between 2001 and 2012 (see Fig. 2). Current activities include:

- construction of a new building for the Carbon Fiber Technology Facility, a manufacturing pilot plant in Development Area (DA) 3B;
- clearing approximately 90 acres at Development Area 6 (DA 6), one of the undeveloped areas along the northwestern boundary of the site; and
- construction of a new sewer line and other utilities in Development Area 1 (DA 1).

Since 2006, there have been various construction projects unrelated to activities at Parcel ED-1 that had potential to encroach on the NA and contribute to water quality and habitat degradation in East Fork Poplar Creek (EFPC) and/or its tributaries, or otherwise affect sensitive natural resources in the NA (Fig. 2). Several of these projects had the potential to generate discharges of significant amounts of sediment that would potentially impact habitat for aquatic resources. To date only development activities at Rarity Oaks have resulted in Notices of Violation for water quality issues (see Sect. 2.1.2). These projects include:

- Widening Oak Ridge Turnpike (SR 95) from Illinois Avenue to Wisconsin Avenue, TDOT, May 2008 to August 2010 (Fig. 1);
- Widening Oak Ridge Turnpike from Wisconsin Avenue to SR 58/95 Interchange, TDOT, January 2010 to November 2012) [Fig. 1]; and
- Rarity Oaks, Private Commercial Development, 2006 to present.

2.1.1 Parcel ED-1 Activities

Parcel ED-1 activities include past and ongoing activities initiated by CROET, the IDB, and various tenants of Horizon Center. These activities include past and present road and utility construction, building construction, land-clearing, and routine maintenance of the infrastructure at Horizon Center. Figure 2 summarizes construction, maintenance activities, and operations at Parcel ED-1 from 1998 to present. The following discussion summarizes conditions that were observed during monitoring activities at each development area conducted in April and May 2012.

2.1.1.1 Development Area 1

Development activities at DA 1 have been limited to vegetation clearing and installation of a new transformer pad and sewer lift station. There is no evidence that these activities have caused any sediment releases to EFPC. New silt fences were in place around the construction area and in good condition during the survey. Silt fences were removed after the disturbed area around the new transformer pad and lift station was reseeded and mulched.

Approximately 30% of the vegetation was cleared several years ago at DA 1; clearing has not encroached on the ED-1 NA (Fig. 3). Vegetation planted in the cleared area consists mostly of tall fescue; the planted vegetation fully occupies the site and there are no signs of erosion. The remainder of the site is predominately occupied with a dense, second-growth loblolly pine forest that naturally revegetated following the pine beetle outbreaks of the 1990s. Future development plans at DA 1 include construction of an office facility by Remediation Services, Inc.

2.1.1.2 Development Area 2

Development activities at DA 2 have been limited to vegetation clearing, construction of a 1500-ft road into the site parallel to the northern boundary, and a sculpture area. Approximately 750 ft of the road is paved and curbed; the remainder is unimproved. There is no evidence that the activities caused any sediment releases to EFPC. Silt fences were installed and all are in good condition.

Vegetation clearing has occurred on about 90% of the site and has not encroached on the ED-1 NA (Fig. 3). Vegetation planted in the cleared area consists mostly of tall fescue; the planted vegetation fully occupies the site and there are no signs of erosion. The remainder of the site is predominately occupied with a dense, second-growth loblolly pine forest that naturally revegetated following the pine beetle outbreaks of the 1990s.

2.1.1.3 Development Area 3

Past development activities at DA 3 include the construction of Palladium Way and the Impact Services building (formerly occupied by Theragenics). New development includes construction of the Carbon Fiber Technology Center and additional vegetation clearing. There is no evidence that these new activities have caused any sediment releases to Dace Branch, Bear Creek, or EFPC.

Vegetation clearing has occurred on about 75% of the site and has not encroached on the ED-1 NA (Fig. 3). Vegetation in the cleared area fully occupies the site and there are relatively few signs of erosion. Eroded areas at the site are small and should not require any further action.

Extraordinarily heavy storms in early spring 1999 breached the silt fences adjacent to Dace Branch near the Impact Services building (DOE 2000). These fences were replaced as soon as weather conditions permitted on-site activities. However, Dace Branch received higher than normal sediment loads during a short period in early spring 1999. Diligent monitoring of silt abatement structures and proactive maintenance prevented further breaches in 2000.

2.1.1.4 Development Area 4

No development has occurred at DA 4 and on November 17, 2010, CROET formally donated DA 4 (approximately 53 acres) to the Tennessee Parks and Greenways Foundation (TPGF) for perpetual conservation (Fig. 3). This land is now managed by the Tennessee Wildlife Resources Agency (TWRA), which also manages the Black Oak Ridge Conservation Easement (BORCE).

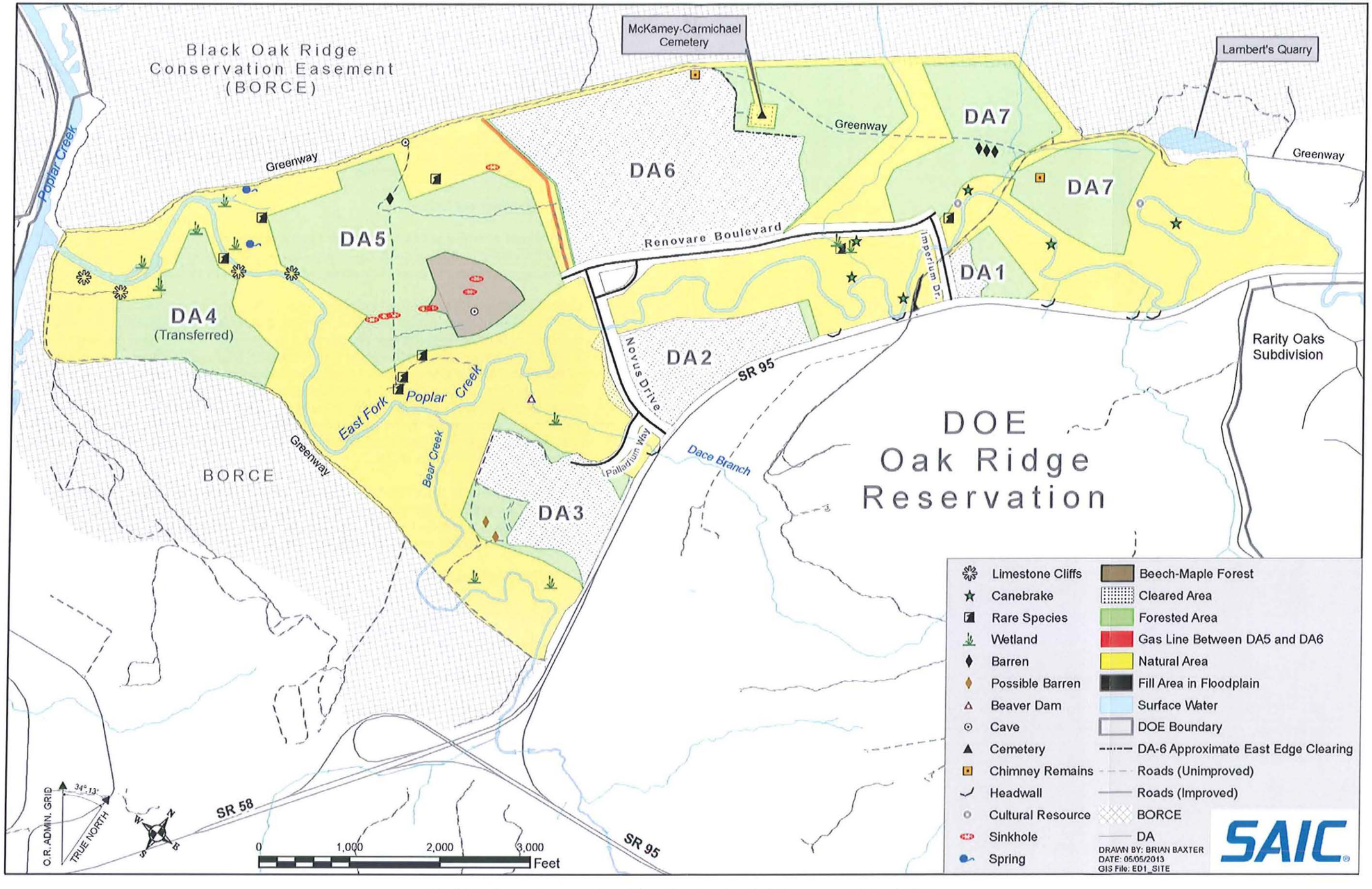

Fig. 3. Development areas and sensitive cultural and ecological resources at Parcel ED-1.

2.1.1.5 Development Area 5

Development activities at DA 5, to date, have been limited to clearing a short section of right-of-way (ROW) for an extension of Renovare Boulevard (Fig. 3). About 550 ft of paved road was constructed and an additional 300 ft of ROW cleared.

Since previous development activities have been extremely limited, surveys at DA 5 were limited to confirming known locations of rare species or sensitive habitats/resources previously mapped on the site (see Sect. 3.6, "Sensitive Communities").

