Crawfish Frog Wetland Project Design
Unit 46
Big Oaks National Wildlife Refuge
Madison, Indiana

Crawfish Frog

Thomas R. Biebighauser
Sheltowee Environmental Education Coalition
January 11, 2023

Project Name: Crawfish Frog Wetland Project

Site Name: Unit 46, Wetlands 1, 2, 3 and Impoundment

Field Design Date: December 13, 2022

Landowner: U.S. Fish and Wildlife Service, Big Oaks National Wildlife Refuge, Madison, Indiana

Designer name: Thomas R. Biebighauser

People assisting: Audrey Basson (Intern, U.S. Fish and Wildlife Service), Rob Chapman (U.S. Fish and Wildlife Service), Ethan Crane (Intern, U.S. Fish and Wildlife Service), Joe Rob (U.S. Fish and Wildlife Service)

Objectives of the project:

1. Build wetlands that will provide dependable breeding habitat for the Crawfish Frog.
2. Build naturally appearing and functioning wetlands that will require little, if any maintenance.

Project Description: Three-ephemeral wetlands will be built to provide breeding habitat for the Crawfish Frog on the Big Oaks National Wildlife Refuge near Madison, Indiana. One existing impoundment with a dam that washed out would be rebuilt to appear and function like a natural wetland.

The wetlands will be built to require little, if any maintenance. Water may be removed from the wetlands at any time of year to control fish, bullfrogs, salamanders, and newts. The wetlands will be suitable for crayfish to live in them when they are full of water or when they are drained. The soil that is removed from building the wetlands will be spread and loosened so that areas continue to provide habitat for crayfish.

This project involves building wetlands that beavers are not able to build. This is because beaver must construct a dam across a stream with a perennial flow to create a pond or a wetland. For this project wetlands would be built by reshaping natural basins, filling ditches, and by removing buried drainage structures, and not by damming streams.

Area Description: The wetlands were designed in a large field that was farmed until the 1940's when the military acquired the land for use in bombing practice. The military has since cleared the field where the wetlands would be built of unexploded bombs. Each wetland was designed in a shallow basin within the field. The U.S. Fish and Wildlife Service is managing the field as a prairie, burning it on a regular basis. The basins where the wetlands were designed do not hold water.

The prairie is an excellent place to build wetlands to provide habitat for the Crawfish Frog as the Crawfish Frog is found in the prairie, along with a strong population of crayfish that are

important to the survival of the crawfish frog. The basins where the wetlands were designed appear to be drained wetlands. The site contains clay texture soils that may be shaped into shallow wetland basins.

The prairie contains an existing impoundment that is not holding water because the dam washed out. The dam will be repaired and reshaped by this project so it appears like a natural ridge on the landscape. A wide spillway will be constructed on a gradual slope to prevent the dam from breaching again. The basin will be recontoured with gradual slopes and a varied bottom to increase plant diversity.

The wetlands will be built so they fill naturally with water, and can be drained any time of year to control predators and competitors of the Crawfish Frog. Basins of various sizes and depths will be shaped to provide wetland pools of various hydroperiods for breeding Crawfish Frogs. Shallow water areas will be shaped in full-sunlight for egg hatching and larval development. Large woody debris and branches will be placed in and around the wetlands for hiding cover. Compacted soils within and surrounding the wetland will be loosened to facilitate crayfish burrowing using the rough and loosen technique. A diversity of native plants will be seeded and planted within and surrounding the wetlands.

The wetlands can be expected to provide high quality habitat for waterfowl as they will be built to contain a diversity of water depths, slopes, and plant species. This will be done by making dips, pits, mounds, pools, ridges, points, and peninsulas in the wetland basins. Compacted soils will be loosened to facilitate crayfish burrowing and invertebrate and plant colonization. The wetlands will be managed to control fish and American bullfrogs that eat ducklings and compete with waterfowl for food. A diversity of flowering plants used by pollinators will be sown on the soils removed from building the wetlands. These areas will provide waterfowl with nesting habitat.

