

Restoration in the Big River at Calico Creek  
Southeast Missouri Lead Mining District  
Big River and Southwest Jefferson County Mine  
Sites, MO  
Natural Resource Damage Assessment and  
Restoration:  
Stream, Riparian, Floodplain and Upland Habitats  
  
Draft Restoration Plan and Environmental  
Assessment

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**MISSOURI**  
DEPARTMENT OF  
NATURAL RESOURCES

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# 1 Introduction

The U.S. Department of the Interior, acting through the U.S. Fish and Wildlife Service (USFWS) and the State of Missouri, acting through the Missouri Department of Natural Resources (MoDNR), acting in their capacity as natural resource trustees (Trustees) have prepared this Draft Restoration Plan (RP/EA) to propose restoration actions to compensate the public for natural resources injured and ecological services lost due to releases of hazardous substances, including heavy metals at and from mines, mills, smelters, and tailings impoundments of the Big River Mine Tailings and Southwest Jefferson County Lead Mine Superfund Sites (collectively called “Big River” or “Superfund Sites”) within the Old Lead Belt of southeast Missouri. Pursuant to applicable regulations, the Trustees have initiated natural resource damage assessment and restoration (NRDAR) processes at different sites throughout the Southeast Missouri Lead Mining District (SEMOLMD or SEMO) and have successfully recovered money damages to use to restore impacted natural resources and their services.. This proposed restoration actions complement planned response action by the U.S. Environmental Protection Agency (USEPA) at the Superfund Sites.

For over a century, heavy metals, including, but not limited to lead and zinc were mined, milled, and smelted in the Old Lead Belt. Lead mining, milling, and smelting no longer occur in the Old Lead Belt, though past and ongoing releases of hazardous substances into nearby soils, sediments, and surrounding waters, in particular the Big River watershed, have led to natural resource injuries. A number of natural resources, including surface water, sediments, geologic resources, fish, mussels (including species listed pursuant to the Endangered Species Act “ESA”), crayfish, and migratory birds, have been exposed to and adversely affected by hazardous substances released from the mining associated facilities in the Big River watershed (Allert et al.2010, Besser et al.2009, McKee et al. 2010, and Roberts et al. 2016). Big River sediment and floodplain soils are contaminated with lead, zinc and cadmium for over 100 miles below the first large industrial scale lead mining and milling facility in Leadwood, St. Francois County, MO. (Pavlowsky et al.2010). (See Figure 1). Contaminated floodplain soils have been shown to have adverse effects on plant communities and migratory songbirds. (Struckhoff et al. 2013 and Beyer et al. 2013).

## 1.1 Purpose and Need for Restoration

The purpose of this Draft RP/EA, in accordance with the analysis contained in the [Southeast Missouri Ozarks Regional Restoration Plan](#) (SEMORRP), is to address injured natural resources/services lost due to release(s) of hazardous substances including heavy metals in the Big River. The need for this Draft RP/EA is to describe the restoration actions or projects that have been proposed by the Trustees to address those natural resource injuries.

To date, the response actions proposed and implemented by the EPA and the MoDNR in the Old Lead Belt have focused on the reduction of threats to human health including the removal and disposal of contaminated yard soils and stabilizing eroding mine tailings piles within the Superfund Sites. EPA is currently conducting Remedial Investigation/Feasibility Studies (RI/FS) to investigate the impacts of heavy metals and the ecological risks they pose

in and around the Big River. In conjunction with the RI/FS, EPA is conducting pilot projects to develop remedial strategies for addressing risks from lead contamination in and around the Big River but not to restore natural resources and their services. Thus, there is an opportunity to efficiently integrate natural resource restoration under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) with EPA's pilot remedial project to enhance the ecological outcomes from remedial actions.

As a result, the Trustees propose to undertake the restoration activities described in this Draft RP/EA. Specifically, the Trustees are proposing to fund restoration activities including replanting and management of trees and other native vegetation in riparian corridors, floodplains, and upland areas and preservation of lands at and surrounding the EPA Pilot Project at Calico Creek. The pilot is located at the confluence of Calico Creek and the Big River. The project area comprises a lengthy section of rapidly eroding stream bank determined to be inputting large quantities of metals impacted soil to the Big River. The Corps of Engineers estimated the erosion rate for this particular site is 12,000 tons/year of soil eroded annually (from 1990 and 2018), carrying 15 tons/year of lead into the river, which is one of the worse sites measured in Jefferson County. EPA's proposed actions include bank reshaping, channel reorientation and bioengineered bank stabilization utilizing large trees and natural materials to stabilize the eroding banks and prevent contaminated soil from eroding into the river.

In addition to EPA activities within the Big River watershed, the U.S. Army Corps of Engineers (the Corps) has completed the St. Louis Riverfront-Meramec River Basin Ecosystem Restoration Feasibility Study with Integrated Environmental Assessment (Meramec FS), which provides an evaluation and recommended plan of habitat restoration projects along the Big River and within the Meramec River Basin pursuant to the Water Resources Development Act and the National Environmental Policy Act (NEPA). The Meramec FS identifies contaminated sediment and eroding contaminated soil from stream banks as targets for restoration due to impacts on federally listed endangered freshwater mussels. The recommended plan within the Meramec FS focuses on bank instability, erosion, excessive suspended and bedded sediments, riparian zone loss, altered stream geomorphology, and freshwater habitat decline at approximately 50 sites along the Big River in an effort to reestablish a more natural, stable river. The proposed riparian and floodplain restoration projects under consideration in this Draft RP/EA are contemplated in the Meramec FS. If selected, these restoration projects would occur in conjunction with the EPA Pilot Project discussed above, and the Corps' ecosystem restoration project as described in the Meramec FS.

This Draft RP/EA has been developed in accordance with CERCLA and NEPA to inform the public as to the types and scale of restoration to be undertaken towards compensating for injuries to natural resources and their associated services. The Trustees are soliciting comments on this Draft RP/EA, and will address comments, if any, in preparing a Final RP wherein the Trustees will identify the selected Restoration Alternative(s).

## **1.2 Relationship to the Southeast Missouri Regional Restoration Plan**

In 2014, the Trustees produced the SEMORRP, which provides a process framework governing the approach for restoration project identification, evaluation, selection and implementation. In the SEMORRP, the Trustees selected Alternative D as the Preferred Alternative (see Section 3.5, pages 23 and 24 of SEMORRP for a description), where the Trustees will consider a combination of restoration actions and projects to accomplish restoration goals at or near the site(s) of injury.

The goal of this Draft RP/EA is to improve or protect water quality, the quality of aquatic and riparian, floodplain, and upland habitats, and the species and communities dependent on those natural resources in and around the Big River near the confluence with Calico Creek. This Draft RP/EA tiers (40 CFR 1502.20, 40 CFR 1508.28, and 43 CFR 46.140) from and incorporates by reference (40 CFR 1502.21 and 43 CFR 46.135) portions of the SEMORRP for expediency and efficiency, as appropriate. Specific sections of the SEMORRP are identified, including a brief summary description of the incorporated material, where incorporation by reference is used below. The proposed activities associated with this Draft RP/EA are in alignment with the goals of the SEMORRP, and compliant with the Preferred Alternative selected in the SEMORRP.

### **1.3 Restoration Goals**

Based on the nature of the natural resource injuries and losses, the restoration goals listed below were identified by the Trustees and guided development of this plan. These goals are in alignment with project types described under the Preferred Alternative of the SEMORRP.

Goal 1: Enhance or restore portions of the adversely affected stream segments and associated fish, wildlife, and supporting habitats;

Goal 2: Enhance or restore portions of the adversely affected terrestrial habitat, particularly those supportive of migratory birds and sensitive species; and

Goal 3: Enhance and protect, via conservation easements, the conservation value of upland or aquatic habitats supportive of species injured by hazardous substances originating from the Superfund Sites.