2.1.1.6 Development Area 6

Development activities at DA 6 have been limited to construction of a soil borrow area, construction of the Philotechnics facility on a 4.5-acre sub-parcel, and vegetation clearing on approximately 90 acres of the site (approximately 15 acres of this area had been cleared in 1998 to use as a soil borrow area).

Vegetation clearing has occurred on about 70% of the site and has not encroached on the ED-1 NA (Fig. 3). Clearing consisted of completely removing existing forest vegetation (including stumps) from the southern portion of the site (see Photograph 1 in Appendix A). The northern portion remains forested. There is no evidence that past or current activities at DA 6 have caused any sediment releases to EFPC or its tributaries. All silt fences installed along the northern boundary were in place and in good condition. Silt fences along the southern boundary had been removed; riprap sediment dams remain in place on topographic drainages along the southern boundary. Future activities at DA 6 include construction of a transmission line corridor for a proposed 69-kilovolt transmission line from the Oak Ridge Electric Department substation on Blair Road to Horizon Center. The route would follow the greenway adjacent to the southern boundary of the BORCE.

Vegetation planted in the cleared area consists mostly of grass that was planted across the site after clearing was completed. The planted vegetation is beginning to occupy the site and there are no signs of off-site erosion. The remainder of the site is predominately occupied with a dense, second-growth loblolly pine forest that naturally revegetated following the pine beetle outbreaks of the 1990s.

2.1.1.7 Development Area 7

Development activities at DA 7 have been limited, to date, to the construction of a communications tower in 2000 (Fig. 3). As a result, surveys at DA 7 were limited to confirming known locations of rare species or sensitive habitats/resources previously mapped on the site (see Sect. 3.6, "Sensitive Communities").

2.1.2 Vicinity Activities

Activities in the vicinity of Parcel ED-1 include two recent road construction projects associated with the widening of SR 95 (Oak Ridge Turnpike) and construction at the Rarity Oaks subdivision (see Fig. 2). The first TDOT project entailed widening SR 95 (Oak Ridge Turnpike from Wisconsin Avenue to Illinois Avenue) and the second entailed widening SR 95 from Wisconsin Avenue to the SR 95/58 interchange (see Fig. 1).

2.1.2.1 State Route 95 (Oak Ridge Turnpike)

The first TDOT project (widening SR 95 from Wisconsin Avenue to Illinois Avenue) began in May 2008 and was completed in August 2010 (see Fig. 1). The southern terminus of the project is within one mile of Parcel ED-1. There are no known Notices of Violation or releases of sediment or other pollutants to

EFPC. It is unlikely that this project had any adverse effects on water quality in EFPC that would affect water quality or other resources at Parcel ED-1.

The second TDOT project (widening SR 95 from Wisconsin Avenue to the SR 95/58 interchange) began in January 2010 and was completed in November 2012 (see Fig. 1). In general, TDOT ROW clearing and grading did not directly affect the ED-1 NA. The vegetation clearing and excavation for widening SR 95 was confined to TDOT ROW and did not encroach on the NA (see Photograph 2 in Appendix A).

One exception to this occurred along an old, abandoned road within the NA west of the intersection of SR 95 with Imperium Drive where a TDOT contractor filled a large portion of the old roadbed with excess rock, rubble (concrete and asphalt), and excavated soil (Fig. 4; see also Photographs 3 and 4 in Appendix A). The filled area extends approximately 400 ft long. The height of the filled area averages about 7 ft deep. The fill is about 26 ft across. The volume of the filled area is approximately 2700 yd^3. The filled area along the old roadbed also encroaches on the floodplain of EFPC. The filled area (0.4 acres) effectively dikes off about 0.3 acres of the 100-year floodplain from the creek (0.4 acres of the 500-year floodplain). After discussing the situation with TDOT and the Tennessee Department of Environment and Conservation (TDEC), DOE decided that the fill could remain in place without serious impacts to the NA or floodplain functions.

There have been minor sediment releases at four of the outfalls associated with tributaries flowing across the SR 95 ROW (Dace Branch, and three tributaries) and other major drainage ditches associated with highway drainage (see Photograph 5 in Appendix A). These releases appear to have introduced small amounts of silt and/or gravel into the downstream reaches; at least one of these releases appears to have reached EFPC. These releases are minor and are not likely to have any lasting effects on EFPC water quality.

2.1.2.2 Rarity Oaks Subdivision

Rarity Oaks subdivision is located directly across SR 95 from the eastern end of Parcel ED-1 (see Fig. 1). Construction associated with Rarity Oaks subdivision began in 2006. Most of the construction activity included limited site clearing and installation of infrastructure (a bridge across EFPC and a road system).

Development activities at Rarity Oaks were the subject of enforcement actions by TDEC since 2006 (TDEC 2007). TDEC documented several instances of stormwater and sediment control violations that adversely affected EFPC and Pin Hook Branch, a tributary, and could have contributed to water quality degradation at Parcel ED-1. TDEC required the respondents to remove accumulated sediment from the streams and restore an excavated section of an unnamed, spring-fed tributary. Rarity Oaks went into foreclosure proceedings in 2010 and no further construction has occurred at the site.

Survey work for the MAP included only limited investigation at Rarity Oaks. The area around the bridge across EFPC at the eastern entrance to the subdivision is now stable with a narrow riparian zone vegetated with trees and shrubs. The roads into the subdivision are gated and posted against trespassing. No construction activities have occurred since foreclosure proceedings in 2010 so no further attempt was made to gain access to the site.

2.1.3 Other Vicinity Influences

Other vicinity influences that have affected and continue to affect water quality in EFPC are historic and ongoing mercury releases from the Y-12 Nuclear Security Complex (Y-12 Complex) and leakage and wastewater discharges from the Oak Ridge sanitary sewer system.

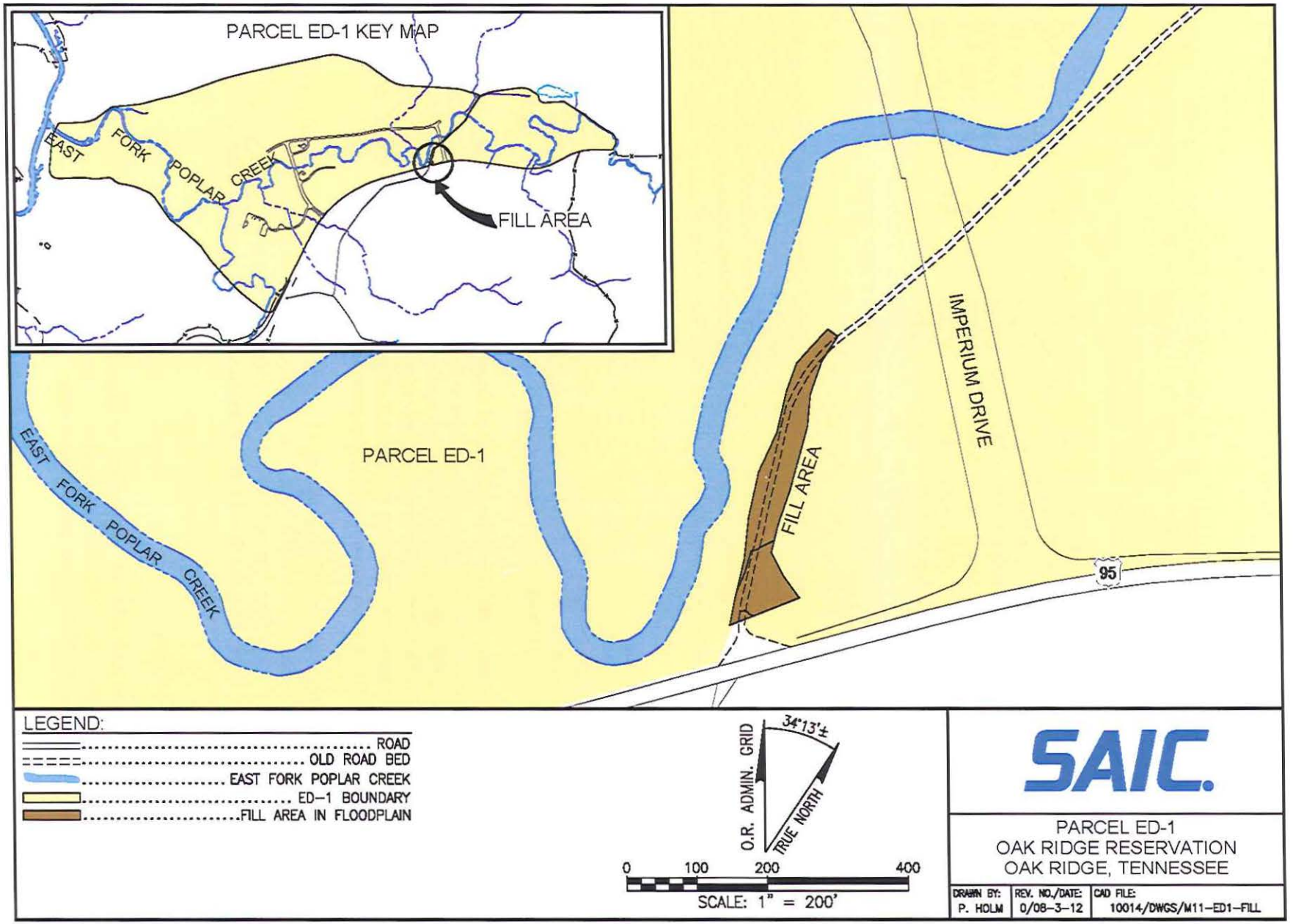

Fig. 4. TDOT fill area at Parcel ED-1.

