

# Appendix E

## Civil Engineering Appendix

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### Attachments

Attachment A – Engineering Plates

Attachment B - Construction Schedule

## 1 General

This appendix documents the engineering analysis and follows the format in Appendix C of Engineering Regulation 1110-2-1150. Included with this appendix are Engineering Plates (Attachment A) and the Construction Schedule (included in Attachment B).

Ten alternatives (both structural and non-structural) were developed and considered in this study. These alternatives each involved construction at an existing feature of the project area to restore the ecosystem. The locations are specified in Attachment A to this appendix. The alternatives were:

Alternative A: Remove RC1 (Structural). Remove the entire structure of RC1.

Alternative B: Notch RC1 (Structural). Cut a notch in the existing upper concrete low water crossing at location RC1 in the main channel to the width of the Maumelle River above impounded pool.

Alternative C: Remove RC2 (Structural). Remove the entire structure of RC2.

Alternative D: Notch RC2 (Structural). Cut a notch in the existing middle concrete low water crossing at location RC2 in the main channel to the width of the Maumelle River above impounded pool.

Alternative E: Open SC1 (Structural). Reconnection of side channel 1 to the main channel. This involves notching an existing levee and removing culverts in two locations (metal culverts and concrete culverts) along an out-of-service road.

Alternative F: Open SC2 (Structural). Reconnection of side channel 2 to the main channel. This involves notching an existing levee and removing a road crossing of an out-of-service road.

Alternative G: Restore Tributary A (Structural and Non-structural)). Block channelized ditches while creating microtopography (pimple mounds or elongated ridges) to allow soil to spread across field, plant bottomland hardwood trees, notching a levee, and convert a culvert to a gravel low water crossing on an existing road.

Alternative H: Reforestation of Sod Farm (Non-structural). Plant bottomland hardwood to establish native growth in area of existing sod farm.

Alternative I: Repair RC3 Bank Erosion (Structural). Construct rock vanes at 20-degree angle upstream.

Alternative R: Combinations of River Crossings (Structural). This is actually four combinations of Alternatives A, B, C, and D that were used in the planning software as the AAHU calculations for each separate alternative were not additive. The combinations are as follows:

- R1 – Notch RC1 and Remove RC2
- R2 – Notch RC1 and Notch RC2
- R3 – Remove RC1 and Notch RC2
- R4 – Remove RC1 and Remove RC2

Combinations of these alternatives were developed to form seven plans, including a No Action Plan. The plans were developed based on the cost effective-incremental cost analysis (CEICA) results using IWR Planning Suite. The plans considered in this study were determined to be the best buys of the cost-effective plans generated by IWR Planning Suite (inclusive of the No Action plan) and are as follows:

Plan	Alternatives	Description
1	N/A	No Action
2	G	Restore Trib A
3	G, E	Restore Trib A, Open SC1
4	G, E, H	Restore Trib A, Open SC1, Reforestation of Sod Farm
5	G, E, H, R4	Restore Trib A, Open SC1, Reforestation of Sod Farm, Remove RC1 and RC2
6	G, E, H, R4, F	Restore Trib A, Open SC1, Reforestation of Sod Farm, Remove RC1 and RC2, Open SC2
7	G, E, H, R4, F, I	Restore Trib A, Open SC1, Reforestation of Sod Farm, Remove RC1 and RC2, Open SC2, Repair RC3

The plans were evaluated with Plan 5 being the Tentatively Selected Plan (TSP). The rationale for the TSP and plan evaluation can be found in the Main Report. A more in-depth explanation of the combinations of alternatives and plans developed thereof can be found in Appendix B: Socioeconomics and CEICA.

## 2 Surveying, Mapping, and Other Geospatial Data Requirements

No topographic survey was conducted with this feasibility study. A survey from USGS for the river and structures RC1 and RC2 was conducted for H&H purposes (Re: Appendix A). Quantities and data for civil engineering were taken from measurements on Google Earth and assumptions of similarity for structures constructed with other projects. Site visits confirmed the rough order of magnitude for these measurements.

A more current and comprehensive topographic survey will be required in order to develop plans and specifications. This survey must provide topographic features, boundary lines, easements, structures, utilities, roads, etc.

### **3 Geotechnical**

No existing geotechnical borings were available for this study. For the purposes of this feasibility study, the soil types are not significant as this is a restoration to existing conditions.