### **1.4 Natural Resource Trustee Authority**

Under federal law, the natural resource trustees are authorized to act on behalf of the public to assess injuries to natural resources and services resulting from the release of hazardous substances into the environment. The NRDAR process allows trustees to pursue claims against responsible parties for monetary damages based on these injuries in order to compensate the public. Pursuant to CERCLA, the goal of this process is to plan and implement actions to restore, replace, or rehabilitate the natural resources that were injured

or lost as a result of the release of a hazardous substance, or to acquire the equivalent resources or their services (42 U.S.C. § 9601 *et seq.*; 43 C.F.R. Part 11). The Trustees for the Big River NRDAR are the State of Missouri, represented by the MoDNR, and the Department of the Interior, represented by the USFWS. See also the National Contingency Plan 40 C.F.R. §§ 300.600 *et seq.*

## **1.5 National Environmental Policy Act Considerations**

NEPA applies to federal agency actions that affect the human environment. Federal agencies are obligated to comply with NEPA regulations adopted by the Council on Environmental Quality (CEQ). NEPA requires that an Environmental Assessment (EA) be prepared in order to determine whether the proposed restoration actions will have a significant effect on the quality of the human environment. If an impact is considered significant, then an Environmental Impact Statement is prepared. If the impact is considered not significant, then a Finding of No Significant Impact (FONSI) is issued. The Trustee's Final Restoration Plan will include a FONSI determination, if such a determination is made. In accordance with NEPA and its implementing regulations, this Draft RP/EA summarizes the current environmental setting; describes the purpose and need for restoration actions; identifies alternative actions; assesses their applicability and potential impact on the quality of the physical, biological, and cultural environment; and outlines public participation in the decision-making process.

Tiering is permissible under NEPA provided that the proposed activity is within the range of alternatives and nature of potential environmental consequences considered in the programmatic document. 40 C.F.R. §1502.20. The proposed activities associated with this Draft RP/EA are in alignment with the goals of the SEMORRP, and compliant with the Preferred Alternative selected in the SEMORRP. Further, this Draft RP/EA tiers (40 C.F.R. §1502.20 and 40 C.F.R. §1508.28) from and incorporates by reference (40 C.F.R. §1502.21) portions of the SEMORRP for expediency and efficiency, as appropriate

Consistent with federal laws, the Federal Trustees are continuing to evaluate the Preferred Alternative identified in this Draft RP/EA for compliance with other applicable laws, which may include:

- Endangered Species Act
- National Historic Preservation Act

## **1.6 Summary of NRDAR Settlement**

The Trustees recovered monetary damages from ASARCO LLC as a part of bankruptcy proceedings in 2008 to settle certain legal claims concerning injuries to natural resources and their services associated with releases of hazardous substances from the Federal Mine and Mill Complex, part of the Big River Mine Tailings Superfund Site in St. Francois County. Since that settlement, the Trustees have expended restoration funds to restore injured natural resources. Currently, there are approximately \$24.7 million available from the Big River ASARCO settlement. The trustees propose to fund the restoration projects

described in this Draft RP/EA from these remaining settlement funds. The expected cost of the Preferred Alternative is approximately \$1.225 million.

## 1.7 Public Participation

Public participation and review is an integral part of the restoration planning process, and is specifically required in the CERCLA NRDAR regulations (*e.g.*, 43 C.F.R. §11.81(d) (2)). In addition, NEPA and its implementing regulations require that federal agencies fully consider the environmental impacts of their proposed decisions and that such information is made available to the public. This Draft RP/EA will be open for public comment for 30 days from the date of publication of a notice of availability in the Jefferson County *Leader* and the St. Francois County *Daily Journal*. Based on the public's comments, or other information, the trustees may amend the RP/EA, if significant changes are made to the type, scope, or impact of the projects. In the event of a significant modification to the RP/EA the trustees will provide the public with an opportunity to comment on that particular amendment. The trustees will address public comments and will document responses to those comments as part of the Final RP/EA. Interested individuals, organizations, and agencies may submit comments by writing or emailing:

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Copies of this document are available online at:

[U.S. Fish & Wildlife Service Southeast Missouri Natural Resource Damage Assessment and Restoration Website](#)

and

[Missouri Department of Natural Resources Natural Resource Damage Assessment and Restoration Website](#)

Physical copies of the document are also available for review by interested members of the public at the USFWS Missouri Field Office in Columbia, MO and the Missouri Department of Natural Resources' office in Jefferson City, MO. Arrangements must be made in advance to review or obtain copies of physical records at the USFWS Missouri Field Office by contacting the USFWS representative listed above.

The Trustees have also maintained records documenting the information considered and actions taken during this NRDAR process. These records are available on the Southeast Missouri Lead Mining District NRDAR [website](https://www.fws.gov/Midwest/es/ec/nrda/SEMONRDA/index.html):  
(<https://www.fws.gov/Midwest/es/ec/nrda/SEMONRDA/index.html>).

## 2 Summary of Natural Resource Damage Assessment at Superfund Sites

The trustees initiated NRDAR process at numerous sites within the Southeast Missouri Lead Mining District (SEMOLMD), including Big River Mine Tailings and Southwest Jefferson County Lead Mine Superfund Sites. The trustees completed a Damage Assessment Plan in 2009, summarizing existing information on natural resource injuries and describing proposed studies to evaluate past, current, and future impacts to natural resources and the services they provide. In addition, the Damage Assessment Plan outlined how information gathered from the studies would be used to determine the types and scale of restoration needed to address these injuries. The trustees have conducted a series of site-specific studies assessing the exposure of natural resources, such as songbirds, sediments, geologic resources, mussels, crayfish, plant communities, and mammals, to hazardous substances and potential effects resulting from that exposure. These trustees assessment studies have shown heavy metals contamination have potentially caused injuries to geologic resources (sediment and soil), aquatic resources (mussels, crayfish, macro invertebrates, and benthic fish), and terrestrial resources (songbirds and floristic quality). Evidence to support injury determination in the Big River and its floodplains (See Figure 1) includes:

- exceedances of water quality criteria due to elevated heavy metals in sediment, established for the protection of aquatic biota
- sediment and soil contamination at concentrations that effect geologic resources ;
- reduction in mussel density and community richness;
- reduction in crayfish density;
- lead concentrations in benthic fish exceeding World Health Advisory consumption advisories;
- lead concentrations in songbird tissues in excess of levels found to have adverse effects; and evidence of phytotoxicity and reduced floristic quality.

Please see Section 2.2 of the SEMORRP for further information related to the history of lead mining and NRDA in the SEMOLMD as well as our websites::

<http://dnr.mo.gov/env/hwp/sfund/nrda-se.htm>

or

<http://www.fws.gov/midwest/es/ec/nrda/SEMONRDA/index.html>

The proposed projects described in this Draft RP/EA lie adjacent to the Big River downstream of its confluence with Calico Creek, and surrounding riparian, floodplain, and upland areas. (Figure 1).

The trustees have prioritized restoration goals within the Big River (discussed above) which conform to the trustees preferred Alternative D for restoration presented in the SEMORRP. Figure 2 represents the Corps' Meramec FS Tentatively Selected Plan projects and a generalized representation of the trustees priority restoration area for this Draft RP/EA.

Summary information about Southeast Missouri Ozarks' physical, biological, and socioeconomic resources are contained in Section 4 of the SEMORRP. Summary information about Big River, which make up part of the Meramec River Watershed of the

Southeast Missouri Ozarks, including physical resources (geology, topography, soil, surface water, and groundwater), aquatic habitat, and biological resources, including sensitive species, is contained in Appendix D of the SEMORRP (see pages 14 – 17, 22, 25, 26, 27, and 32). These sections of the SEMORRP are incorporated by reference herein.

### **3 Proposed Restoration Alternatives**

To compensate the public for injuries to natural resources resulting from releases of metals from facilities in the Big River watershed, the Trustees are required to develop alternatives for the “restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the natural resources and the services those resources provide” (42 C.F.R. §11.82 (a)). The Trustees developed the SEMORRP and identified broad categories of restoration types. As described in Alternative D (Preferred Alternative) of the SEMORRP, the Trustees presented a suite of restoration project types that would be considered for implementation, including riparian corridor and stream bank restoration or enhancement. Except for Alternative A, the No Action Alternative, all restoration alternatives proposed by the Trustees in this Draft RP/EA are consistent with the preferred alternative in the SEMORRP and fall into categories of floodplain and riparian corridor enhancement, surface water quality and aquatic resource improvement; and terrestrial habitat protection and enhancement.

#### **3.1 Restoration Evaluation Criteria**

To ensure the appropriateness and acceptability of restoration options addressing ecological losses, the Trustees evaluated each option against restoration evaluation criteria.