2.1.3.1 Y-12 National Security Complex

During the Cold War mercury was used extensively at the Y-12 Complex for nuclear weapons production. Numerous spills over the years resulted in discharge of large quantities of mercury into EFPC. Mercury use ceased at the Y-12 Complex many years ago, but there is still residual mercury contamination in soils around former process buildings at the EFPC headwaters at Y-12 and in the EFPC floodplain. The *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee*, DOE/OR/02-1370&D2 (DOE 1995), specified certain removal actions to excavate mercury-contaminated soils from discrete locations in the EFPC floodplain. The Record of Decision also specified continued monitoring requirements to track the status of mercury in the Lower East Fork Poplar Creek (LEFPC) system. The *2012 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee: Data and Evaluations*, DOE/OR/01-2544&D1 (DOE 2012), summarizes the current status of conditions in LEFPC. In 2011, a total of about 43.2 kg of mercury was released from the Y-12 Complex into LEFPC and levels of mercury in fish tissue have remained elevated throughout the stream.

2.1.3.2 Oak Ridge Sanitary Sewer System

For many years the Oak Ridge sanitary sewer system has been the source of wastewater discharges into EFPC during high-flow events. In September 2010, the city of Oak Ridge received an Administrative Order from the U.S. Environmental Protection Agency (EPA), which directed the city to undertake significant work activities, conduct numerous studies, and prepare numerous reports toward the elimination of overflows from the sanitary sewer system (EPA 2010). Since that time the city has implemented a focused program to identify sources and causes of wastewater discharges and has begun implementing specific measures to fix problem areas and eliminate future discharges. The Administrative Order specifies that the Oak Ridge sanitary sewer system be in compliance with the Order by September 28, 2015.

2.2 PUBLIC AND AGENCY INVOLVEMENT

Public and agency involvement at Parcel ED-1 over the last few years includes several non-governmental organizations (NGOs) and state agencies. NGOs include CROET, the Oak Ridge IDB, and TPGF. Public agencies include TDEC, TWRA, TDOT, and the city of Oak Ridge.

2.3 MITIGATION ACTIVITIES

The most substantial mitigative action at Parcel ED-1 was the establishment of the NA by DOE and CROET. This action served to avoid, minimize, reduce, and in many cases eliminate impacts to the sensitive resources found on the parcel. After CROET transferred Parcel ED-1 to the IDB in 2010, CROET continued to lease the NA until September 2011. After that DOE assumed full responsibility for the preservation and maintenance of the integrity of the NA, including the sensitive resources it contains.

Additional mitigative actions implemented by CROET and the IDB include recommendations in the Horizon Center Covenants, Conditions, and Restrictions for site tenants to use native plants for all revegetation of disturbed areas and landscaping of developed areas. These recommendations include plant species that are native to the Ridge and Valley Province and consistent with local community types (see the recommendation in the Horizon Center Covenants, Conditions, and Restrictions document). Lawn areas are also be kept to a minimum to the extent possible.

Other mitigative actions include the use of best management practices (BMPs) like those described in the *Tennessee Erosion and Sediment Control Handbook* (TDEC 2002) to help control erosion and sedimentation during land-disturbing activities. Examples of some of these BMPs include vegetative practices (e.g., buffer zones and temporary vegetation); structural practices (e.g., silt fences, diversions, sediment basins); or a combination of both. In addition to the proper design and installation, any BMPs must also be properly maintained in order to effectively reduce erosion and sedimentation. With the exception of a sediment release into Dace Branch in 1999 (see Sect. 2.1.1.3), implementation of BMPs during construction activities has been effective at preventing sedimentation/siltation of surface water due to erosion.

Thus far, the mitigative measures specified in the original and revised MAPs have been sufficient to protect the sensitive natural resources contained within the NA. TDEC has not issued any Notices of Violation for water quality problems at Parcel ED-1, and no additional mitigation activities have been required.

3. ECOLOGICAL MONITORING

The Parcel ED-1 MAP (DOE 1996b) prescribed pre- and post-development monitoring to assess "natural succession and impacts of development on natural communities and populations." These objectives of the MAP were reaffirmed and restated in the revised MAP as "...to detect and characterize changes from the baseline (pre-development) conditions" (DOE 2003b). For purposes of this report, the post-development phase includes discrete development activities (e.g., clearing vegetation, excavating for utilities, building roads, bridges, buildings and other infrastructure, and ongoing industrial operations). The potential impacts of development identified in the 1996 and 2003 MAPs were habitat alteration or loss, disruptions to reproductive or migratory behaviors, and community changes following local extinctions or species invasions.

Monitoring was initiated for birds, benthic invertebrates, and fish at ED-1 in 1996 to define their pre-development baseline conditions. Monitoring continued in 1997. During late 1998, development activities began, and the initial clearing, road and bridge construction, and utility installations were complete by the end of 2000. Monitoring also continued during the first few years of the post-development period. The monitoring data were compiled by DOE in Annual Reports (DOE 1997, DOE 1998, DOE 1999, and DOE 2000). No monitoring data were collected at ED-1 in 2000 and 2001, per the requirements stated in the revised 2003 MAP; monitoring was resumed in 2002 after the property was transferred to CROET and continued through 2004. CROET prepared annual reports for three years of monitoring (DOE 2003c, DOE 2004, and DOE 2005a). A summary report, including the most recent data collected after preparation of the 2003 MAP, was published in 2009 (DOE 2009).

This MAP implementation report summarizes results of the monitoring data, focusing on the period between 1996–2011. It also includes a qualitative comparison of the monitoring results from the period 1996–1999 (pre-development) and 2002–2011 (initial post-development period) at the Horizon Center. The comparison of the pre- and post-development monitoring results examines when maximum values occurred and observable trends in the data. Examination of the pre- versus post-development monitoring results provides insights as to whether the ecological conditions were improving (recovering), remaining stable, or worsening since development began at Horizon Center. Comparisons of Parcel ED-1 data with similar data from other streams on the ORR and nearby reference streams provides context for understanding the observed results. This report also presents a quantitative comparison of the bird monitoring data available from the period 1996–2011.

Regular monitoring by CROET of Parcel ED-1 was discontinued in 2004, but some occasional monitoring and ecological sampling has occurred since. A stream-habitat characterization and herpetofaunal assessment of forested NAs was conducted in 2008 (DOE 2009). DOE's Biological Monitoring and Abatement Program (BMAP) monitoring of benthic invertebrates at East Fork kilometer (EFK) 6.3 continued until 2005; these data are available in the Oak Ridge Environmental Information System (OREIS). There are no fish data from Dace Branch after 2004 in OREIS. Likewise, stream characterization data for EFPC on Parcel ED-1 that may be available for years prior to 2008 have not been identified. Breeding bird surveys at one of two routes continued through 2011 by independent parties. No monitoring of the Parcel ED-1 floodplain route is known to have occurred after 2004. Parcel ED-1 breeding bird survey data obtained from the state of Tennessee are used in this report to evaluate trends and compare pre- (1996–1999) and post-development (2002–2011) periods.

The following sections include summaries of the monitoring data for fish (Sect. 3.1), amphibians and reptiles (Sect. 3.2), birds (Sect. 3.3), and benthic macroinvertebrates (Sect. 3.4) collected during sampling between 1996–2011 at Parcel ED-1. For fish (Dace Branch only), birds, and benthic invertebrates, the summary of the monitoring data includes both qualitative and statistical comparisons between the pre- and post-development periods. The summaries for benthic invertebrates and fish cover the periods from 1996–1999 (pre-development) and 2002–2004; no additional monitoring data were obtained.

The Wilcoxon Rank-Sum (WRS) test was used to statistically compare the monitoring data for the bird, benthic macroinvertebrate, and Dace Branch fish data from the pre- versus post-development years at different locations. The WRS test is a nonparametric test for comparing two independent groups when there is no knowledge of the distribution of the population. Because there was a maximum of only three samples from both the pre- and post-development periods for all of the monitoring data, there were not enough data to determine the distributions of the populations. Therefore, the WRS test was chosen for these analyses. The independent groups for each type of monitoring data were defined as pre- and post-development years, respectively. The WRS one-tailed tests were used to evaluate whether or not there were statistically significant differences between pre- and post-development monitoring results.