A diversity of bat species can be expected to use the new wetlands for drinking and foraging. The wetlands will be made so they dry in late summer, creating conditions that are not suitable for cattail development. The open water areas will be of great importance to bats for drinking. A diversity of flowering plants used by pollinators will be sown on the soil removed from building the wetlands. The moths attracted to these plants at night will provide food for bats.

Thomas R. Biebighauser will be on site full-time directing the construction of the wetlands. He will provide training to biological personnel and heavy equipment operators in the use of techniques he has developed over the past 43-years for restoring wetlands to provide habitat for rare species of frogs across North America.

The construction of the wetlands involves implementing 3-main actions:

1. Disabling ditches and buried drainage structures so that precipitation and runoff are held on the land, restoring hydric soils and hydric plants.

2. Restoring natural contours on the land to create wetland basins of various shapes, sizes, and depths.
3. Creating natural hummocks, tussocks, mounds, ridges, depressions, and pits of various elevations, sizes, and densities to restore hydric soils and a diversity of hydric plants.

Project Design: The texture of soil at each designed wetland location was measured in the field using the ribbon test. Soil test holes were dug using a 48-inch long-3-inch diameter open-face soil auger. Tile probes measuring 4-feet and 8-feet long were used to help measure soil texture, determine the presence of rock, and groundwater.

A long-range laser-level and receiver were used to record elevations for the wetland projects that were designed. Wetland construction areas were marked to contain no more than a 12-inch change in elevation from the upper to lower edge.

The perimeter of each designed wetland was marked using colored plastic flagging tied to vegetation. Each designed wetland was mapped using a smartphone linked to a Garmin GPS with the *Fields Area Measure* Program. Photographs were taken and a detailed Design Form was completed for each wetland project that was identified and designed in the field.

The designed wetlands will be restored to appear and function like natural wetlands, requiring little if any maintenance. No dams, berms, dikes, levees, diversions, or pumps would be used in their construction.

The techniques to be used to restore the wetlands designed for this project are described in the books written by Thomas R. Biebighauser *Wetland Restoration and Construction – A Technical Guide*, and *Wetland Drainage, Restoration, and Repair.*

The wetlands were designed to appear and function as natural wetlands without the use of berms, dams, dikes, or levees. The following explains why dams would not be built for this project:

1. It is difficult and expensive to build a berm or a dam that would hold water and not wash away during a flood. Building any type of dam requires significantly more time and costs more money than simply excavating a shallow basin to build a wetland.
2. Dams and berms must be constructed from soil that is high in clay with optimal moisture content and compacted in layers so they don't leak. This requires constant monitoring of heavy equipment operations, soil texture, and soil moisture to be successful.
3. Leveling the top of a dam and shaping the slopes on a dam is challenging. This is normally done by highly skilled dozer operators. There are very few dozer operators that know how to build a dam.
4. All constructed dams or berms must have a functional spillway to carry overflow around the dam. Building a spillway requires skill and is expensive.

5. Spillways constructed on slopes steeper than 1-percent must be armored with rock to prevent head-cuts from forming that would destroy the wetland.
6. The construction of a dam often results in creating an impoundment with a deep pool of open water that would not support emergent wetland plants, trees, or shrubs.
7. *Dams and berms occupy large areas of land that can be made into wetlands.* A greater area of wetlands may be built if dams are not constructed. A 3-foot-high dam that has a 12-foot wide top with 33-percent slopes would cover a strip of nearly level land that is at least 40-feet wide. This land can be made into naturally appearing and functioning wetlands if a dam is not constructed.
8. All dams require frequent inspections and expensive maintenance.
9. Dams must be kept mowed so trees and shrubs do not grow on them.
10. Muskrats and beaver would tunnel into dams and destroy them.
11. Beaver would often block spillways resulting in the breaching and failure of constructed dams.
12. Dams are often damaged by floods.
13. Dams look artificial.
14. Dams block aquatic organism passage.
15. The failure of a dam can destroy homes, highways, railroads, and kill people.

Tom Biebighauser has found that all dams require maintenance, and that it is better and less expensive to build wetlands without the use of a dam. This is based on his experiences building over 1,400-dams in the past 44-years.