Below are the criteria used to evaluate the potential restoration alternatives described in this Draft RP/EA as part of the NRDAR process. The criteria reflect the “factors to consider when selecting the alternative to pursue” (NRDAR factors) as described in 43 C.F.R. § 11.82(d)(1-10). Specifically, the Trustees have considered the following factors in evaluating the alternatives presented in this Draft RP/EA:

- Relationship to the Injured Resource and Services
- Technical Feasibility (43 CFR 11.82(d)(1);
- Compliance with Laws, Regulations, and Policies (43 CFR 11.82(d)(9-10);
- Consistency with the Trustees Restoration Goals;
- Public Health and Safety (43 CFR 11.82(d)(8);
- Avoidance of Further Injury (43 CFR 1.82(d)(5);
- Time to Provide Benefits
- Duration of Benefits

The trustees’ evaluation of these criteria is consistent with the criteria identified in Sections 6.4 and 6.5 of the SEMORRP, incorporated by reference herein. Additional criteria that the

Trustees use in evaluating restoration projects contained in Appendix A of the SEMORRP include:

- Benefits federal and state listed species;
- Restores lost human uses
- Creates connectivity between habitat areas
- Conservation cost effectiveness
- Measures of performance success, and
- Inclusion of contingency plans or adaptive management.

### **3.2 Alternative A-No Action Alternative (Natural Recovery)**

Under this alternative, the Trustees would rely on natural recovery and would take no direct action to restore natural resources or compensate for interim lost natural resource services. This alternative would include the continuance of ongoing monitoring programs, such as those initiated by the MoDNR for benthic macroinvertebrates but would not include additional activities aimed at reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes. Under this alternative, no compensation would be provided for lost resource services pending restoration.

Under the No Action Alternative, no habitats would be preserved, restored, or enhanced beyond what agencies and organizations are already doing in the area with limited existing resources. Aquatic and riparian habitats would continue to be degraded along Big River, and in adjacent habitats. Water and sediment quality would continue to be impaired. Migratory bird individuals and/or populations would continue to be adversely impacted by degradation of resting, foraging, and nesting habitat. Local citizens and visitors recreating in the affected areas would not benefit from improved ecological resources, such as fish populations and wildlife habitat providing wildlife viewing opportunities. Agricultural land would continue to be lost due to stream bank erosion.

### **3.3 Alternative B – Big River and Calico Creek Riparian Restoration**

This alternative focuses on the restoration and protection of stream banks through planting riparian forests along Big River and Calico Creek on private property. This alternative involves integration of restoration activities with the EPA's Pilot Project in Calico Creek and with the Corps' proposed projects as described in the Meramec FS. Riparian corridor work along the Big River would be implemented after access road construction and bank stabilization activities. Specific projects will include:

- Re-forestation of approximately 3.5 acres of riparian corridor through the establishment of native grasses, shrubs and trees appropriate for the area in a zone extending 50 to 150 feet perpendicular to the streams (depending on stream size);

- Preservation of project areas and 71 acres of existing riparian corridor through establishment of a conservation easements with willing land owners will ensure long-term protection; and.
- Adaptive management, and monitoring of the restoration for 30 years will further ensure ecological integrity of the restoration.

Specific benefits provided by this alternative include:

- Restores native habitat to the riparian zones of contaminated streams;
- Improves water quality by preventing erosion of silt and soil into streams through bank stabilization and runoff filtration;
- Reduces land lost due to erosional processes;
- Replaces non-native plants with native plants and trees which will increase wildlife habitat diversity and robustness including important habitat for migratory birds and other trust species;
- Stabilizes in-stream habitat necessary to support aquatic species and their habitats including non-game and sport fish;
- Collaboration with EPA/Corps bank stabilization project will help prevent continued erosion of the bank that would de-stabilize riparian restoration, release contaminated soil, and degrade riverine habitat; and
- Land protections will ensure the longevity of the project and its benefits.

The Trustees have used U.S. Department of Agriculture Natural Resource Conservation Service (2019) cost guide to estimate commonly implemented conservation practices. The Trustees outline the anticipated costs of the projects in Table 1 below.

**Table 1. Cost Estimates for riparian corridor restoration (Alternative B)**

<b>Costs Description</b>	<b>Quantity</b>	<b>Estimated Costs</b>
Riparian Buffer Revegetation	3.5 acres	\$3,000
Easements and Preservation of Existing Corridor	75 acres	\$170,000
Implementation, Adaptive Management, and Monitoring	75 acres for 30 years	\$34,000
<b>Total</b>		<b>\$207,000</b>

### 3.4 Alternative C - Big River Floodplain Soil Restoration

This alternative focuses on restoring floodplain soils and revegetating fields currently planted in non-native grasses on private property to restore natural resources and associated service. Components of this alternative include restoration of 125 acres in total described below:

- Pilot phosphate treatment study and potential stabilization of up to 25 acres of contaminated floodplain soils through application of high phosphate soil amendments and lime. Research on contaminated Big River floodplain soils and other heavy metals contaminated areas demonstrates that application of high phosphate fertilizer can change the form of lead in the soil and significantly reduce its bioavailability and toxicity (Weber et al. 2015, Mosby et al. 2006, and Tang et al. 2009). Beyer et al. (2016) demonstrated reduced bioavailability to Japanese quail dosed with Big River floodplain soils and other Missouri soils treated with phosphate. Soil amendments would consist of four to six tons of high phosphate fertilizer and three to five tons of lime per acre followed by mulching with natural material or covering with a biodegradable landscape fabric. Soil amendments will be added in relatively small increments (one to two acre plots) to insure proper management of nutrients. Revegetation of this area with native grasses, shrubs and/or trees would follow soil treatment. Monitoring activities will evaluate the effectiveness of the Pilot Study and its potential for broader implementation in other areas of the Big River.
- Planting native bottomland forest or wet meadow species in 75 acres old field floodplain in Big River and Calico Creek bottomland;
- Forest management of approximately 25 acres of bottomland forest by thinning and removal of undesirable overstocked species and allowing black walnut, other nut producing hardwood species, and bottomland forest tree species to thrive.
- Preservation of all project areas through establishment of a conservation easement with willing land owners to ensure long-term protection.
- Monitoring and adaptive management of the restoration will further ensure ecological integrity of the restoration

Specific benefits provided by this alternative include:

- Restores native habitat to the floodplain zones of contaminated streams;;
- Improves water quality by preventing erosion of silt and soil into streams through runoff filtration;
- Reduce land lost due to erosional processes;
- Replaces non-native plants with native plants and trees which will increase wildlife habitat diversity and robustness including important habitat for migratory birds and other trust species;

- Restored floodplain will provide further protection of bank stabilization and riparian corridor restoration and indirectly support aquatic species and their habitats including non-game and sport fish.
- Collaboration with EPA/Corps bank stabilization project will: help ensure continued erosion of banks will not de-stabilize riparian restoration; reduce releases of contaminated soil from eroding banks; and provide additional enhancements of riverine habitat.

**Table 2. Cost Estimates for Big River Floodplain Restoration (Alternative C)**

<b>Costs Description</b>	<b>Quantity</b>	<b>Estimated Costs</b>
Floodplain Forest and Wet Meadow Revegetation	75 acres	\$115,000
Existing Bottomland Forest Management	25 acres	\$5,000
Phosphate and Lime Treatment of Soil	25 acres	\$100,000
Conservation Easement	125 acres	\$175,000
Implementation, Adaptive Management, and Monitoring	125 acres for 30 years	\$129,000
<b>Total</b>		<b>\$524,000</b>

### 3.5 Alternative D - Upland Forest, Woodland, and Glade Restoration

This alternative focuses on upland forest and woodland management of currently unmanaged forest and woodland areas. Components of this alternative include:

- Upland forest enhancement of approximately 385 acres through mechanical thinning and burning of overstocked trees to enhance wildlife habitat. Forest in the proposed restoration area is variably overstocked with many poor quality even-aged stands in some locations. This alternative would thin overstocked areas selecting for quality native oaks, hickories and pine species with a mix of dogwoods, cherry, persimmons and other understory trees. Other areas could be burned to thin overstocked understory trees and restore native glade and woodland habitats;
- Thirty year management of the forest, including periodic burning or herbicide application to control invasive species, would be additional components of this alternative.

- Preservation of all project areas through establishment of a conservation easement with willing land owners will ensure long-term protection. The upland forest and woodland in this proposed restoration area is in private ownership. The existing quality of the forest and woodland under consideration is variable. Long-term protection of the restoration and existing quality forest areas.