3.1 FISH CENSUS

Fish were monitored in 1997, 1998 and 1999 (pre-development) and 2000 (during development) at five stations on Parcel ED-1: EFK 2.3, 5.1 (except 1997), and 6.3; Bear Creek kilometer (BCK) 0.1; and Dace Branch kilometer (DBK) 0.3. Fish were monitored in two seasons (spring, fall), except in 1998 (fall only). The fish monitoring data included five measurements: (1) fish density (fish/m^2), (2) number of taxa, (3) percent of generalist feeders, (4) percent of piscivores, and (5) percent of tolerant fish. Numerical increases in the values of fish density, number of taxa, and percent of piscivores indicate recovery of or a healthy fish community, as do decreases in percent of generalist feeders and percent of tolerant fish. These data are presented in the annual reports for the corresponding years. Per the 2003 MAP (DOE 2003b), fish were monitored only in the spring at DBK 0.3 in 2002, 2003, and 2004 (post-development), so pre- and post-development comparisons are only possible for the spring data from the Dace Branch station for years 1997, 1999, and 2002–2004.

The fish monitoring data indicate that there has been no improvement or recovery of the fish community at DBK 0.3 during the post-development years. The ranges of observed values for all five fish metrics from the post-development sampling (2002–2004) were mostly within the ranges of the observed values from the pre-development (1997 and 1999) sampling, but the number of taxa and fish density decreased, and the percent of generalist feeders and maximum percent of tolerant fish increased. The number of taxa was significantly lower ($P < 0.064$) during the post-development years than during the pre-development years, suggesting no improvement, and possibly a worsening, in the fish community's conditions. Fish density and percent of piscivores did not increase during the post-development years ($P < 0.386$ and $P < 0.500$, respectively), nor did percent of generalist feeders or percent of tolerant fish decrease in the post-development years ($P < 0.500$ and $P < 0.386$, respectively).

3.2 AMPHIBIAN AND REPTILE OBSERVATIONS

Various levels of effort and techniques have been used to "monitor" amphibians and reptiles (herpetofauna) at ED-1 by the different investigators since 1996, so direct comparisons of pre- and

post-development are not feasible. In 1997, 11 reptile species and 11 amphibian species (3 salamanders and 8 frogs/toads) were observed at ED-1 using a variety of traps and visual methods (DOE 1997). The abundance of 10 species of frogs and toads (7 common to the 1997 report) was compared based on intensity of calling activity over 6 months (March through August) in 1997 and 1999 (DOE 1999), and intensity results for the same 10 species were reported for 2002 (DOE 2003c). Incidental observations of herpetofauna (7 frog species, common turtles, and snakes) during fish and macroinvertebrate sampling, avian surveys and "seasonal tours by biologists" were reported in 2003 and 2004 (DOE 2003c, DOE 2004). No herpetofauna observations or data are reported for 1998 and 2000; herpetofauna monitoring in 1999 was limited only to amphibians (DOE 1998, DOE 1999, and DOE 2000).

Herpetofaunal observations were conducted in July 2008 at 10 sites in the NA (DOE 2009). The observation locations included five stations in proximity to benthic invertebrate sampling stations along EFPC and five stations in proximity to small mammal sampling stations in the three vegetated corridors, which separate development areas and connect Renovare Road and the northern boundary of ED-1. Observations were made using visual encounter surveys [Crump and Scott 1994], which include observation by monitoring the environment and listening for sounds and calls, looking through leaf cover on the ground, and rolling over small tree limbs or small rocks.

The lack of moisture and high temperatures at the timing of the July 2008 field event was not conducive to observing herpetofauna. One turtle and one skink were observed; one bullfrog was heard. The blue-tailed skink was observed running across a fallen log near EFPC; the blue tail is common to both Five-lined skink (*Eumeces fasciatus*) and the Southeastern five-lined skink (*Eumeces inexpectatus*). Given their range in Tennessee, both species could be present on ED-1. No amphibians were observed at ED-1 during the investigation. No other herpetofauna was observed at ED-1 during the 2008 field event.

In 2012, reptile and amphibian monitoring consisted of casual observations recorded while conducting the general site monitoring. In total, eight reptile species (three turtles, two lizards, and three snakes) and two amphibians (one toad and one frog) were recorded in 2012 (Table 1). Observations in 2012 included two reptile species that had not previously been reported at Parcel ED-1, Northern fence lizard (*Sceloporus undulatus hyacinthinus*) and Black kingsnake (*Lampropeltis getula nigra*). Only two amphibians were identified in the 2012 monitoring.

Table 1. Reptiles and amphibians observed at Parcel ED-1 (1997–2012)

Common name	Scientific name	1997	2002	2003	2004	2008	2012
Reptiles							
Turtles and terrapins							
Snapping Turtle	*Chelydra serpelltina*			✓			
Painted Turtle	*Chrysemys picta*			✓	✓	✓	✓
Red-Eared Slider	*Trachemys scripta elegans*			✓	✓	✓	✓
Eastern Box Turtle	*Terrapene carolina carolina*	✓		✓	✓		✓
Lizards							
Five-Lined Skink	*Eumeces fasciatus*	✓				✓	✓
Northern Fence Lizard	*Sceloporus undulatus hyacinthinus*						✓
Ground Skink	*Scincella lateralis*	✓					

Table 1. Reptiles and amphibians observed at Parcel ED-1 (1997–2012) – cont.

Common name	Scientific name	1997	2002	2003	2004	2008	2012
Snakes							
Copperhead	*Agkistrodon contortrix*		✓	✓	✓		
Eastern Worm Snake	*Carphophis amoenus amoenus*	✓	✓				
Northern Black Racer	*Coluber constrictor constrictor*	✓	✓	✓	✓	✓	✓
Northern Ringneck Snake	*Diadophis punctatus edwardsii*	✓	✓				
Black Rat Snake	*Elaphe obsoleta obsoleta*	✓	✓	✓	✓		
Black Kingsnake	*Lampropeltis getula nigra*						✓
Water Snake	*Natrix sipedon*		✓		✓		✓
Northern Brown Snake	*Storeria dekayi dekayi*	✓					
Northern Redbelly Snake	*Storeria occipitomaculata occipitomaculata*	✓					
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	✓	✓				
Smooth Earth Snake	*Virginia valeriae*	✓					
Amphibians							
Salamanders							
Northern Dusky Salamander	*Desmognathus foscus fuscus*	✓	✓				
Northern Two-Lined Salamander	*Eurycea bislineata*	✓					
Long-Tailed Salamander	*Eurycea longicauda*		✓				
Northern Slimy Salamander	*Plethodon glulinosus*	✓	✓				
Frogs and toads							
American Toad	*Bufo americanus*	✓	✓	✓	✓		✓
Fowler's Toad	*Bufo woodhousei fowleri*	✓	✓				
Spring Peeper	*Hyla crucifer*			✓			
Cope's Gray Treefrog	*Hyla versicolor*			✓	✓		✓
Upland Chorus Frog	*Pseudacris triseriata feriarum*	✓	✓	✓	✓		
Bullfrog	*Rana catesbeiana*	✓	✓	✓	✓	✓	
Green Frog	*Rana clamitans melanola*	✓	✓	✓	✓		
Pickerel Frog	*Rana palustris*	✓	✓				
Southern Leopard Frog	*Rana utricularia utricularia*	✓	✓	✓	✓		
Eastern Spadefoot	*Scaphiopus holbrookii holbrookii*	✓	✓				

3.3 AVIAN CENSUS

Breeding bird surveys on Parcel ED-1 predate the lease of the property and continue to the present day. Bird surveys are currently conducted independently by trained volunteers and are not directly related to DOE activities. Pre-existing Partners-in-Flight (PIF) stations along two PIF routes were combined to form the Periphery route (called the Poplar Creek by PIF) for the pre-development ecological surveys (DOE 1997) required by the original MAP (DOE 1996b). For implementation of the 1996 MAP, DOE also established new survey points along EFPC to create the Floodplain route (DOE 1997). Bird survey data were collected along the Periphery and Floodplain routes on Parcel ED-1 for one or more seasons by various agencies and personnel since 1996, and the summarized data are presented in the annual reports for the implementation of the MAP for the lease of Parcel ED-1 (DOE 1997, DOE 1999, and DOE 2000). The data presented in these reports were compiled and summarized in the revised 2003 MAP (DOE 2003b).

Summaries of the monitoring data, including comparisons of the pre-development and post-development results, are presented in Tables 2 through 4 for birds on the Periphery route (1996–2011).

As specified in the revised MAP (DOE 2003b), birds were quantitatively surveyed in the spring along the two Parcel ED-1 routes (Periphery and Floodplain) in each of the years 2002, 2003, and 2004 (DOE 2003c, DOE 2004, and DOE 2005a). Spring season surveys occurred from mid-May to early July, which is the breeding season for most birds. Monitoring of the Floodplain route ceased following the 2004 survey. Breeding bird surveys of the Periphery route by independent parties continued through the present.

The breeding bird survey data from 1996–2011 for the PIF stations constituting the Periphery route were obtained from the state of Tennessee ornithologist, Mr. Scott Somershoe, and these data are used in this report to evaluate trends and compare pre- (1996–1999) and post-development (2001–2011) periods. The data for 2000 are not included in the comparison of pre- and post-development effects because most of the initial development activities (i.e., clearing and road construction) occurred during 2000. The bird data obtained from the state ornithologist include number of birds by species observed within the area (50-m radius of point) during the observation period (5 min) as specified by the standard surveyed method. Additional data include number of birds observed outside the specified area and period (e.g., flyovers). The annual reports for the implementation of the MAP (e.g., DOE 1999) present counts (number of stations where a bird species was observed) and number of birds observed for two survey dates in each year.