Evidence of historic drainage: The area was historically drained for farming. The “lands” pattern of drainage is visible on the surface. It is possible that buried drainage structures are present. Crayfish burrows are common in the field and ditches border the old field. The shadows of drained wetlands can be seen on aerial photographs.

Construction fill present (buried asphalt, concrete, soil, wood): Not found.

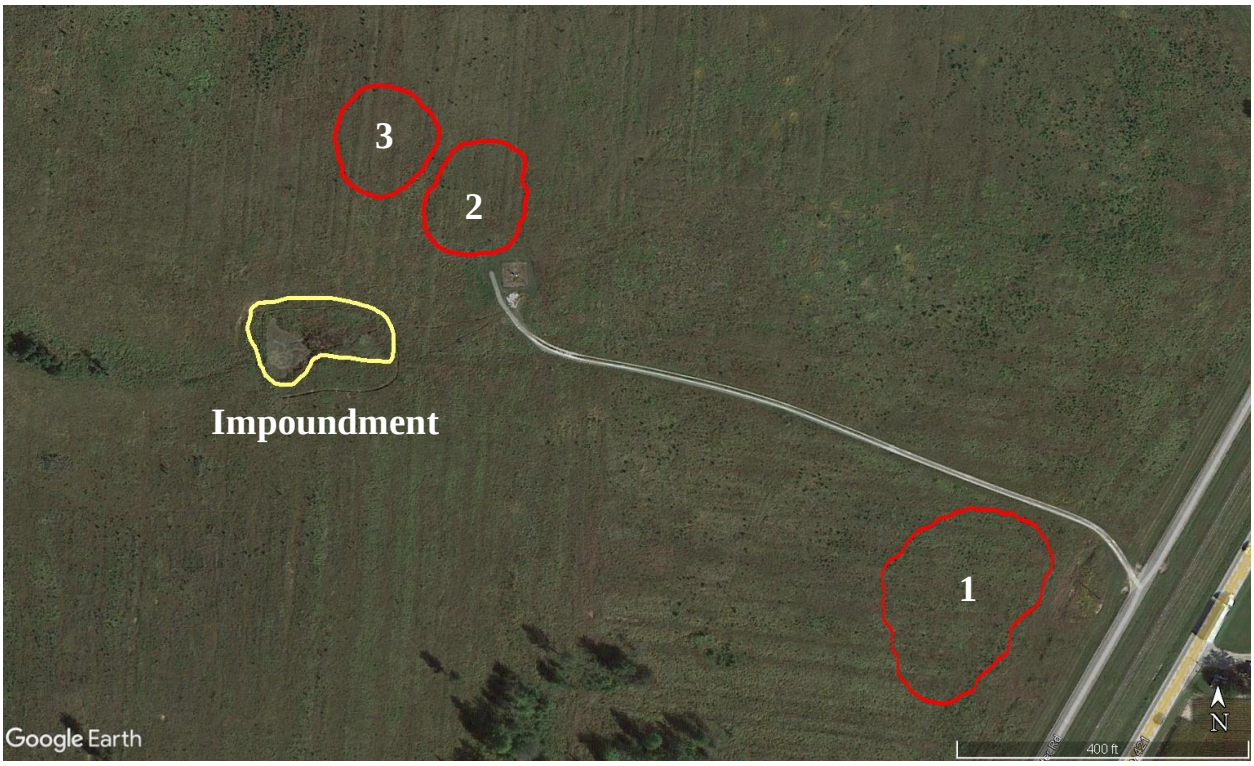
Would a stream or drainage enter the planned wetlands? No. The sites were purposely chosen because they do not have a large watershed.

Are head-cuts located upstream or downstream that may threaten the designed wetlands? No.