Specific benefits provided by this alternative include:

- Restores native habitat to the upland areas near Big River benefitting certain migratory bird species, federally listed bats and other terrestrial species;
- Improves water quality incrementally by preventing erosion of silt and soil into lowland areas through runoff filtration and watershed protection;
- Reduces erosion by preventing conversion of forested uplands to agricultural or residential uses; ;
- Replaces non-native plants with native plants and trees which will increase wildlife habitat diversity and robustness including important habitat for migratory birds and other trust species; and
- Restored upland will provide indirect and limited benefits in protection of bank stabilization, riparian corridor, and floodplain restoration projects by increasing infiltration in the watershed.

**Table 3. Cost Estimates for Upland, Woodland and Glade restoration (Alternative D)**

<b>Costs Description</b>	<b>Quantity</b>	<b>Estimated Costs</b>
Burning woodland and glades	195 acres	\$15,000
Timber stand improvement (thinning)	190 acres	\$80,000
Easements	385 acres	\$335,000
Implementation, , Adaptive Management, and Monitoring	385 acres for 30 years	\$64,000
<b>Total</b>		<b>\$494,000</b>

### **3.6 Alternative E- Riparian Corridor, Floodplain, and Upland Restoration, Enhancement, and Conservation (Preferred)**

This project alternative encompasses all the components of Alternatives B through D and involves the preservation of lands, pilot treatment of impacted soils, enhancement of riparian corridor, floodplain forests, and uplands in and around Big River and Calico Creek. Figures 3.a.b.and c. show proposed projects separated by property ownership.

This Alternative provides greater geographic benefits than the other Alternatives. Alternative E is a more comprehensive approach to habitat restoration and stream stabilization than the other alternatives individually. Maintaining native vegetation in a larger part of the watershed (e.g. the floodplain and uplands) will reduce flashy precipitation within the watershed that cause erosive degradation of riparian areas. These indirect effects will significantly increase the effectiveness of riparian corridor projects intended to support bank stabilization efforts. Additionally, selection of an alternative that revegetates the upland and floodplain without revegetating the riparian corridor will have only indirect effects on controlling erosion in the Big River or Calico Creek and will not prevent direct erosion of soil critical to the success of the project site.

From a terrestrial perspective, the larger blocks of protected and restored forest and woodlands presented in this alternative are more effective at establishing ecosystem function by restoring both upland and bottomland migratory bird habitat, than smaller patchwork restoration proposed by other alternatives. Many bat species need diverse forested habitat that has access to streams for foraging. A diversity of habitats as proposed under this alternative would also be beneficial to a wider diversity of wildlife. The total area of restored and preserved forested habitat under this alternative are over 430 acres.

Specific benefits provided by these proposed projects include:

- Restores native habitat to the upland areas near Big River benefitting certain migratory bird species, federally listed bats and other terrestrial species;
- Water quality improvements by preventing erosion of silt and soil into lowland areas through runoff filtration and watershed protection;
- Indirectly reduces land lost due to erosional processes;
- Replaces non-native plants with native plants and trees which will increase wildlife habitat diversity and robustness including important habitat for migratory birds and other trust species;
- Restored upland will provide indirect and limited benefits in protection of bank stabilization, riparian corridor, and floodplain restoration projects by increasing infiltration in the watershed;
- Reduces bioavailability of metals and exposure on flora and fauna to elevated lead concentrations through the stabilization of contaminated floodplain soils via application of high phosphate soil amendments and lime; and
- Increases efficiency and success of remedial and restoration efforts through coordination with EPA and Corps.

**Table 4. Cost Estimate of Alternative E (Preferred)**

<b>Costs Description</b>	<b>Quantity</b>	<b>Estimated Costs</b>
Riparian Corridor Restoration	75 acres	\$207,000
Floodplain Forest and Wet Meadow Restoration	125 acres	\$524,000
Upland Forest Restoration	385 acres	\$494,000
<b>Total</b>	<b>585 acres</b>	<b>\$1,225,000</b>

#### **4 Environmental Assessment**

Actions undertaken by a federal agency to restore natural resources or services under CERCLA are subject to the NEPA (42 U.S.C. § 4321 *et seq.*) and other federal laws, including but not limited to the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA). NEPA requires an assessment of any federal action that may impact the human environment. To the extent additional analysis is warranted and as appropriate, the public will have the opportunity to comment.

##### **4.1 Environmental Assessment**

In this section, the Trustees analyze the environmental consequences of Alternatives A, B, C, D, and E to determine whether implementation of any of these alternatives may significantly affect the quality of the human environment, particularly with respect to physical, biological, socio-economic, or cultural environments. This section also identifies the preferred alternative and whether it should be implemented following the public comment period and publication of the Final RP/EA.

The Corps also completed an environmental analysis (EA) of the projects identified in the Meramec FS. Restoration Alternatives B and portions of the Preferred Alternative E are evaluated within the Meramec FS/EA. As identified more fully herein, the Trustees incorporate by reference portions of the Corps' Meramec FS/EA, as appropriate.

The following definitions will be used to characterize the nature of the various environmental consequences evaluated in this Draft RP/EA:

- *Short-term or long-term impacts.* In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.
- *Direct or indirect impacts.* A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action.
- *Negligible, minor, moderate, or major impacts.* These relative terms are used to characterize the magnitude of an impact. Negligible impacts are generally not quantifiable and do not have perceptible impacts on the human environment. Minor impacts are generally those that might be perceptible but, in their context, are not amenable to measurement because of their relatively inconsequential effect. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth under NEPA (40 C.F.R. § 1508.27) and, thus, warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.
- *Adverse or beneficial impacts.* An adverse impact is one having unfavorable or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.
- *Cumulative impacts.* Cumulative impacts are defined as the “impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 C.F.R. § 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time within a geographic area.

#### **4.1.1 Affected Environment**

This section describes the current physical, biological, socio-economic, and cultural resources of the Big River watershed area that may be affected by the restoration alternatives under consideration. This information will ensure that potential restoration projects are designed to maximize ecological benefits while minimizing or eliminate project-related adverse environmental consequences.

##### **4.1.1.1 Big River Watershed**

The Big River lies within the Meramec River Watershed and is the largest tributary to the Meramec River. Summary information about Southeast Missouri Ozarks’ physical, biological, and socioeconomic resources are contained in Section 4 of the SEMORRP. Summary information about the Meramec River Watershed of the Southeast Missouri Ozarks, including physical resources (geology, topography, soil, surface water, and

groundwater), aquatic habitat, and biological resources, including sensitive species, is contained in Appendix D of the SEMORRP (see pages 14 – 17, 22, 25, 26, 27, and 32). These sections of the SEMORRP are incorporated by reference herein.

Prior to implementing restoration practices described by this RP/EA additional Endangered Species Act consultation will be completed due to the potential presence of federally-listed species, such as Indiana bats or pink mucket mussels. In addition, National Historic Preservation Act consultation will also be completed prior to construction activities.

There are a number of areas in Big River affected by one more or more environmental stressors. Stressors in the Big River include not only hazardous substances released from hard rock mining, but also effluent from waste water treatment facilities and other point source discharges and sedimentation and erosion from agricultural and logging practices.

When evaluating restoration projects and areas, it is important to identify stressors in order to identify the locations and types of projects to prioritize (e.g., areas by watershed; areas most in need of restoration; areas most at risk; areas where restoration will be most likely to succeed, etc.). The existing stressors are also considered in the evaluation of injury when establishing the baseline conditions of the area.

#### **4.1.1.2 Terrestrial Environments**

Terrestrial restoration projects are proposed within the Big River watershed. These projects will be planned for upland areas (hill sides and ridgetops). Summary information about physical and biological resources of terrestrial environments is contained in Section 4 of the SEMORRP and in Appendix D. These sections of the SEMORRP are incorporated by reference herein.

## **4.2 Demographics**

A summary of demographic data is provided in the Meramec FS and is incorporated herein by reference. In general, the proposed project area is rural and agricultural land, with pasture cattle, hay cropping, and timber production. The closest towns to the project area are Richwoods in Washington County, approximately 5 miles away and De Soto in Jefferson County, approximately 10 miles away. De Soto is a larger municipality than Richwoods and correspondingly contains more developed commercial and light industrial districts. Whereas, Richwoods has very few businesses or amenities. Additional information on demographics of the areas within which the Trustees propose restoration activities in this Draft RP/EA are discussed in SEMORRP section 4.3.2 page 30 and are incorporated by reference herein.