The sampling metrics evaluated here are total numbers of birds and total number of species (Table 2), as well as number of birds of conservation concern and birds on the PIF national Watch List (Table 3). Numerical increases in any of these four measurements are generally an indication of improving ecological conditions.

Between 1996 and 1999, a maximum of 241 individual birds and 39 species were observed (1997) on the Periphery route (Table 2). Since 2001, the number of individual birds observed has ranged from a minimum of 65 in 2005 to a maximum of 102 in 2006 at the Periphery route (Table 2). The number of species observed since 2001 ranged from 23 species in 2005 to 30 species in 2008 and 2010. The data suggest a decreasing trend in the total numbers of birds and no, or a slightly decreasing, trend in species richness for the Periphery route (Table 2).

Table 2. Numbers of birds and bird species, Periphery (Poplar Creek) route, breeding season (1996–2011)

Year	Total birds	Total species
1996	65	32
1997	241	39
1998	179	36
1999	90	28
2000	119	35
2001	87	27
2002	89	26
2003	75	26
2004	ND	ND
2005	65	23
2006	102	29
2007	ND	ND
2008	95	30
2009	79	28
2010	69	30
2011	83	26

Source: Tennessee Wildlife Resources Agency.
ND = no data available.

Table 3. Numbers of birds of conservation concern and birds on national PIF Watch List, Periphery (Poplar Creek) route, breeding season (1996–2011)

Year	Birds of conservation concern	PIF national Watch List
1996	26	8
1997	121	38
1998	85	30
1999	38	15
2000	43	11
2001	39	10
2002	33	12
2003	29	8
2004	ND	ND
2005	22	2
2006	30	5
2007	ND	ND
2008	29	3
2009	26	10
2010	15	3
2011	22	9

Source: Tennessee Wildlife Resources Agency.
ND = no data available.
PIF = Partners in Flight.

Table 4. Results of Wilcoxon Rank-Sum test for comparison of pre-development (1996–1999) versus post-development periods (2001–2011) bird populations, Periphery (Poplar Creek) route, breeding season

Population	Wilcoxon 1-tailed probability
Total number of birds	0.1397
Total number of species	0.0147
Number of birds of conservation concern	0.0442
Number of birds on PIF Watch List	0.0220

PIF = Partners in Flight.

Between 1996 and 1999, the number of observed birds of conservation concern along the Periphery route ranged from 26 in 1996 to 121 in 1997 (Table 3). During the same period, the number of observed birds on the national PIF Watch List ranged from 8 in 1996 to 38 in 1997. Since 2001, the number of birds of conservation concern has decreased, ranging from 39 in 2001 to 15 in 2010. Likewise, the number of birds on the national PIF Watch List decreased, ranging from 12 in 2002 to 2 in 2005. The data show a decreasing trend in the number of birds of conservation concern and on the PIF Watch List for the Periphery route (Table 3).

Results of WRS tests (one-sided test) of whether the post-development breeding season total number of birds, total number of species, number of birds of conservation concern, and number of birds on the national PIF Watch List are less than the pre-development values that are presented in Table 4. The post-development monitoring data were significantly lower than the pre-development data at p-values less than 0.05 for number of bird species and number of birds on the PIF Watch List. These nonparametric statistical test results corroborate the clear visual observation that these four ecological measurements of bird abundance and diversity decreased during the post-development sampling compared to values from the pre-development sampling.

3.4 BENTHIC MACROINVERTEBRATE CENSUS

Benthic macroinvertebrates were monitored in 1997, 1998 and 1999 (pre-development), 2000 (during development), and 2002 (post-development) at four stations on Parcel ED-1: EFK 2.3 and 5.1, BCK 0.1, and DBK 0.3. Benthic macroinvertebrates were monitored in two seasons (spring, fall), except in 1998 (fall only) and 2000 (spring only). The benthic macroinvertebrate monitoring data included counts of organisms to the lowest taxonomic level possible, from which the following metrics were calculated: (1) density (individuals/m^2), (2) number of taxa, (3) percent of tolerant, and (4) percent of intolerant. Numerical increases in the values of intolerant species, e.g., Ephemeroptera, Plecoptera and Trichoptera (EPT) species, indicate recovery of or a healthy benthic macroinvertebrates community, as do decreases in tolerant species, e.g., Chironomidae (midges) and oligochaete worms. These data are presented in the annual reports for the corresponding years.

As specified in the revised MAP (DOE 2003b), benthic macroinvertebrates were sampled in one season (spring) in 2003 and 2004 at two stations within Parcel ED-1 (EFK 2.3 and 6.3) and in 2005 at station EFK 6.3 by BMAP. Station EFK 2.3 is located at the downstream end of the developed area at ED-1 and EFK 6.3 is located near the upper end of the parcel. In addition, benthic macroinvertebrates were sampled in 2002, 2003, and 2004 from the reference site at Station Mitchell Branch kilometer 1.43 (MIK 1.43). These data supplement the original benthic macroinvertebrate data set for 1997 through 2000 for Station

EFK 2.3, between 1986 and 1999 for EFK 6.3, and for 1999 and 2000 for MIK 1.43 (DOE 2009). The benthic macroinvertebrate sampling included four measurements: (1) mean number of organisms per sample; (2) mean number of taxa per sample; (3) mean percent of EPT; and (4) mean percent Chironomids.

At EFK 2.3 and EFK 6.3, two of the four metrics (mean number of taxa and mean percent EPT organisms) indicate general improvement of the benthic community through 2004, but the other two (mean percent Chironomids and total number of organisms per sample) indicate worsening conditions (DOE 2009). For MIK 1.43, there was only one year of pre-development sampling in 1999 to compare against the three years (2002 through 2004) of post-development sampling. The post-development range of mean percent Chironomid organisms and mean number of organisms per sample exceeded the pre-development value, indicating a potential worsening of conditions for the benthic community, but mean number of taxa and mean percent EPT (32%) suggest no change in the condition of the benthic community at MIK 1.43 (DOE 2009). The mean number of taxa and mean percent EPT were significantly higher ($P < 0.0745$) in the post-development years for EFK 2.3 and EFK 6.3, suggesting that the benthic macroinvertebrate communities were recovering or improving at those two locations (DOE 2009). However, these were the only two benthic macroinvertebrate monitoring results that indicated potential recovery for any of the three locations. The mean percent Chironomids was significantly higher ($P < 0.0745$) for the post-development years than for the pre-development years at EFK 2.3, indicating a potential worsening of conditions at that location. There were no other statistically significant different results for the other benthic macroinvertebrate measurements at any of the locations.

3.5 GENERAL VEGETATION SURVEY

Vegetation patterns documented in the baseline survey and subsequent surveys continue to represent conditions observed in April and May 2012. In general, the areas with mature forest, e.g., the floodplain forest along EFPC and the beech-maple forest, appear to be in much the same condition. The most visible changes have occurred in the areas formerly occupied by loblolly pine plantations that were affected by southern pine beetle and/or salvage logging operations in beetle-killed pine stands. Many of these areas have grown up into mixed pine-hardwood forests but others have become dense, second-growth loblolly pine forests that naturally revegetated following the pine beetle outbreaks. One big change in vegetation patterns occurred in DA 6 where roughly 90 acres of mature hardwood and dense pine forests were cleared in 2012 for development.

Invasive pest plants are still present throughout Parcel ED-1. These plants continue to represent a threat to habitat integrity and biodiversity, but in most situations the occurrence of invasive species still appears to be secondary to native species. The most common invasive pest plants observed include Chinese privet (*Ligustrum sinense*), greater periwinkle (*Vinca major*), lesser periwinkle (*Vinca minor*), Nepal grass (*Microstegium vimineum*), multiflora rose (*Rosa multiflora*), and Japanese honeysuckle (*Lonicera japonica*).

3.6 SENSITIVE COMMUNITIES

The sites used for ecological monitoring in 2012 were the same as those established in the 1997 baseline studies and used in each of the subsequent years in which monitoring occurred.

3.6.1 Beech-Maple Forest

The beech-maple forest is located in a protected part of DA 5 (Fig. 3 and Photograph 6 in Appendix A). It remains the only documented occurrence of this forest community on the ORR. The forest is still in good condition and generally free from invasive pest plants.

3.6.2 Limestone Cliffs

Limestone cliffs occur at several reaches along EFPC (Fig. 3 and Photograph 7 in Appendix A). Most vary in height from 10 to 30 ft. All limestone cliffs are within the NA and have been protected from disturbance. Several areas with cliffs were visited during the 2012 MAP survey; all were in good condition.