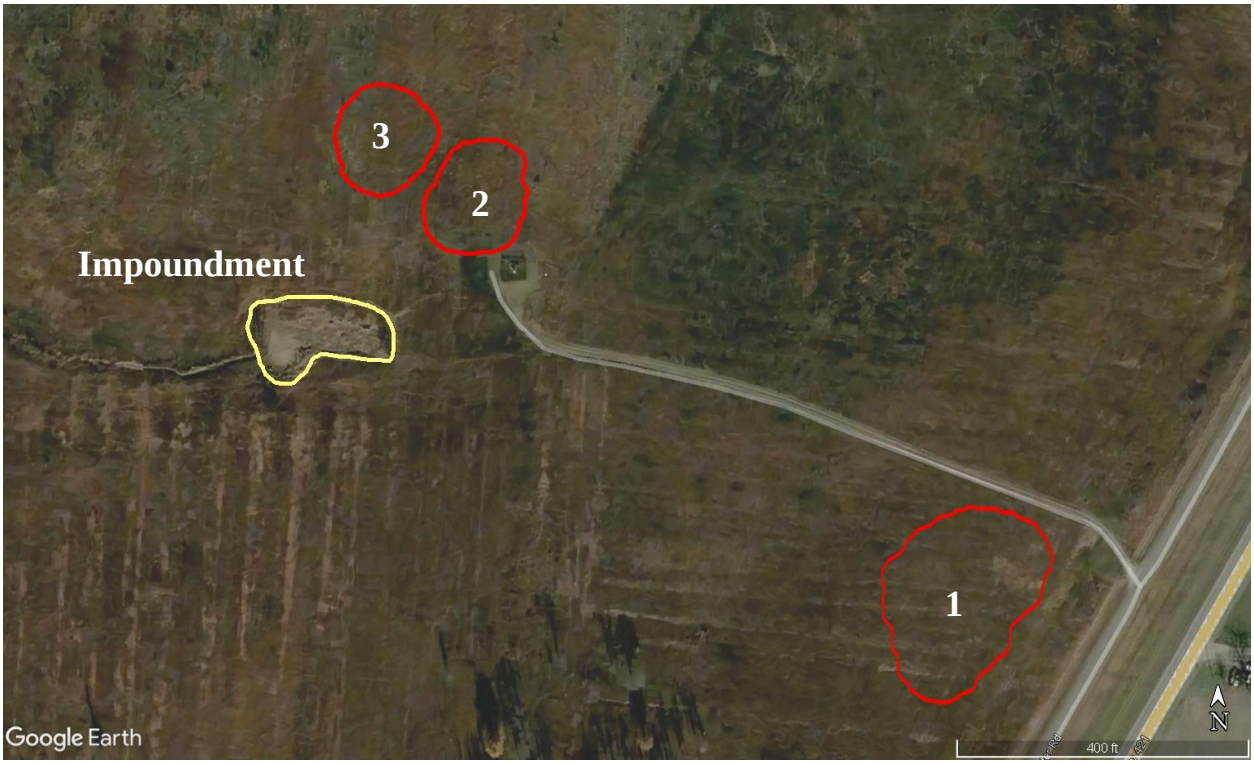
Primary plant species present within the planned wetland areas: Aster, goldenrod, broom sedge, mountain mint, deer tongue grass

Invasive species present: None

Hydric plants present? Scattered wool grass and steeplebush *Spiraea tomentosa*



Location of designed wetlands



The lands pattern of farming wetland can be seen in this 2020 aerial photo. The light-colored parallel lines are dead furrows where soil was removed to build lands for farming

Designed Wetland Data

Wetland Number	GPS (center)	Area (ft^2)	Flagging color	Ground water elevation (inches)	Elevation Change (inches)	Soil texture
1	38°55’26.35” N 85°21’44.59” W	42,639	Orange	6	6	0-3-inches topsoil, 3-48-inches clay
2	38°55’3.75” N 85°21’52.92” W	17,425	Pink	n/a	9	0-3” topsoil, 3-14” silt-loam, 14” + Silt-clay-loam
3	38°55’32.56” N 85°21’54.53” W	15,958	Lime Green	41	6	0-5” topsoil, 5-60” silt-clay-loam, 60-66” gravel
Impoundment	38°55’29.97” N 85°21’55.88” W	16,631				Not measured
	Total	92,653				

Photos showing Designed Wetlands

Wetland 1 Unit 46

Wetland 2 Unit 46

Wetland 3 Unit 46

The impoundment dam that washed out would be repaired A spillway would be constructed to carry water around the dam and the drainpipe would be replaced.