### **4.2.1 Executive Order 12898 Analysis**

The Meramec Feasibility Study evaluated project effects of restoration in Jefferson County under Executive Order 12898 which analyzes environmental justice to low-income or

minority populations. This analysis within Section 2.10.3, pages 46 and 47 is incorporated by reference herein.

### **4.3 Recreation**

Recreational resources are highlighted in the SEMORRP in Section 4.3.1 and a list of public lands in the SEMO provided in Appendix F. These sections of the SEMORRP are incorporated by reference herein.

Impacts to recreation are anticipated to be beneficial for the property owners within the project area, and marginally enhanced to the general public. The conservation easements would not allow public access to the property. The project is located between Missouri Department of Conservation boat accesses. Therefore, boat-based recreational activities are expected to be marginally enhanced due to improved scenic and habitat features within the river due to the project construction.

### **4.4 Cultural and Historic Resources**

The proposed projects are located in Jefferson County, Missouri. Significant historical and cultural resources, including Native American cultural and archeological sites, some of which are protected through Missouri State Parks system are found in the vicinity of the restoration areas; however, there are no known cultural or historic resources within the boundaries of the proposed restoration sites.

Prior to the implementation of the proposed restoration projects, potential impacts to historic and archaeological resources will be reviewed. Section 106 of the NHPA requires federal agencies to consider the effects of preferred alternatives on historic properties. Historic properties must also be given consideration under NEPA.

The Trustees will consult with the Missouri State Historic Preservation Office to complete Section 106 review and compliance prior to taking on-the-ground restoration actions.

### **4.5 Components Not Affected or Not Analyzed in this Document**

The following components, identified as not being present, affected, or analyzed are not brought forward for additional analysis in this Draft RP/EA:

- Social/Economic/Environmental Justice – No social or economic impacts are expected from the proposed restoration projects because of the remote location and types of projects proposed. There are low-income populations near proposed project areas, but these populations will not be adversely affected due to the intended beneficial environmental outcomes of the projects and use of some of the areas for recreation. The restoration

projects proposed are expected to be performed by Trustee contractors. The Trustees contracting process can encourage local employment opportunities through the companies to conduct restoration activities.

- Recreation – Impacts to recreation are anticipated to be marginally beneficial in the vicinity of the project areas where public access will be allowed, such as boating on the Big River. The project is located between Missouri Department of Conservation boat accesses. Therefore, boat-based recreational activities are expected to be enhanced. Other types of recreation to be benefited by the property owners include forest-based recreation, such as hunting, where allowed, other wildlife-associated activities, and hiking. However, public access will not be allowed on private property where the restoration projects would be constructed.
- Cultural and Historic Resource Concerns – The Trustees will consult with the Missouri State Historic Preservation Office prior to implementing any restoration activities.
- Air and Climate – Proposed activities, including operation of heavy construction equipment, are not expected to produce air pollutants at levels to exceed state air quality standards.

#### **4.6 Evaluation of Alternative A: No Action/Natural Recovery**

The No Action/Natural Recovery Alternative in this Draft RP/EA (Alternative A) is similar to the No Action from the SEMORRP (see SEMORRP p. 16, 25, and 26).. Environmental consequences of the No Action alternative are described on pages 35 and 36 of the SEMORRP, incorporated by reference herein.

##### **4.6.1 Conclusion on Alternative A**

The Trustees found that the No Action Alternative would not meet the purpose and need for restoration under this Draft RP/EA, the Restoration Evaluation Criteria, or CERCLA, including as defined by CERCLA NRDAR procedures. Therefore, the No Action Alternative is not a preferred restoration alternative when evaluated against the NRDAR evaluation criteria.

#### **4.7 Evaluation of Alternative B: Big River and Calico Creek Riparian Corridor Restoration**

Environmental consequences associated with implementation of Alternative B have been evaluated at a programmatic level on pages 37 through 40 of the SEMORRP, which discusses among other components restoration, enhancement or protecting riparian corridor resources. These sections of the SEMORRP are incorporated by reference herein. The analysis of riparian corridor and related stream bank restoration is discussed in the Meramec FS/EA at pages 84-97, Section 4.0. That analysis is incorporated by reference herein.

##### **4.7.1 Physical and Biological Environment Impacts**

Some restoration activities within this category may cause minor to moderate, short-term, direct or indirect adverse impacts; however, the long-term benefits listed above are expected to outweigh any of these adverse impacts. During project implementation, there would be minor to moderate short-term, direct disruptions to habitat due to the movement soils as a result of tree planting, and other related actions. These impacts are expected to be localized, temporary and minor. Long-term beneficial impacts to aquatic resources and riparian plants and animals would occur due to the reduced contaminant burdens, reduced erosion, and increased shelter provided by new plantings, and beneficial impacts would span a large geographic area downstream.

#### **4.7.2 Conclusion on Alternative B**

The Trustees found Alternative B to meet the purpose and need for this Draft RP/EA and all the Restoration Evaluation Criteria, including alignment of the proposed project and the Trustees' restoration goal of improving stream condition and supporting native aquatic communities. The Trustees have found Alternative B to have negligible adverse impacts to the human environment, with most anticipated effects being beneficial and long-term. For these reasons, Alternative B, taken together with the other alternatives described herein, is a component of the Preferred Alternative (Alternative E).

### **4.8 Alternative C: Big River Floodplain Restoration**

Environmental consequences associated with implementation of Alternative C have been evaluated at a programmatic level on pages 37 through 40 of the SEMORRP, which discusses among other components restoration, enhancement or protecting floodplain resources. These sections of the SEMORRP are incorporated by reference herein. Because the SEMORRP did not include a more-detailed analysis of the proposed project type (floodplain restoration), this document provides a more in-depth analysis as the alternative is described in Section 3.C, above. The analysis of floodplain and related stream bank restoration is also discussed in the Meramec FS/EA at pages 84-97, section\_4.0. That analysis is incorporated by reference herein.

#### **4.8.1 Physical and Biological Environment Impacts**

Soil restoration activities as proposed are expected to cause minor to moderate, short-term, localized adverse impacts to existing natural resources, and result in moderate long-term benefits across a localized area. Stabilizing contaminated soils will reduce the risk of effects associated with wildlife exposure to hazardous substances commingled with the soil in the environment, and result in enhanced condition of local wildlife populations, including migratory birds and sensitive species.

Some of the soil restoration activities will result in direct and indirect, short-term, localized adverse impacts on natural resources such as soil, sediment, soil-dwelling organisms, and vegetation. Existing habitat may in some cases be substantially modified to create the vegetation necessary for the successful development of terrestrial habitats supportive of native plants and wildlife. This will likely involve the use of heavy forestry machinery and

other equipment, which may result in soil compaction, localized emissions from heavy equipment, removal or crushing of understory vegetation, and increased soil erosion in the immediate area of construction operations. However, the long-term direct and indirect benefits expected from soil excavation, regrading, and soil restoration activities outweigh the potential adverse impacts.

In some areas where soil lead concentrations remain relatively high (>350 mg/kg), phosphate in the form of triple superphosphate may be added along with lime to reduce soil lead bioavailability. Phosphate amendments have been shown to reduce soil lead leaching and plant lead uptake while having negligible to minor adverse effects on the environment (Tang et al. 2009; Weber et al. 2015). The Trustees will use best available science to inform the soil amendment process to increase likelihood of success for reducing soil lead bioavailability, while minimizing likelihood of potentially adverse environmental consequences. Decisions from the implementation of the phosphate treatment of soils will inform the trustees on the scalability of phosphate treatment work for future efforts.

Other restoration actions associated with Alternative C, including planting bottomland forest species, invasive species control, and erosion reduction, will have negligible to minor short-term, direct and indirect adverse effects on the environment. Minor to moderate long-term benefits across a broad geographic scope are anticipated though, including reduction of invasive species, reduced sediment transport into local waterways, and increases in local native wildlife species. Long-term, moderate beneficial impacts to resources and associated flora and fauna are expected due to the reduced erosion and increased shelter provided by plantings.