### **4 Civil Design**

#### **4.1 Site Selection and Project Development**

In order to find a solution for ecological restoration, a number of structural and non-structural measures (alternatives) were explored for different features and structures in the area that would contribute to the stated purposes of this restoration. Plans were compiled from combinations of these alternatives and evaluated to determine the available alternatives and the Tentatively Selected Plan (TSP). The Project Delivery Team (PDT) conducted site visits, considered existing improvements via aerial photography, and prepared preliminary cost comparisons in order to help facilitate selection of the most feasible and ecologically economical plan - what provided the greatest opportunity for average annual habitat units (AAHU's) for the cost.

In addition to the IWR Planning Suite results, the team also evaluated the alternatives as follows:

#### Alternatives B, D, R1, R2, and R3: (Not included in the TSP)

Alternatives involving notching the concrete structures RC1 and RC2 were considered in lieu of complete removal of these structures to reduce construction cost and schedule. These alternatives could cause increased velocities during higher flows that would result in streambed scour and bank erosion as well as still retaining sediment behind what remained of these structures. These alternatives could also result in not fully meeting the objectives of this project concerning facilitation of aquatic species migration and restoration of natural stream and floodplain conditions. These alternatives were included in the CEICA, but they did not provide the environmental benefit that complete removal of these structures would.

#### Alternative A: (Included in the TSP)

Removal of RC1 consists in the demolition and disposal of approximately 300 feet of the paved low-water crossing with a width of approximately 30'. Material to be removed was estimated to be 225 cubic yards of concrete (based on an estimated 8" thickness) and 441 cubic yards of gravel. To access this area, a 15-foot wide path would have to be cleared to the sod farm gravel road for 250 feet in length. Caution will have to be taken with access construction as a gas utility line crosses this area.

#### Alternative C: (Included in the TSP)

Removal of RC2 consists in the demolition and disposal of approximately 150 feet of the paved low-water crossing with a width of approximately 40'. Material to be removed was estimated to be 138 cubic yards of concrete (based on an estimated 8" thickness) and 232 cubic yards of

gravel. To access this area, a 15-foot wide path would have to be cleared to Higginbotham Road for 650 feet in length.

Alternative E: (Included in the TSP)

Reconnection of SC1 involves several areas of construction.

An opening in the levee at the width of the SC1 channel will be constructed to allow the water from the river to enter the side channel during higher flows as the channel used to convey prior to the levee's construction. The levee is estimated to be about 8' high with 3:1 slopes and a 6-foot wide top. The channel is approximately 40' wide. An estimated 400 CY of levee material will have to be removed to provide the proper notch size.

Approximately 1200' downstream from the split with the Maumelle River, SC1 splits into two channels upstream from a road crossing. At the road crossing are two culverts (one at each channel) are 15' long, 18" corrugated metal pipe (CMP) culverts. Demolition of these culverts involves an estimated 75 cubic yards of soil removal for each.

Approximately 2500' downstream from the split with the Maumelle River, there is another road with a two-barrel culvert (SC1 is back to a single channel at this point). The two 12-foot long, 18" CMPs and approximately 10 cubic yards of soil will have to be removed with demolition.

The access to the work areas for SC1 are estimated to involve 465' of 15-foot wide clearing and 1580' of 10-foot wide gravel surfacing to allow for construction vehicle access.

Alternative F: (Screened out)

Similar to SC1, the reconnection of SC2 involves a similar size levee notch (400 cubic yards of removal), excavation of a road crossing to open the channel (40 cubic yards of removal), and 2135' of 15-foot wide clearing with 10-foot gravel surfacing for construction vehicle access. This alternative was included in Plan 6. The CEICA indicated a high incremental cost to incremental output (average annual habitat unit (AAHU)) for Plan 6, and this alternative was screened out.

Alternative G: (Included in the TSP)

The restoration of Tributary A involves several construction items on and around the existing sod farm.

There are three channelized ditches that were constructed to drain the sod farm that also drain water away from Tributary A. These ditches will be plugged to allow water for Tributary A to follow its natural course. The three blockages will use an estimated 40 cubic yards of soil.

The channel for Tributary A will then be excavated to restore to pre-developed condition. This excavation is estimated to be 4500 cubic yards.

There is a two-barrel culvert under the sod farm gravel road that will be removed. The culverts are 18" CMP and 12-feet long. 10 cubic yards of excavation is required with this culvert removal.