The tall and narrow impoundment dam would be reshaped to appear natural with a wider top and gradual slopes to prevent damage by muskrats and beaver.

The ditch that was dug to drain the impoundment would be reshaped to restore wet-meadow wetlands.

Construction Specifications (Wetlands 1-3)

1. The wetlands will be built in shallow basins that were drained for agriculture. The basins will have slopes that are less than 1-percent with little or no watershed. The texture of soils in the basins will be high in clay.
2. Permits and approvals will be obtained prior to construction.
3. A check for buried utilities will be completed by going online and submitting a map showing the wetland construction two-weeks prior to construction.
4. Dates for construction will be reserved in advance with Tom Biebighauser. He will be onsite full-time supervising the construction of the wetland and providing training to heavy equipment operators, agency personnel, and volunteers.
5. The services of a contractor or agency will be arranged to provide and operate a minimum of one excavator and one dozer, each with skilled operators, to complete the project. The heavy equipment must be equivalent or larger than the following:

    Excavator (for digging, shaping, and loosening compacted soils)
    Cat 335F
    273 HP Net
    77,000 lbs. operating weight
    Large bucket without teeth
    Thumb attachment

Dozer (for pushing soil away from the excavator and for spreading soil)
Caterpillar D6N LGP or equivalent (low ground pressure)
150 HP Net
39,222lbs Operating weight
Ground Pressure no greater than 5lbs/inch²

6. The heavy equipment used for the project will most likely be unloaded from truck and trailers near the maintenance building. The heavy equipment may then be "walked" to the wetland project area. It is not necessary to unload the heavy equipment near the wetland construction site.
7. Colored plastic flagging was used to mark the perimeter of the wetlands being built. These will be refreshed and replaced prior to construction. GPS shapefiles showing the perimeter of each wetland being built are available from Tom Biebighauser.
8. Different colored plastic flagging will be used to mark any trees, shrubs, and plants to be protected or transplanted, including sedges and rushes that may be present.
9. Colored plastic flagging will be used to mark areas where soil will be spread, spillways constructed, and inlets shaped.
10. The construction of these wetlands involves reshaping soils that are high in clay to form shallow-water basins of various shapes, sizes, and depths.
11. Heavy equipment will be used to remove trees and shrubs within the marked wetland areas and from the areas where soil will be spread. These trees and shrubs may be saved for later placing in and around the completed wetlands.
12. Any nonnative plants that are present will be removed and placed on the surface to dry, or buried.
13. Topsoil will be saved and respread following construction of the wetland.
14. The wetlands will be built to be deepest in the center. They will be shaped like large satellite dishes with gradual slopes.
15. No dams will be built. Muskrat or beaver will not be able to damage the wetlands if no dams are built. Floodwaters will not be able to damage the wetland if no dams are built.
16. After vegetation and topsoil are removed from within the marked area a groundwater dam will be built. The groundwater dam is designed to expose and interrupt subsurface permeable layers of soil and gravel, and buried drainage structures made from wood, rock, clay tile, and plastic drainpipe.
17. The groundwater dam is built around the lower 1/2 to 2/3 perimeter of the wetland being built.
18. The center location for the groundwater dam will be marked using wire flags during construction.
19. Groundwater dams will also be constructed across ditches where they exit the marked perimeter of the wetland being built.
20. Trees and shrubs should be removed from the area where the groundwater dam is built. Woody debris will be saved for later spreading in and around the finished wetland.
21. Vegetation and topsoil will be removed from the area where the groundwater dam is being built, and from where clay texture soil will be obtained for filling the trench dug for groundwater dam.