#### **4.8.2 Conclusion on Alternative C**

The Trustees found Alternative C to meet the purpose and need of this Draft RP/EA and all of the Restoration Evaluation Criteria, including alignment of the proposed project and the Trustees' restoration goal of improving habitat conditions for migratory birds and sensitive species. The Trustees have found Alternative C to have negligible to moderate short-term adverse impacts to the human environment, with the majority of anticipated effects being beneficial and long-term. For these reasons, Alternative C, taken together with the other alternatives described herein, is a component of the Preferred Alternative (Alternative E).

#### **4.9 Alternative D: Upland Forest, Woodland, and Glade Restoration**

Environmental consequences associated with implementation of Alternative D have been evaluated at a programmatic level on pages 37 through 40 of the SEMORRP, which discusses among other components restoration, enhancement or protecting upland resources. These sections of the SEMORRP are incorporated by reference herein.

Alternative D could have short-term negative consequences to some wildlife, since it involves tree thinning and burning. Wildlife present during these activities will be negatively impacted. Some soil compaction during the operation through use of heavy

equipment will occur. However, best management practices and implementation of these activities in winter months will reduce the short term negative impacts to soils and wildlife.

Alternative D will result in new or improved habitat in forested and other upland areas. Improved habitat conditions will lead to an improved resource-based recreational activities, such hunting, hiking and bird watching. Land preservation through easements will ensure long-term viability of these projects. Alternative D would also allow the Trustees to implement monitoring and long-term stewardship activities to ensure existing natural resource services and aesthetic values are conserved and are available into the future.

#### **4.9.1 Conclusion on Alternative D**

The Trustees found Alternative D to meet the purpose and need of this Draft RP/EA and all of the Restoration Evaluation Criteria, including alignment of the proposed project and the Trustees' restoration goal to preserve and/or enhance conservation value of upland or aquatic habitats supportive of injured natural resources. The Trustees anticipate Alternative D to have primarily beneficial direct and indirect long-term impacts in the form of improved land management activities enhancing fish and wildlife populations and recreation opportunities. For these reasons, Alternative D, taken together with the other alternatives, is a component of the Preferred Alternative (Alternative E).

### **5 Alternative E: Preferred Alternative**

The Trustees have selected a combination of three alternatives (B, C, and D) as the Preferred Alternative, which includes riparian corridor and floodplain restoration, soil restoration and re-vegetation and timber stand improvement of terrestrial habitats; and property protection. Specifically, the Preferred Alternative would include a variety of activities, taken as a whole provide the most benefits to the public by restoring and compensating for natural resources and associated services in aquatic and riparian habitats. Stream restoration will involve riparian corridor and floodplain forest plantings. This activity will benefit fish, crayfish and other aquatic invertebrates that are negatively affected by the erosion of heavy metal into the stream. Soil restoration with revegetation will involve treatment of contaminated soil to reduce its toxicity and provide less toxic terrestrial habitat. Conservation easements will insure long-term protection of approximately 585 acres of terrestrial habitat. Collectively these activities combine to form the Preferred Alternative, which will provide improved terrestrial habitat and improved stream habitat for the public benefit. The combination of the various alternative into the Preferred Alternative will provide more benefits than the sum of the parts. Protecting large sections of the upland watershed and riparian area will help ensure lowland restoration remains intact and retains its effectiveness in preventing erosion. Improving stream access through habitat corridors will have greater benefit to upland wildlife through access to water. A diversity of habitats is also considered ecologically beneficial. This range of restoration alternatives is consistent with the Preferred Alternative selected within the SEMORRP.

## **5.1 Conclusion on Alternative E**

The Trustees found Alternative E to best meet the purpose and need of this Draft RP/EA and all of the Restoration Evaluation Criteria, including alignment of the proposed project and the Trustees' restoration goal to preserve and/or enhance conservation value of upland or aquatic habitats supportive of injured natural resources. The Trustees anticipate Alternative E to have primarily beneficial direct and indirect long-term impacts in the form of improved land management activities enhancing fish and wildlife populations and recreation opportunities.

## **5.2 Cumulative Impacts**

Cumulative impacts associated with the Preferred Alternative of the SEMORRP can be found in Section 5.5.1 of that restoration plan, incorporated by reference herein. This section expands upon that analysis to a project-specific level.

Cumulatively, the Preferred Alternative is anticipated to have a cumulative impact that is long-term and beneficial. Water and sediment quality will be enhanced as a result of stream bank protections. Improved stream conditions should enhance habitat for fish and other aquatic life, and direct and indirect benefits may also be provided to wildlife using enhanced stream segments and downstream areas. Terrestrial habitats will be restored or enhanced after potential minor to moderate short-term impacts to terrestrial natural resources and some adjacent water bodies, such as nearby creeks. Terrestrial wildlife habitat conditions will improve as a result of improved habitat structure and increased native plant cover. Recreational activities may also be enhanced as a result of the improved environment within and downstream of the enhanced stream segment.

The Preferred Alternative is not expected to result in significant cumulative impacts on the human environment since it alone, or in combination with other current and future activities in the vicinity, would not change the larger current hydrological patterns of discharge in the Big, Meramec, and tributaries; recreational use; economic activity or land-use in the proposed project areas. Future activities within the scope of the Preferred Alternative, either completed by Trustee agencies or other organizations, agencies, or groups, will enhance habitat that exists naturally in the areas. For example, future stream or riparian restoration actions completed near the proposed project area may also enhance ecological conditions as a result of a more intact riparian corridor over a greater distance within the Big River.

There are several environmental regulatory activities ongoing in the Big River that in combination with the proposed restoration activities described herein will provide additional cumulative benefits to the environment. EPA led remedial activities at the Calico Creek pilot project location will result in stabilization of the stream bank within the project area. Future remedial actions throughout the Big River may address contaminated sediment and eroding stream banks through remedial activities. The Trustees and the Corps of

Engineers also expect additional ecosystem restoration activities in and around the Big River. Integration of NRDAR efforts at sites with remedial actions is anticipated to reduce the time for natural resources and their services to return to baseline conditions. However, the actual implementation of EPA and Corps projects is uncertain at this time. Other ongoing non-regulatory land-use activities that will likely have cumulative impacts on the area would include continued mining, milling, and smelting activities, and limited logging and cattle grazing operations.

## **6 Implementation, Monitoring, and Adaptive Management**

All components of the Preferred Alternative would include construction and implementation oversight by the Trustees. This could include contractor oversight, working with land-owners to ensure their questions and concerns are addressed, and working with partnering agencies such as the Corps and EPA. In addition, the Trustees can seek outside expertise on various components of the restoration that will improve overall habitat outcomes.

Most revegetation restoration efforts involve periodic management to ensure that the desired assemblage of native vegetation is sustained. Such management is based, in part, on adapting to the initial restoration and rehabilitation efforts as well as mowing, burning, additional mechanical tree thinning, or herbicide application to control invasive species.

Monitoring of all projects will be conducted by a Trustee representative or cooperative partners. Inspections will occur on an annual basis after the completion of the outlined restoration activity and for a period of time that will be designated in the contractual agreement with the implementing group/agency. For cost estimating purposes, the Trustees estimated monitoring and adaptive management costs for 30 years. The first five years of monitoring costs are more intensive and combined with implementation and adaptive management activities. The last twenty-five years of monitoring is restricted to one or two days inspection per year across the entire project area and continued management of the restoration to realize the ecological benefits of the projects. All restoration activities will be documented, and all practices monitored using pre-and post-photo points over the designated monitoring period. If survivorship of planted tree seedlings is determined to be less than a predetermined threshold, additional trees will be established within the riparian forest buffer. At the end of the outlined monitoring timeframe, a final report will be produced, summarizing the status of the restoration practice, amount of growth of the trees/shrubs, any undesirable growth of invasive plant species and overall success of the project. The report will also include a photographic history from the beginning stages of the project to the end of the monitoring period.

In addition to vegetation monitoring, bird and pollinator community measurements may be taken, as well as water and soil quality metrics. The phosphate treatment of soil components of the floodplain restoration will require specialized and intensive monitoring upon initial implementation. Phosphate treatment monitoring will include water quality analyses of runoff from initial constructed treatment areas and measures

of the soil to ensure the proper pH and desired lead bioavailability objectives have been met.

Monitoring will inform whether adaptive management activities are necessary. Examples of adaptive management could include increasing lime application to adjust soil pH of phosphate treatment, changing a vegetation mix in the floodplain to better compete with invasive species, discontinuing a planned burning regime in the upland due to bird response, etc.