3.6.3 Limestone Barrens

The 2012 MAP survey included the two limestone barrens previously documented at Parcel ED-1 (Fig. 3). Neither of the barrens previously documented at Parcel ED-1 is located in protected areas. One barren is in DA 5 along Harrell Road near the Walnut Plantation Access Road, and the second is in DA 7 near the intersection of the Greenway and the road to Lambert's Quarry. Both barrens consist of complexes of small openings dominated by grasses and herbaceous plants in a mixed eastern redcedar–hardwood forest. Despite their small size both barrens are in good condition and are relatively free of exotic species. It is expected that, in the absence of any active management measures to control colonization by woody plants (e.g., prescribed burns), the barrens would eventually succeed to a forest or woodland community.

Two additional potential barrens were located in the southwest corner of DA 5 (Fig. 3 and Photograph 8 in Appendix A). Both areas were about 50 ft in diameter and consisted of a mix of grasses and other herbaceous plants with scattered small eastern redcedar. The surrounding area consisted of a young forest dominated by a mix of loblolly pine and various deciduous trees. Both of the potential barrens have been colonized by Chinese lespedeza (*Lespedeza cuneata*) and oxeye daisy (*Chrysanthemum leucanthemum*).

3.6.4 Canebrakes

During the 2012 MAP surveys, several areas mapped as canebrakes were visited (Fig. 3 and Photograph 9 in Appendix A). Most of the locations were in dense forest habitats, which are not optimal conditions for canebrake development. All the canebrakes visited in 2012 were in reasonably healthy condition. As was noted in previous MAP implementation reports (DOE 2003c; DOE 2004; and DOE 2005a), the areas where the canebrakes are doing best are in the areas cleared around the bridges across EFPC at Imperium and Novus Drives.

3.6.5 Walnut Plantations

Two walnut plantations were planted at Parcel ED-1 prior to 1977 (Fig. 3). Walnut Plantation 1 is located within the NA on the floodplain of EFPC near the southeast corner of DA 5. Walnut Plantation 2 is located in the NA near the mouth of EFPC adjacent to the North Perimeter Road. Neither walnut plantation at Parcel ED-1 is currently maintained; both plantations are slowly being colonized by plants in what were formerly mowed areas between the walnut trees.

3.6.6 Threatened and Endangered Plant Species

Four threatened or endangered plant species have been documented at or near Parcel ED-1 (Table 5). All are state-listed species; there are no known federal-listed plant species at Parcel ED-1.

Table 5. Threatened or endangered species at Parcel ED-1

Common name	Scientific name	Status[a]		Location
		Federal	State	
Canada Lily	*Lilium canadense*	NL	T	Natural Area southeast of DA 5 and Natural Area southeast of DA 6
Ginseng	*Panax quinquefolius*	NL	S-CE	Natural Area southeast of DA 6
Goldenseal	*Hydrastis canadensis*	NL	S-CE	Two locations in Natural Area southeast of DA 5
Pink Lady Slipper	*Cypripedium acaule*	NL	S-CE	DA 4

[a] TDEC 2012; URL: http://www.tn.gov/environment/na.
DA = Development Area; NL = Not Listed; T = Threatened; and S-CE = Special Concern Species due to commercial exploitation.

3.6.6.1 Canada Lily

Canada lily (*Lilium canadense*) was previously documented at one location in the NA growing within a population of goldenseal (*Hydrastis canadensis*) near the southeast corner of DA 5 (Fig. 3) [DOE 1996; DOE 1997; DOE 2003c; DOE 2004; and DOE 2005a]. Approximately 20 Canada lily plants were observed at the original monitoring location in 2012. The mix of mature and juvenile plants indicates that the plant is successfully reproducing at the site.

In 2012, a previously undocumented occurrence of Canada lily was discovered in the NA growing on the floodplain of an unnamed tributary to EFPC near the intersection of Renovare Boulevard and Imperium Drive (Fig. 3). The population included 15 mature plants and approximately 100 juveniles, indicating that the plant is successfully reproducing at that location.

3.6.6.2 Goldenseal

Goldenseal was documented at two locations (Fig. 3) near the southeast corner of DA 5 (DOE 1996; DOE 1997; DOE 2003c; DOE 2004; and DOE 2005a). In 2012, the plant was observed at both locations. The plants observed in 2012 included a mix of adult and juvenile plants indicating that goldenseal is successfully reproducing at both locations. None of the mature plants had flowers or fruit.

3.6.6.3 Pink Lady Slipper

A large population of pink lady slipper (*Cypripedium acaule*) was previously documented in the NA at one location (Fig. 3) near the northwestern edge of DA-4 (DOE 1996; DOE 1997; DOE 2003c; DOE 2004; and DOE 2005a). The site was not visited in 2012, because DA 4 was transferred to TPGF in 2010 and is no longer part of Horizon Center.

3.6.6.4 Ginseng

One occurrence of ginseng (*Panax quinquefolius*) was previously documented at one location (Fig. 3) in the NA near the intersection of Renovare Boulevard and Imperium Drive (DOE 1996; DOE 1997). The population included nine mature plants in reproductive condition (see Photograph 10 in Appendix A). In 2002, 2003, and 2004, samplers were unable to find the original occurrence of the plant (DOE 2003c;

DOE 2004; and DOE 2005a). In 2012, the plot was successfully located again and eight plants were observed including seven mature plants and one juvenile.

3.6.7 Beak Rush Community

White-topped beak rush (*Rhynchospora colorata*) was discovered in 1996 at one location in Lambert's Quarry, which is adjacent to, but outside, the northern end of Parcel ED-1 (Fig. 3) [DOE 1996; DOE 1997]. Attempts to find the original sample location were unsuccessful in 2002, 2003, and 2004 (DOE 2003c; DOE 2004; and DOE 2005a). The record of the plant at Lambert's Quarry remains the only documented occurrence of the plant in Tennessee. The presence of the plant at that site is considered to be an unexplained occurrence and is possibly the result of accidental introduction. The occurrence of the white-topped beak rush was confirmed by a private citizen in July 2012 (McAlister 2013).

3.6.8 Cave Entrances

One cave entrance was documented in a wet weather conveyance that flows in a drainage ditch beside the North Boundary Greenway (Fig. 3) [DOE 1996; DOE 1997]. In 2002, 2003, and 2004, the cave opening was observed and reported to be open and unobstructed (DOE 2003c; DOE 2004; and DOE 2005a). In 2012, the cave opening (approximately 2 to 3 ft in diameter) was found again (see Photograph 11 in Appendix A). The entrance was open and receiving a small amount of stream flow in the ditch. No attempt was made to explore the entrance.

In 2012, a second potential cave opening was observed in the NA near the southeastern corner of the Beech-Maple Forest in DA 5 (Fig. 3). The opening is a shallow pit approximately 3 to 4 ft across and 10 to 12 ft deep. The pit was partially filled with leaves and branches and no opening was visible. No attempt was made to explore the entrance.

3.6.9 Springs

Two springs were described in the lower reaches of the EFPC floodplain (DOE 1996; DOE 1997). Both springs are associated with wetlands along EFPC (Fig. 3 and Photograph 12 in Appendix A). In 2002, the occurrence of an additional spring was reported, although no location information was provided (DOE 2003c). All three springs were revisited in 2003 and 2004 (DOE 2004; DOE 2005a). The two springs originally documented in 1996 and 1997 were revisited in 2012. Both springs were flowing and contribute to the hydrology in two of the wetlands on EFPC.

3.6.10 Sinkholes

There are several sinkholes of various sizes located across Parcel ED-1 (DOE 2003c; DOE 2004; and DOE 2005a). The largest of these is in the NA between DA 5 and DA 6 adjacent to the Greenway.

Several sinkholes were observed during the 2012 survey (Fig. 3 and Photograph 13 in Appendix A). Most were very small and/or shallow and most did not have active openings to the subsurface. At least three sinkholes were located in the Beech-Maple Forest in the NA. There are several other sinkholes located within DA 5 and DA 7 that were not mapped.

3.6.11 Wetlands

Five wetlands, all associated in some way with EFPC (Fig. 3), were described within the NA (DOE 1996; DOE 1997); all five wetlands were monitored from 2002 through 2004 (DOE 2003c; DOE 2004; and DOE 2005a). The hydrology of all five of these wetlands is strongly affected by streamflow fluctuations in EFPC

that are influenced by conditions on Watts Bar Reservoir and streamflow in Poplar Creek. The largest wetland has been altered by beavers in the past and it also receives groundwater flow from a large volume spring and surface water flow from an intermittent tributary to EFPC. One other wetland on the right bank of EFPC receives groundwater flow from a large spring. Both of these spring-influenced wetlands could possibly provide suitable habitat for the Valley Flame Crayfish (see discussion in Sect. 3.6.15)

During the 2012 monitoring three of the five wetlands were visited and a fourth was observed from across EFPC (see Photograph 14 in Appendix A). The fifth wetland was not visited. Most of the wetlands are in reasonably good condition. Exotic, invasive pest plants observed in Parcel ED-1 wetlands included privet (*Ligustrum sinense*), creeping Jenny (*Lysimachia nummularia*), marsh dayflower (*Murdannia keisak*), and Nepalese browntop (*Microstegium vimineum*). All four of these plants commonly occur in wetlands and shoreline habitat on the Tennessee Valley Authority (TVA) reservoirs in the region.