22. A trench will be dug for the groundwater dam that is based on a thick layer of clay or impermeable bedrock.
23. The groundwater dam will be dug to an elevation that is below that of the bottom of crayfish burrows.
24. The trench dug for the groundwater dam will be at least 5-feet wide.
25. Wetland basins that are deepest in the center with gradual slopes will be dug. A laser level will be used to guide the digging of the wetland basins.
26. A pipe will be installed with a simple plug for a water control structure so that water maybe drained from the finished wetland.
27. A 4-inch diameter corrugated solid wall plastic pipe with no slots or holes will be used for the drainpipe. The pipe will be purchased in rolls containing 100-feet of pipe.
28. Tom Biebighauser will be onsite directing the installation of each drainpipe.
29. The drain pipe inlet will be located in the center and deepest part of the wetland.
30. The drain pipe outlet will be located downhill at an elevation that is lower than the invert elevation of the inlet.
31. A simple water control structure will be used such as a cleanout plug for a 4-inch diameter plastic corrugated pipe.
32. The wetland basin will be shaped so water may be drained.
33. The wetlands will be shaped to contain dips, pits, mounds, pools, ridges, points, and peninsulas.
34. A spillway will be shaped to form an ephemeral stream and wet-meadow wetland where water flows out from the wetland without causing erosion. The spillway will measure from 12-20-feet wide, and flow over a slope of 1-percent or less. The spillway will be armored with rock to control erosion if it is placed on a steeper slope.
35. All excavator bucket marks and heavy equipment track marks will be removed during construction.
36. The soil removed from digging the wetland will be spread and shaped to appear as natural rises on the prairie. The soil will be spread in areas marked by colored plastic ribbons. Soil will be placed where it will not wash into the wetlands under flood conditions. The spread soil will not be compacted. All heavy equipment track marks will be removed. Compacted soils within and surrounding the new wetland will be loosened to control erosion and to promote plant germination and growth.
37. Large woody debris consisting of trees with roots attached, logs, tree limbs, and branches will be placed in and around the wetlands to provide birds with perches and waterfowl with loafing sites.
38. To provide habitat for burrowing crayfish and shorebirds a series of shallow basins will be shaped on top of the spread soil to create wet-meadows and small ephemeral wetlands.
39. Colored wire plastic flags will be used to mark the elevation of water in the finished wetland prior to seeding and planting. These will serve as a guide to planting and seeding the higher ground surrounding the constructed wetland.
40. Plants that are native to the area will be seeded or planted to restore diversity in and around the restored wetland. Seeds from native wetland plants growing near the

worksites may be collected and sown by hand on areas of exposed soil. Other seeds and plants may be purchased. Species of plants sown will favor flowering species used by pollinators. Volunteers will be invited to help with planting and construction.

41. The wetlands can be expected to fill naturally with groundwater and precipitation.

Construction Specifications (Impoundment)