The existing levee blocks Tributary A from its confluence with the Maumelle river on the east side of the sod farm. This levee will be notched at this location, opening the tributary to its original mouth. Excavation of 10 cubic yards of material is required.

Using soil to create pimple mounds or elongated ridges creating a microtopography is another feature to this alternative. This involves discing or other methods to create these features over 66 acres.

To protect this area from erosion after construction, a riparian buffer will be placed planting 19,932 trees (302 trees/acre) along the tributary.

For construction vehicle access, clearing a 15-foot wide area with 10-foot wide gravel surfacing for 115' will be required.

#### Alternative H: (Included in the TSP)

The restoration of riparian forest on the sod farm fields consists of planting 22,348 trees (302 trees/acre). Access to this area is already in place.

#### Alternative I: (Screened out)

The bank erosion at RC3 will be restored by placing 348 cubic yards of riprap to form rock vanes at a 20-degree angle upstream. Construction access will require a 15-foot wide, 670-foot long clearing with a 10-foot wide gravel surface. This alternative was included in Plan 7. Similar to Plan 6, the CEICA indicated a high incremental cost to incremental output for Plan 7, and this alternative was screened out.

### **4.2 Real Estate**

This project is entirely on the Central Arkansas Water property and will not require the acquisition of real estate in order to obtain access for construction equipment. Also, real estate acquisition will not be required for staging/lay down areas. Borrow or spoil areas will be off-site and the contractor's responsibility.

### **4.3 Relocations**

This project is entirely on the Central Arkansas Water property and will not require relocation of residents or businesses.

### **4.4 Risk for Cost Overruns in Civil Design**

#### **4.4.1 Utilities**

Team members identified utilities in the vicinity of the project during the site visit and from information received by the sponsors. For the selected plan, no utility relocations are anticipated.

There are overhead electric lines running through the project area. These lines run southeast to northwest between RC2 and the south end of SC2. Overhead lines are outside of anticipated

work areas and high enough to clear construction activities. No interference is anticipated with these electric lines.

There is also a gas line that crosses the Maumelle River upstream of RC1 running east toward the levee notch. This line does cross the construction access to RC1; depending on the depth located, some additional measures to protect the line from construction traffic will be taken. The contractor will be required to coordinate with the gas utility to ensure location and proper implementation protection measures during construction.

#### **4.4.2 Unknown Site Conditions**

Unknown site conditions are always a potential risk on a project. No HTRW or cultural resource sites were identified in the project area. Any new sites found during design could affect cost and schedule. Other possible unknown site conditions include mis-located utilities and unknown subsurface obstructions.

#### **4.5 Design Criteria and Standards**

The following documents and standards, as a minimum, will be incorporated in the design of this ecological restoration project.

- “Manual on Uniform Traffic Control Devices (MUTCD)”, Federal Highway Administration
- Architectural and Engineering Instruction Manual (AEIM), Southwestern Division
- Unified Facilities Criteria (UFC)
- American Society for Testing and Materials (ASTM) International Standards
- SpecsIntact will be utilized to develop the project specifications

### **5 Operation and Maintenance**

The sponsor will be responsible for maintenance such as watering newly planted trees as well as replacing planted trees that have died. The intent of this ecological restoration is to allow the natural flooding cycles and flow patterns to occur uninhibited in order to accommodate native species and habitat. Therefore, there would not be much in the way of on-going maintenance once the post-construction conditions are well established. A site visit by the sponsor to inspect the area note any unforeseen changes should be conducted annually.

### **6 Access Roads**

This project is located within Pulaski County upstream from (west of) Lake Maumelle. The project area is accessed from AR Hwy 10 then to Higginbotham Road (paved). The sod farm can be accessed directly from a gravel road that runs through it. The RC1 and SC1 work areas can be accessed from this same gravel road with some clearing and gravel surfacing. The RC2 work area can be accessed from Higginbotham Road with clearing and gravel surfacing between the road and the RC2 structure. The gravel surfacing will have to be built up to support construction traffic. Gravel will be removed at the end of construction and trees will be planted to restore cleared areas. The measurements and quantities of these internal access measures are noted for each alternative under Section 6.1.



## **7 Schedule for Design and Construction**

The schedule for the TSP, Plan 7 is located within Attachment B. The project is anticipated to have a duration of 14 months starting in FY2023 and ending in FY2024.