Four additional wetlands were identified within the NA. The first is a very small (estimated size < 0.05 acre), forested wetland adjacent to the SR 95 ROW near DA 2 (Fig. 3). It is associated with a wet weather conveyance that receives runoff from the highway. The wet weather conveyance becomes an intermittent stream a short distance downstream from the wetland. The wetland was delineated and described as part of the TDOT project.

The second wetland is located in the floodplain of a small, intermittent tributary to EFPC south of Renovare Boulevard near the intersection with Imperium Drive (Fig. 3). The wetland is small (estimated size 0.1 to 0.2 acre) and is dominated by forest vegetation.

The third wetland is a moderate-size (estimated size 1 to 2 acres) feature behind a former beaver dam on Dace Branch (see Fig. 3 and Photograph 15 in Appendix A). The wetland is dominated by a mosaic of scrub-shrub and persistent emergent vegetation. The main dam has several holes and the area is no longer flooded but remains saturated. There was no evidence that the beavers are still active at the site.

The fourth wetland is a small, forested wetland (estimated size 0.25 to 0.5 acre) that has formed in the floodplain of a small, perennial stream that flows between DA 6 and DA 7 (see Fig. 3 and Photograph 16 in Appendix A). The wetland is located south of Renovare Boulevard and west of Imperium Drive. The wetland is located just upstream of a new population of Canada lily discovered in 2012 (see Sect. 3.6.6.1).

3.6.12 Buffer Zones

In general, the buffer zones are largely intact in the NA and corridors between the BORCE and the NA. There were three events noted during the 2012 monitoring where construction activities at or near Parcel ED-1 have affected the NA. Two of these events occurred sometime between 1998 and 2003 and the third event occurred between 2010 and 2012.

One of these events occurred in the NA Corridor between DA 5 and DA 6 (Fig. 3). Prior to 2003, Oak Ridge Utility District (ORUD) constructed a natural gas line into Horizon Center from a main located adjacent to the BORCE (see Photograph 17 in Appendix A). The ORUD ROW occupies about 2 acres of the corridor. The total affected area is relatively small and has had about a decade or more to stabilize.

Another small intrusion into the NA occurred adjacent to Novus Drive between Palladium Way and EFPC (Fig. 3). The clearing probably occurred when the ROW was cleared for construction of Novus Drive and associated utilities. Approximately 2 acres of NA were cleared. The total affected area is relatively small and has had about a decade or more to stabilize.

The third event occurred during construction of TDOT's SR 95 improvement project and was discussed in detail in Sect. 2.1.2.1 of this report (Figs. 3 and 4 and Photographs 3 and 4 in Appendix A). Approximately 0.4 acres of the NA west of Imperium Drive was filled with about 2700 yd^3 of excess rock, rubble, and soil during the TDOT construction project. DOE, in consultation with TDOT and TDEC, has determined that the fill can remain in place without adversely affecting the NA and floodplain functions.

3.6.13 Game Species

Wildlife management on the ORR is a cooperative effort between DOE, TWRA, and UT-Battelle [*Wildlife Management Plan for the Oak Ridge Reservation*, ORNL/TM-2006/155 (ORNL 2007)]. Game species on the ORR include white-tailed deer, wild turkey, and certain waterfowl (Canada geese, teal, and wood duck) [TWRA 2011].[1] Active hunting programs for white-tailed deer and wild turkey act as the primary method of population control for these species on the ORR (ORNL 2007). Hunting is only one aspect of a multifaceted approach to Canada goose management on the ORR.

Currently there is no hunting at Parcel ED-1. Game species seen at Parcel ED-1 in 2012 included deer, wild turkey, Canada geese, and wood duck. Two wild turkey nests were discovered during the 2012 monitoring (see Photograph 18 in Appendix A). Monitoring of game species at Parcel ED-1 consisted of recording incidental observations while conducting other monitoring activities at the site.

3.6.14 Non-game Mammals

Twenty-four non-game mammals have been observed at Parcel ED-1 (Table 6). Baseline sampling in 1997 identified 22 non-game species including domestic cats and dogs (DOE 1997). Subsequent monitoring between 2002 and 2012 identified a total of 20 non-game mammals (DOE 2003c; DOE 2004; DOE 2005a; and DOE 2009). Intensive surveys were conducted in 1997. Beginning in 2002, surveys consisted of recording incidental observations while conducting other monitoring activities.

Table 6. Mammals observed at Parcel ED-1 (1997–2012)

Common name	Scientific name	1997	2002	2003	2004	2008	2012
Northern Short-Tailed Shrew	*Blarina brevicauda*	✓	✓				
Coyote	*Canis latrans*	✓				✓	
Domestic Dog	*Canis familiaris*	✓	✓				✓
Beaver	*Castor canadensis*	✓			✓		✓
Least Shrew	*Cryptotis parva*	✓					
Domestic Cat	*Felis domestica*	✓					
Southern Flying Squirrel	*Glaucomys volans*	✓					
Bobcat	*Lynx rufus*		✓		✓		
Groundhog	*Marmota monax*	✓	✓				
Striped Skunk	*Mephitis mephitis*	✓	✓		✓		
Mink	*Mustela vison*	✓	✓				

[1] URL: http://www.tn.gov/twra/pdfs/wmaseasons.pdf.

Table 6. Mammals observed at Parcel ED-1 (1997–2012) – cont.

Common name	Scientific name	1997	2002	2003	2004	2008	2012
White-Tailed Deer	*Odocoileus virginianus*	✓	✓	✓	✓	✓	✓
Muskrat	*Ondatra zibethicus*	✓			✓		
Opossum	*Didelphis virginiana*	✓	✓		✓		✓
White-Footed Mouse	*Peromyscus leucopus*	✓	✓				
Deer Mouse	*Peromyscus maniculatus*	✓	✓				
Pine Vole	*Pitymys pinetorum*	✓					
Raccoon	*Procyon lotor*	✓	✓		✓		✓
Eastern Gray Squirrel	*Sciurus carolinensis*	✓				✓	
Southeastern Shrew	*Sorex longirostris*	✓	✓				
Swamp Rabbit	*Sylvilagus aquaticus*				✓		
Eastern Cottontail	*Sylvilagus floridanus*	✓	✓	✓	✓		✓
Eastern Chipmunk	*Tamias striatus*	✓	✓				
Gray Fox	*Urocyon cinereoargenteus*	✓	✓		✓		

3.6.15 Sensitive Animals

Sensitive animals previously documented at Parcel ED-1 include only state-listed species; no Federally listed species have ever been documented at the site. State-listed animal species seen at Parcel ED-1 include Tennessee Dace, Sharp-Shinned Hawk, and Southeastern Shrew. These animals were documented in habitat that will continue to be protected within the NA. The NA also provides potentially suitable roosting habitat for Indiana Bats and foraging habitat for Indiana and Gray Bats. Neither of these Federally listed species has been identified at Parcel ED-1, although several bat surveys were conducted at the site over the past 20 years.

Although not reported to occur on Parcel ED-1, there is some potentially suitable habitat in the NA for the state-endangered Valley Flame Crayfish (*Cambarus deweesae*). The Valley Flame Crayfish is a burrowing crayfish whose occurrence appears to be restricted to five known populations in Anderson and Roane counties. It has not yet been documented on the ORR. The best habitat for the crayfish is in or adjacent to valley floor springs or spring-fed streams, particularly in areas with hydric soils.

There are two wetlands associated with large springs in the EFPC floodplain that could possibly provide suitable habitat for the Valley Flame Crayfish. Both wetlands are located in the NA and are protected from development. In late September 2012, an attempt was made to look for chimneys and other possible evidence of the Valley Flame Crayfish in those two wetlands. Both wetlands were completely inundated at the time of the visit. Such inundation is common in that part of EFPC in the summer and fall due to routine, regular fluctuations in water levels on Watts Bar Reservoir.

4. CULTURAL RESOURCES

All known cultural resources at Parcel ED-1 continued to be protected in 2012. The 100-ft buffer placed around the McKamey-Carmichael cemetery has been maintained (Fig. 3 and Photograph 19 in Appendix A). Former grist mill sites 40RE195 and 40RE200 along EFPC were visited in 2012 (Fig. 3). Both sites are located within the NA and are not located in any areas likely to be affected by any current or planned construction activities.

Two stone structures, remnants of chimneys, were observed during the 2012 monitoring. Both of these structures were documented previously in the original EA (Structures 953A and 954A) (DOE 1996a). Neither structure was deemed eligible for the National Register of Historic Places at that time; no further action is required regarding these two structures.

Structure 953A is in the northwestern side of DA 6 within the area recently cleared; it is approximately 20 ft from the buffer zone on the north side of the parcel. The structure is approximately 6.3 ft high, 3.3 ft deep, and 5.5 ft wide (Fig. 3 and Photograph 20 in Appendix A). It is constructed of quarried, limestone blocks that were cemented together. The chimney is open to the west and the interior is lined with fire bricks. Clearing did not appear to have affected the structure. The site is clearly visible from the Greenway.