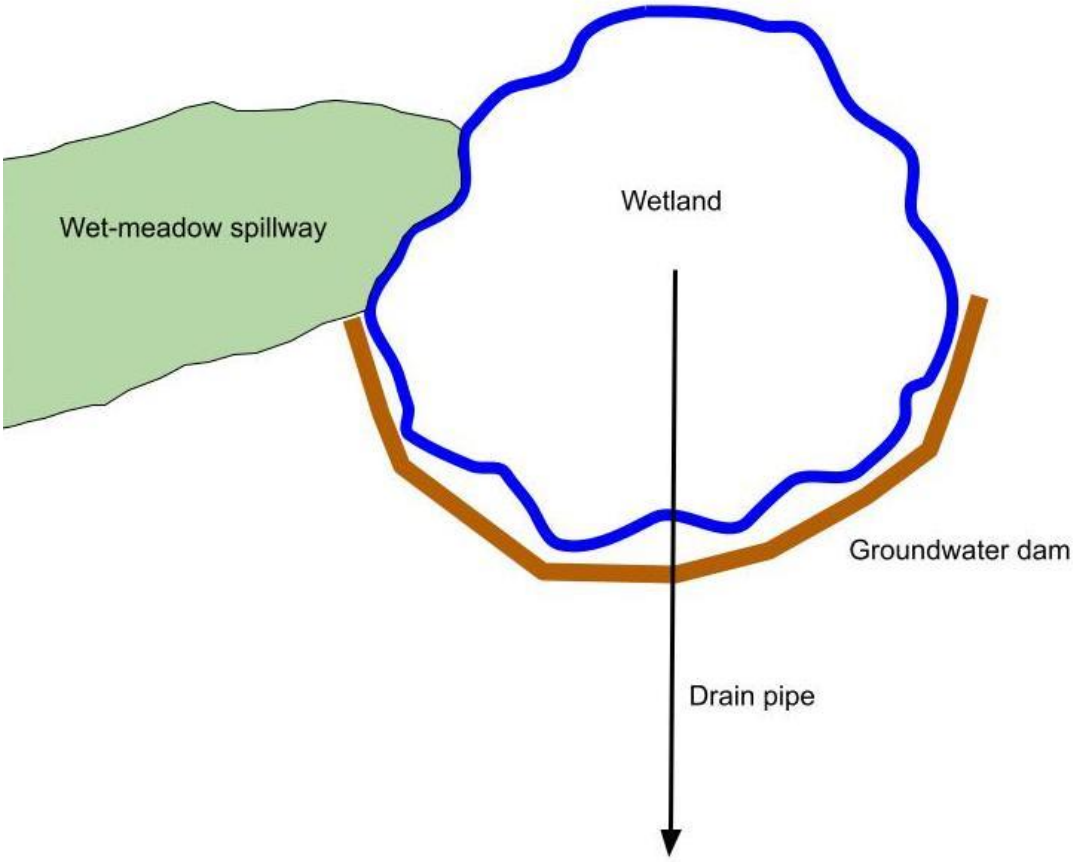
1. The impoundment basin will be reshaped so it is deepest in the middle with gradual slopes. The soil removed will be used to repair the breach in the dam and place gradual slopes on the inside and outside of the dam.
2. The PVC drainpipe will be removed and replaced with a 4-inch diameter corrugated pipe. The pipe inlet will be moved from the toe of the dam to the center of the basin.
3. The narrow and high dam will be reshaped to be wider with gradual slopes.
4. The center of the dam will be made higher than either end of the dam so water cannot flow over the top of the dam.
5. A spillway will be shaped with an entrance that is 1-foot lower than the top of the dam. The spillway will be made 20-feet wide and placed on a slope no steeper than 1-percent to control erosion.

Construction Timing: The wetlands may be built most any time of year.

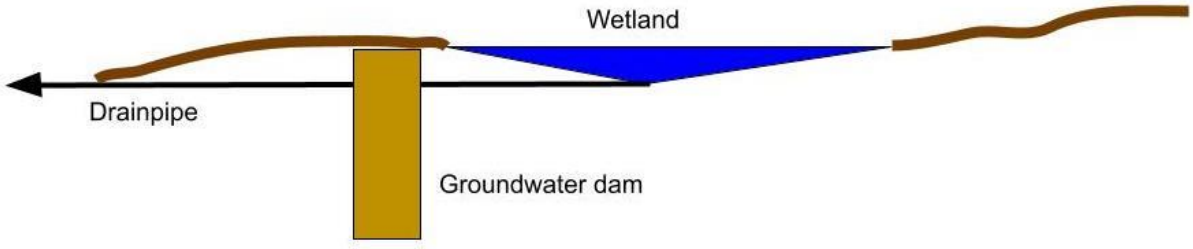
Project Supervision: Tom Biebighauser is available to be on site full-time directing the construction of one or more of the wetlands. He would supervise heavy equipment operators and provide training to personnel in the application of techniques he has developed over the past 43-years to restore wetlands that appear natural and provide habitat for rare animal and plant species.

Wetland Workshop: The wetlands may be built during one or more *Hands-on Wetland Workshops i*nstructed by Tom Biebighauser. The training may be designed to help and encourage agency personnel, nonprofit organizations, and private landowners to build wetlands that provide habitat for the Crawfish Frog. The Sheltowee Environmental Education Coalition and SAVE THE FROGS! are interested in partnering with the U.S. Fish and Wildlife Service to organize the training.