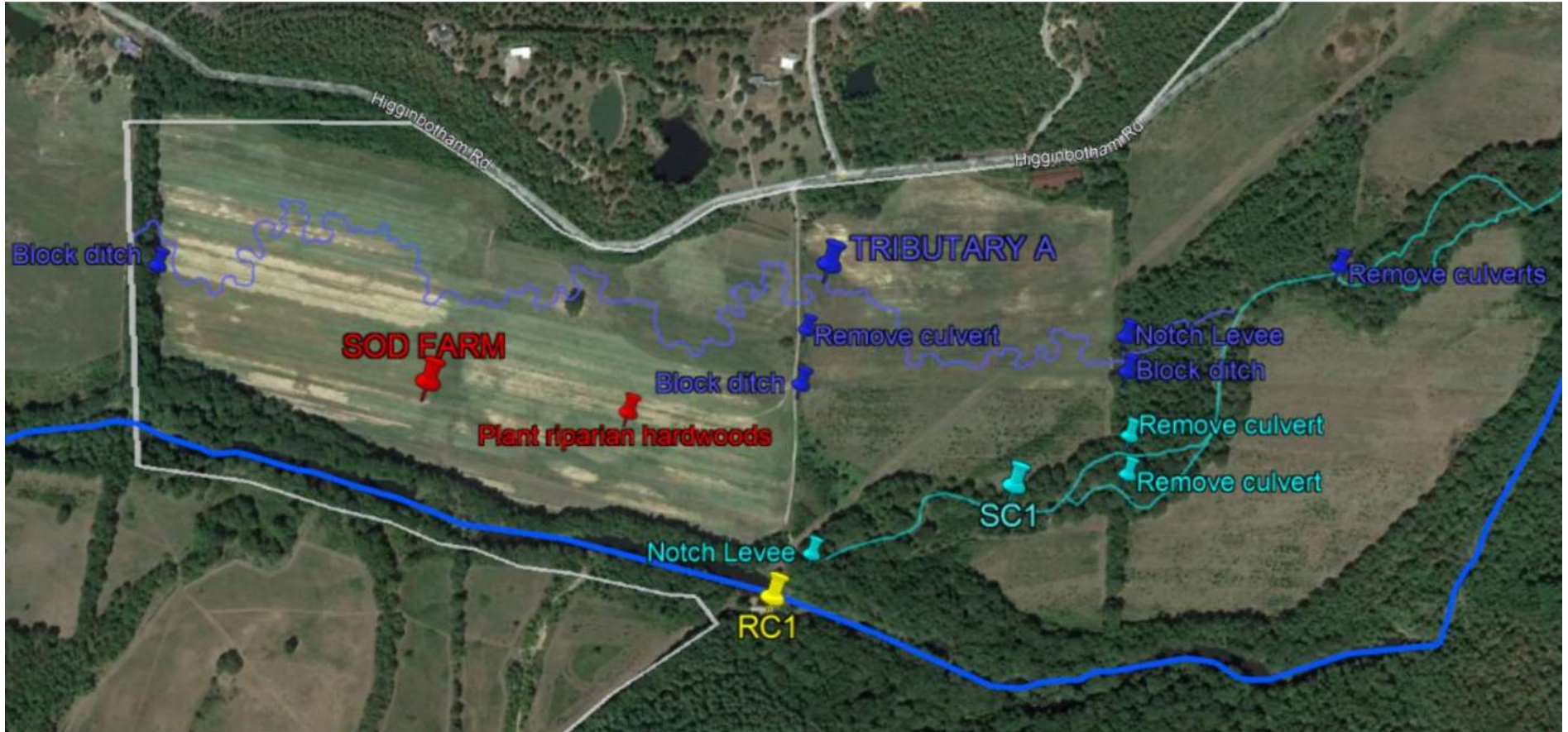
## **8 Plates, Figures, and Drawings**

There are two plates within Attachment A to the main engineering appendix showing plan views for the alternatives considered. Additional maps and drawings can be found in the main report.