## **7 Agencies, Organizations, and Parties Consulted for Information**

U.S. Fish and Wildlife Service  
Columbia Ecological Services Field Office  
101 Park DeVille Drive, Suite A  
Columbia, MO 65203

Missouri Department of Natural Resources  
Environmental Remediation Program  
P.O. Box 176  
Jefferson City, MO 65102-0176

U.S. Army Corps of Engineers  
1222 Spruce St.  
St. Louis Missouri 63103-2833

U.S Environmental Protection Agency  
Region 7  
11201 Renner Blvd  
Lenexa, KS 66219

Ozark Land Trust  
P.O. Box 1512  
Columbia, MO 65205

Missouri Department of Conservation  
St. Louis Regional Office  
2360 Hwy D  
St. Charles, MO 63304

The Nature Conservancy  
Missouri Chapter  
P.O. Box 440400  
St. Louis, MO 63144

Land Learning Foundation  
704 W. Jackson St., P.O. Box 55  
Keytesville, MO 65261

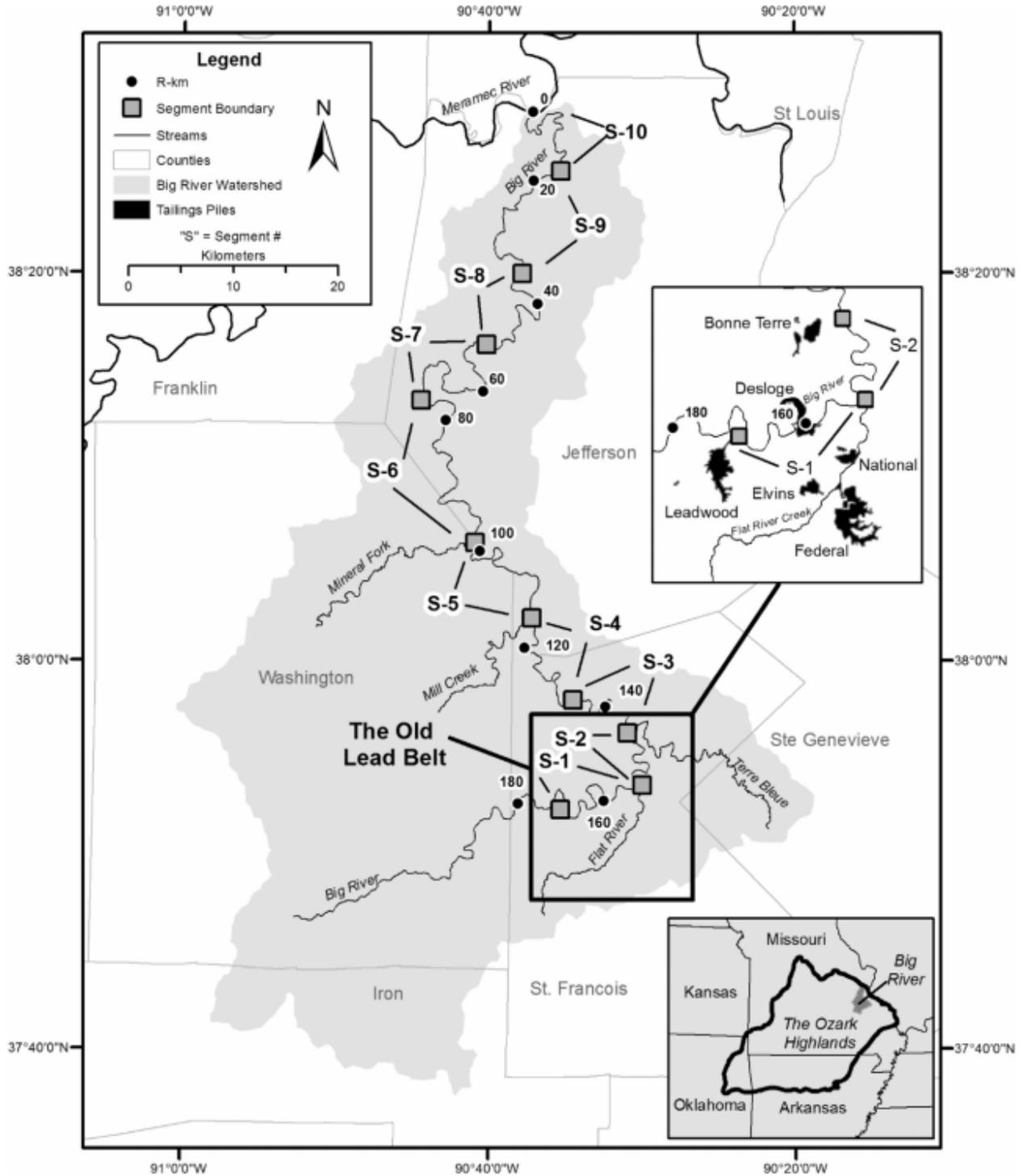
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9 Figures

Figure 1. Map showing Big River watershed and tailings piles from Pavlowsky et al. (2017).



**Figure 2. Map of Meramec FS Study Area and Tentatively Selected Plan Restoration Features from U.S. Corps of Engineers (2019)**