Structure 954A is located in an unimproved area in the eastern part of DA 7 (Fig. 3 and Photograph 21 in Appendix A). This stone structure also consisted of stacked, quarried, limestone blocks. It is about 5 ft high, 3.5 ft deep, and 6.5 ft wide. The chimney is open to the west and the interior is lined with fire bricks.

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5. CONCLUSIONS AND RECOMMENDATIONS

Parcel ED-1 is an approximately 1000-acre parcel of land located in the western portion of the ORR [Fig. 1]. In 1996, DOE leased Parcel ED-1 to CROET(DOE 1996a). In 2003, the DOE transferred ownership of approximately 490 acres of Parcel ED-1 to CROET for development of an industrial/business park now known as the Horizon Center (DOE 2003a). The remaining portion of the parcel (510 acres), referred to as the Parcel ED-1 NA, was retained as DOE property. From 1996 to 2003, CROET leased all of Parcel ED-1, including the NA, from DOE. Following the transfer of Horizon Center in 2003, CROET continued to lease the NA until 2011. CROET transferred title of Horizon Center to the Oak Ridge IDB in 2010.

The 1996 MAP (DOE 1996a) prescribed measures to be implemented to mitigate significant adverse impacts from industrial development on Parcel ED-1. The 1996 MAP specified that mitigation would be accomplished by: (1) excluding areas on Parcel ED-1 from disturbance and development, and (2) conducting surveys and monitoring of industrial development areas prior to disturbance (pre-development) and during industrial operations (post-development). The objectives of these measures included: (1) protection of wildlife habitat, plant communities, T&E species, water resources, wetlands, and historical and archaeological resources; (2) maintenance of habitat connections to reduce the ecological effects of fragmentation; (3) pre- and post-construction assessment of natural succession and impacts of development by collection of data during monitoring of natural communities and populations; and (4) identification of additional mitigation, as needed, to remediate the actual effects of development.

Following the transfer of title to CROET in 2003, the objectives of the 1996 MAP were reaffirmed and restated in the revised MAP as "...to detect and characterize changes from the baseline (pre-development) conditions" (DOE 2003b). The revised MAP covers the transfer of Parcel ED-1 to CROET and specifies monitoring of birds, benthic invertebrates, and fish to evaluate changes from the pre-development conditions, potentially associated with development of the site as an industrial park (DOE 2003b).

The primary mitigative action identified in the original 1996 MAP, and reaffirmed in the 2003 MAP, was to "exclude areas on Parcel ED-1 from disturbance and development." The establishment of the Parcel ED-1 NA was the principal mitigative action that fulfilled this first goal of the original MAP. The MAP identified 510 acres that would be excluded from development, and the originally identified 510 acres have remained mostly undisturbed with the exception of 4 acres that were cleared for infrastructure improvements. Additionally, the total acreage of the NA has been increased by about 53 acres with the addition of DA 4, which CROET donated (via title transfer) to TPGF in 2010 for perpetual conservation. Therefore, the purpose of the MAP to exclude the NA from development has been achieved and enhanced.

In addition to the activities specifically associated with development and operation of Parcel ED-1, there are several ongoing actions unrelated to Parcel ED-1 that have affected aquatic and terrestrial habitat in EFPC and the surrounding area. These other events include two recently completed TDOT projects on SR 95, private residential development at Rarity Oaks (upstream of ED-1), water quality factors associated with past and continuing mercury releases into EFPC from the Y-12 Complex, and leakage from the Oak Ridge sanitary sewer system into EFPC. It is difficult to separate the effects of these outside influences from the effects of development.

The second identified purpose of the 1996 MAP was to "conduct surveys and monitoring of industrial development areas prior to disturbance (pre-development) and during industrial operations

(post-development)." This monitoring was conducted primarily to ensure that the NA remained undeveloped and to evaluate if excluding this area from development was sufficient to protect the resources found within it. To achieve this second stated purpose of the MAP, intensive ecological monitoring was conducted for the periods of 1997 to 2000 and 2002 to 2004. Regular ecological monitoring ceased in 2004, but limited ecological monitoring was conducted after 2004 at Parcel ED-1. PIF (a partnership of state, local NGOs, and individuals) has conducted annual bird surveys in late May or June along the original Periphery route since 1996 (except for 2004 and 2007). In 2008, DOE conducted a stream-habitat characterization of EFPC and a herpetofaunal assessment in the EFPC floodplain. In 2012, DOE conducted additional ecological monitoring including habitat surveys of wetlands, rare plant locations, and other sensitive ecological resources previously documented at Parcel ED-1. Therefore, this purpose of the MAP has also been fulfilled.

Comparisons of pre- and post-development data demonstrate that permanent habitat conversion associated with development at Parcel ED-1 has resulted in measurable decreases in various indicators of ecological condition at the site. Subsequent to the initial development impacts, these same ecological indicators have remained relatively stable as development activities started and ended and routine industrial operations began at the site. Ecological indicators would not be expected to recover to pre-development levels since the conversion of natural habitat for the industrial uses represents a permanent habitat loss. However, the relatively low variation in ecological indicators during the post-development period indicates that conditions have somewhat stabilized. It is anticipated that this pattern of variation would continue as Parcel ED-1 is built out and routine industrial operations continue at the site. Monitoring conducted in 2012 indicated that sensitive resources at the site were intact.

As stated above, the MAP has four purposes of ecological monitoring: "(1) protection of wildlife habitat, plant communities, T&E species, water resources, wetlands, and historic and archaeological resources; (2) maintenance of habitat connections to reduce the ecological effects of fragmentation; (3) pre- and post-construction assessment of natural succession and impacts of development by collection of data during monitoring of natural communities and populations; and (4) identification of additional mitigation, as needed, to remediate the actual effects of development." These four purposes of monitoring at Parcel ED-1 have largely been achieved. The creation of the NA effectively protected the sensitive natural resources in the EFPC floodplain and protected several wildlife corridors from the floodplain to adjacent habitat. Ecological monitoring conducted since development activities began at Parcel ED-1 has demonstrated that ecological functions were initially affected by construction activities but have stabilized. The preservation of the NA has effectively protected wildlife habitat, plant communities, T&E species, water resources, wetlands, and historic and archaeological resources and maintained habitat connections to reduce the ecological effects of fragmentation. Pre- and post-construction assessment of natural succession and impacts of development has demonstrated that initial construction impacts have stabilized, and no additional mitigation is needed to remediate the actual effects of development. It is expected that additional monitoring at Parcel ED-1 would continue to demonstrate these same trends.

The original mitigations identified in the MAP have been demonstrated to be effective. Over 500 acres of NA have been excluded from development and protected from encroachment. Monitoring activities over 16 years have shown that the sensitive resources within the NA have been protected, including state-listed T&E plants, and that monitored plant and animal populations are stable. Implementation of BMPs during construction activities has largely been effective at preventing sedimentation/siltation of surface water due to erosion. Fragmentation impacts appear to have been minimized, and no need for additional mitigation has been identified. With the goals of the MAP successfully achieved over a long duration, additional ecological monitoring is not warranted for the future, and therefore DOE plans to discontinue ecological monitoring of the NA. The NA will continue to be managed by DOE, or a conservation agency, to ensure that the resources continue to be protected.

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APPENDIX A
SITE PHOTOGRAPHS

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Photograph 1. View of cleared land in DA 6 from Renovare Boulevard.

Photograph 2. SR 95 ROW adjacent to the Parcel ED-1 NA boundary.

Photograph 3. View of filled area in Parcel ED-1 NA.

Photograph 4. View of filled area in Parcel ED-1 NA.

Photograph 5. View of drainage outfall in SR 95 ROW adjacent to Parcel ED-1 NA boundary.

Photograph 6. Beech-maple forest in protected area of DA 5.

Photograph 7. Limestone cliff along EFPC near DA 1.

Photograph 8. Limestone barren in southwestern corner of DA 3.

Photograph 9. Small canebrake in Parcel ED-1 NA along unnamed tributary to EFPC.

Photograph 10. Clump of ginseng plants in Parcel ED-1 NA.

Photograph 11. Cave opening in Parcel ED-1 NA along northwestern edge of DA 5 near Harrell Road.

Photograph 12. Spring at head of wetland along EFPC in Parcel ED-1 NA.

Photograph 13. Sinkhole in beech-maple forest in protected area of DA 5.

Photograph 14. Wetland along EFPC in Parcel ED-1 NA.

Photograph 15. Wetland discovered in NA along Dace Branch.

Photograph 16. Wetland in floodplain of perennial stream in NA between Renovare Boulevard and Imperium Drive.

Photograph 17. ORUD natural gas line ROW in Parcel ED-1 NA buffer between DA 5 and DA 6.

Photograph 18. Wild turkey nest with eggs in Parcel ED-1 NA.

Photograph 19. McKamey-Carmichael Cemetery near north side of DA 6.

Photograph 20. Stacked stone chimney remnant (Structure 953A) on north side of DA 6.

Photograph 21. Stacked stone chimney remnant (Structure 954A) in eastern part of DA 7.

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