# **Attachment A**

## **Engineering Plates**

Maumelle River Ecological Restoration, AR.  
Appendix E: Civil Engineering Appendix



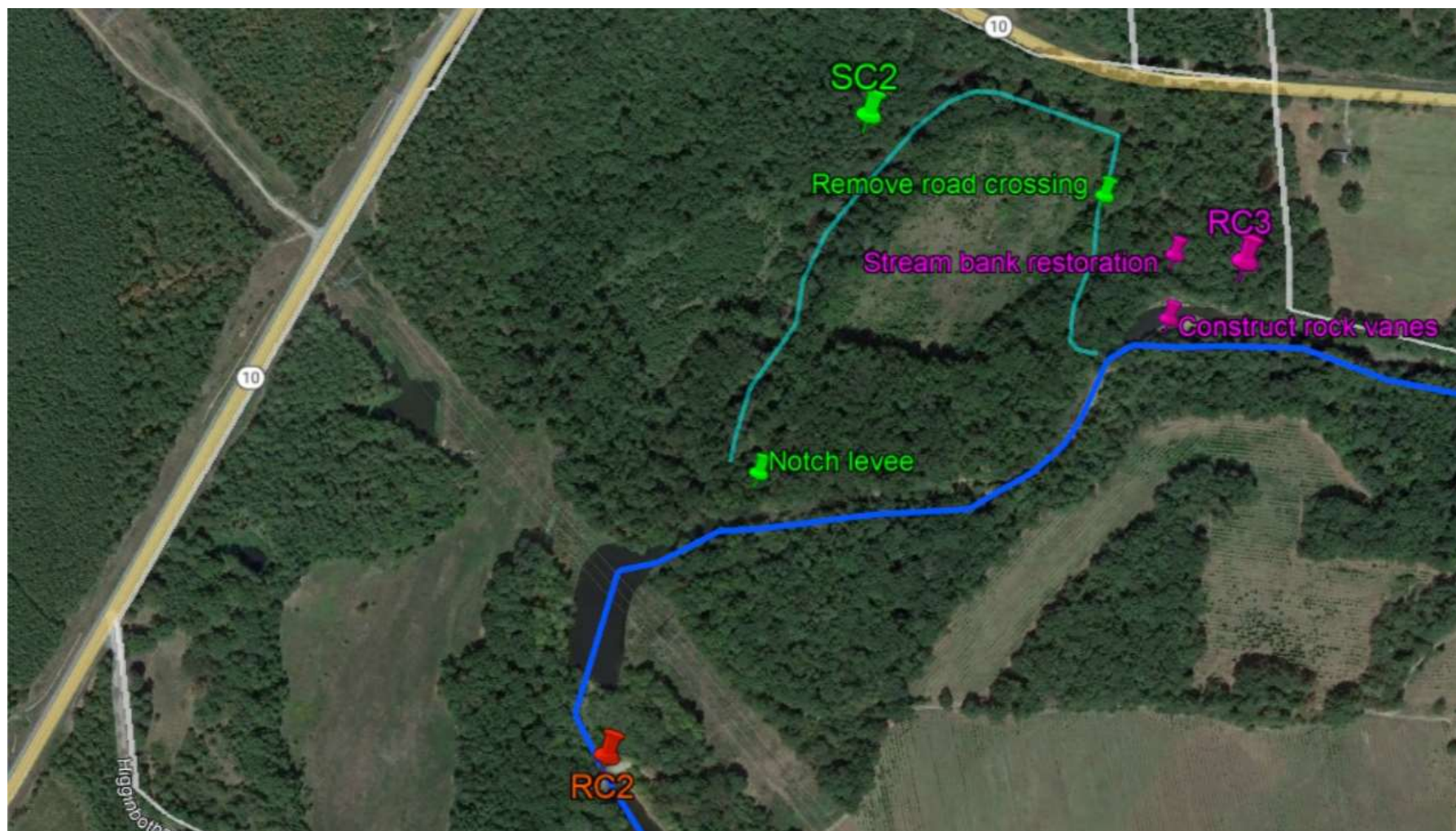
MAUMELLE RIVER 206 – WEST SIDE RESTORATION MEASURES

RC1: Alternatives A, B, R (YELLOW)

SC1: Alternative E (BLUE)

TRIBUTARY A: Alternative G (PURPLE)

SOD FARM: Alternative H (RED)



**MAUMELLE RIVER 206 – EAST SIDE RESTORATION MEASURES**

RC2: Alternatives C, D, R (ORANGE)

SC2: Alternative F (GREEN)

RC3: Alternative I (MAGENTA)

## **Attachment B**

### **Construction Schedule**