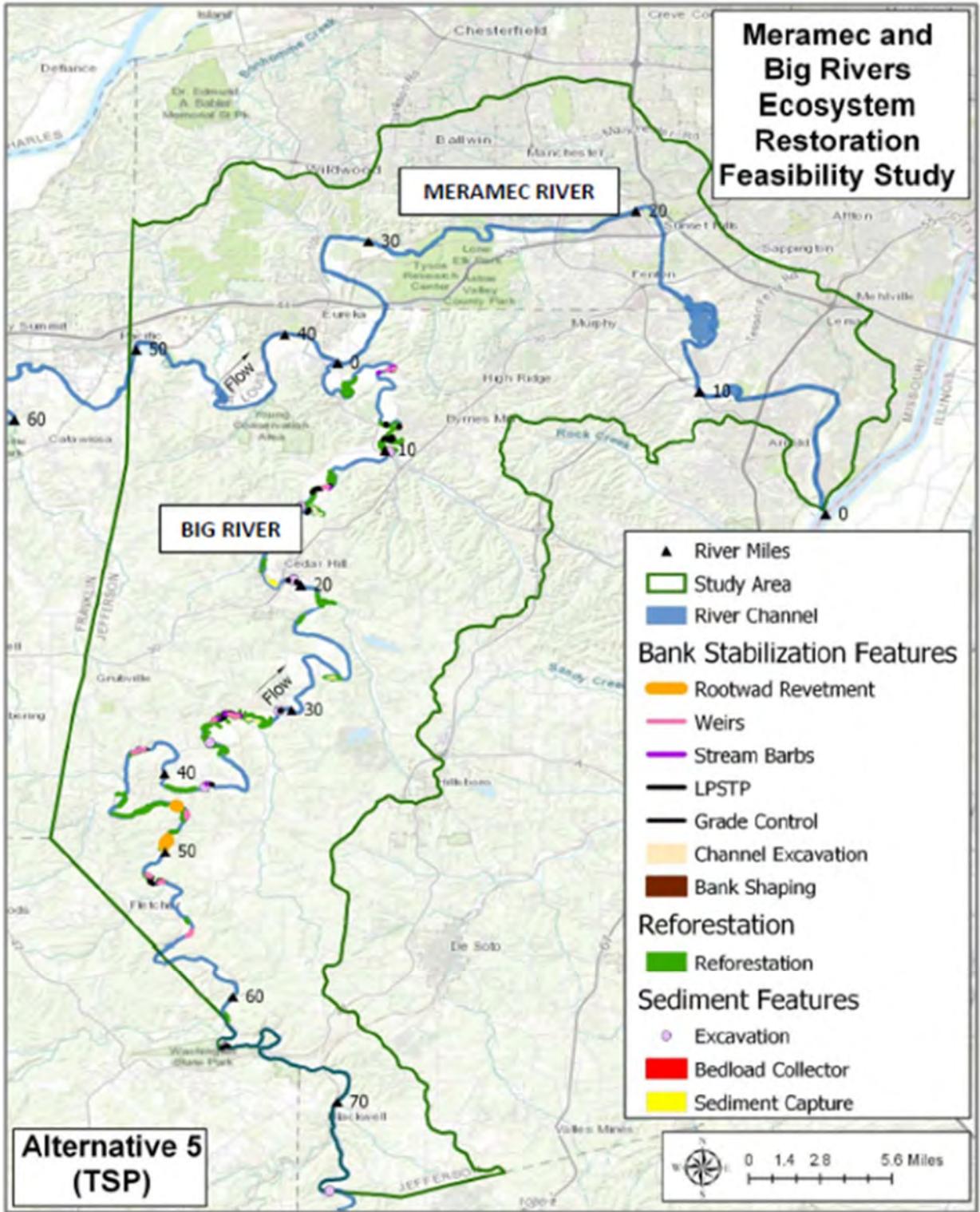
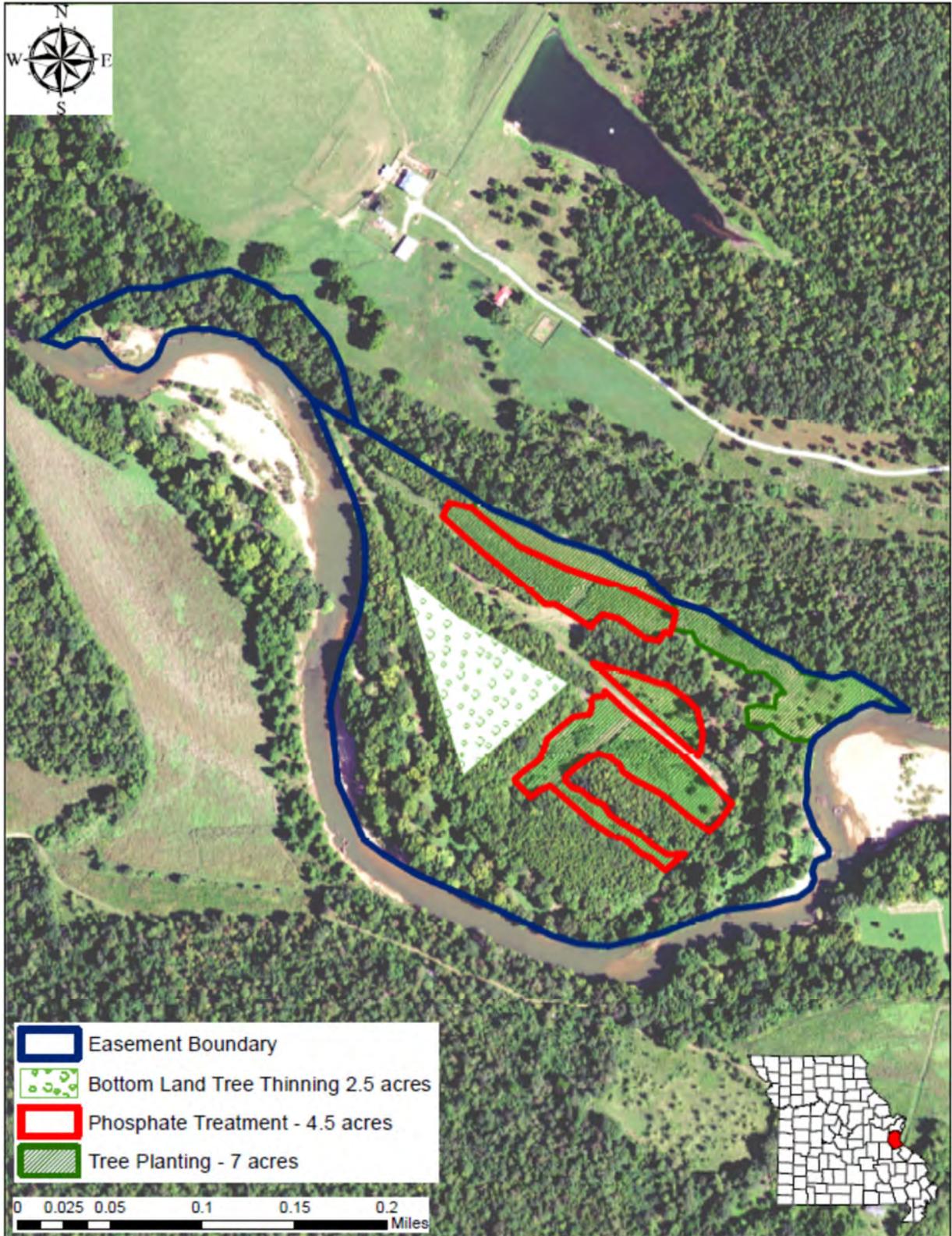
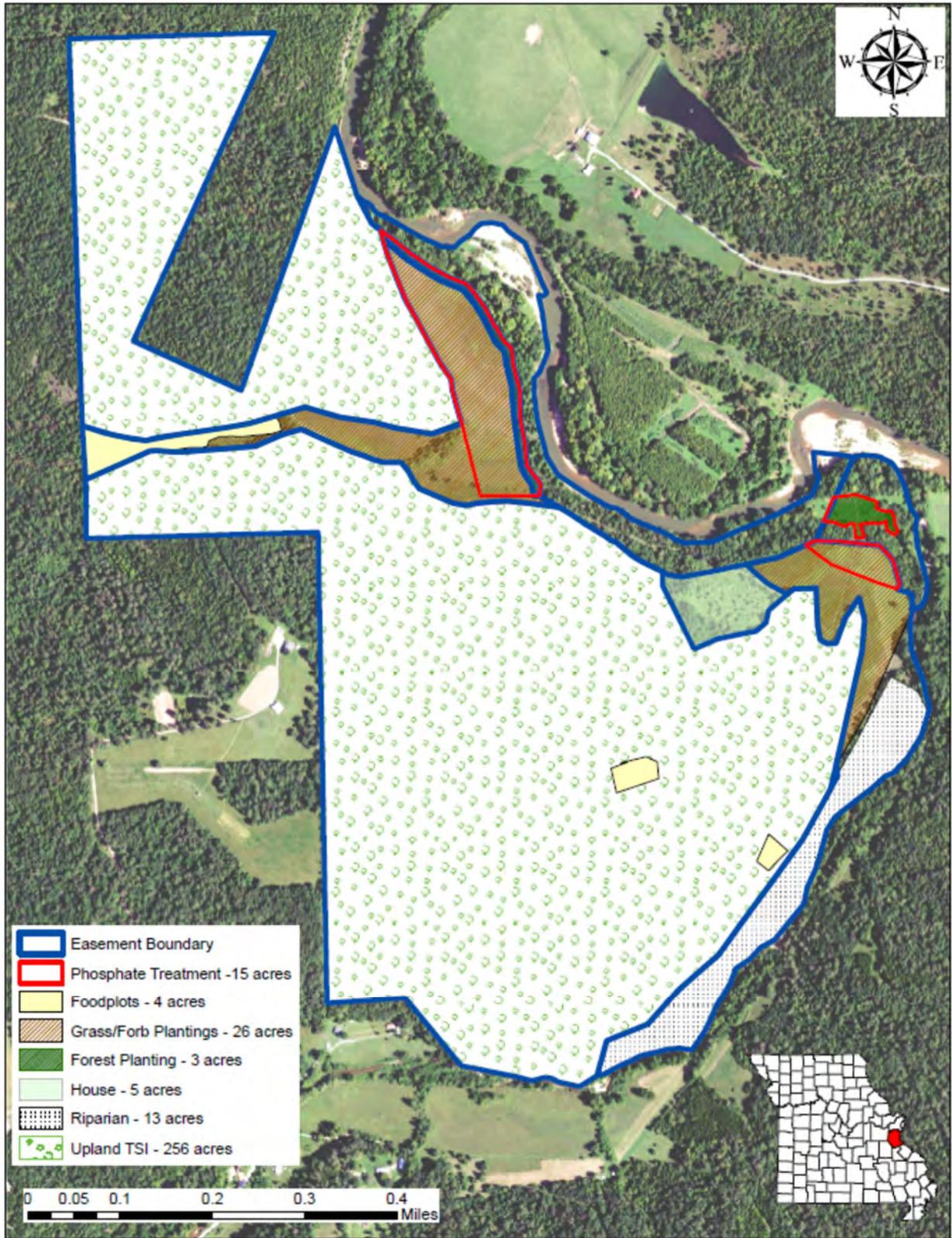


Figure 3.a.b.c. Alternative E Preferred Alternative projects.

a.



b.



c.