Engineering Drawings



Typical plan view of wetland being built (not to scale)



Typical profile view of wetland being built (not to scale)

Estimated Budget

Wetlands 1-3 Unit 46

Wetland Number	Area (ft²) to build	Estimated Progress Rate	Total Heavy Equipment Hours	Excavator Hours	Dozer Hours	Heavy Equipment Cost with operators	Work days estimate	Construction Supervision Cost	Wheat (lbs)	Wheat Cost	Straw Bales	Straw Cost	Native Wetland Seed Cost	Drainpipe length (ft)	Drainpipe & Plug Cost	Total	
1	42639	500	85	43	43	$0	5.3	$7,462	147	$88	10	$60	$1,390	200	$270	$9,470	
2	17425	500	35	17	17	$0	2.2	$3,049	60	$36	10	$60	$568	350	$443	$4,506	
3	15958	500	32	16	16	$0	2.0	$2,793	55	$33	10	$60	$520	350	$443	$4,198	
Total	76022		152	76	76	0	9.5	$13,304	262	$157	30	$180	$2,478	900	$1,155	**$18,174**	**Subtotal**
Impoundment Wetland Rebuild																	
Impoundment	16631	500	33	17	17	$0	2.1	$2,910	57	$34	3	$17	$542	200	$611	$4,314	
Total	16631		33	17	17	0	2.1	$2,910	57	$34	3	$17	$542	200	$611	**$4,314**	**Subtotal**
Mobilization and demobilization of of heavy equipment																$0	
																$0	**Subtotal**
Grand Total	**92653**		**185**	**93**	**93**	**$0**	**12**	**$16,214**	**319**	**$191**	**33**	**$197**	**$3,020**	**1100**	**$1,766**	**$22,489**	**Grand Total**
	2.13 acres																
Notes																	

Wetlands will be built by reshaping a series of basins that vary in size, shape, depth, and slope.
Drainpipe will be 4-inch diameter solid corrugated pipe sold in 100-foot rolls
Plug for each drainpipe will be LASCO 33-3298 Countersunk Slotted ABS Black Plastic Cleanout Plug, 4-Inch = $9.51 or TECHNICAL PRODUCTS No. 15 Rubber Plug for 4 Inch Pipe = $18.94
The soil removed from digging each wetland basin is generally pushed uphill on sloped land. Gaps are left so that runoff may enter and leave each wetland. Soils are prepared for planting using the rough and loosen technique.
Groundwater dams will be built along the inside edge of ditches not being filled to intercept buried drainage structures.
Groundwater dams will generally be built around the lower 1/2-2/3 perimeter of each wetland being built.
Professional heavy equipment operators will work to build the wetlands.
Excavator = Cat 335F or equivalent (compact radius design), 273 HP Net, 77,000 lbs. operating weight, Large digging bucket with teeth, thumb attachment
Dozer: Caterpillar D6T or equivalent, 215 HP Net, 44,795 Operating weight, 6 or 7-way-blade.
All pieces of heavy equipment will be onsite working at the same time.
Plan on heavy equipment operators working 10/hours/day, Monday-Saturday (1-hour in the morning for travel, fueling and greasing, 8-hours operating heavy equipment, 1-hour in the afternoon for traveling and heavy equipment maintenance.
The U.S. Fish and Wildlife Service will provide the heavy equipment, fuel, oil, and maintenance with operators at no cost to the project.
The U.S. Fish and Wildlife Service will mobilize and demobilize heavy equipment at no cost to the project.
Estimated progress rate for heavy equipment = average number of square feet of wetland built per hour by each machine, includes all construction steps.
Estimated number of work days = (Total Heavy Equipment Hours) ÷ (4-pieces heavy-equipment) ÷ (8-hours/day)
Wheat is spread by hand at 100/lbs/acre for erosion control and to reduce colonization by nonnative plants. Wheat is applied using a shoulder mounted seed spreader the same day the wetland is built. Estimated cost = $0.60/lb
Straw is spread by hand on slopes where runoff will enter the wetland to control erosion. One bale will mulch 300ft². Estimated cost = $6.00/bale
Construction Supervision is by Tom Biebighauser who will be onsite marking wetland perimeters, taking elevations, constructing groundwater dams, measuring compaction, directing equipment operators, recording hours worked, and explaining to agency personnel and visitor agency personnel and the public that visit the site what is taking place.
Native wetland seed mix will be planted within and surrounding the wetland to be built at a rate of 20lbs/acre.
Native upland seed mix will be planted surrounding the wetland to be built and on soil spread at the rate of 20lbs/acre.

Summary

Naturally appearing and functioning wetlands may be established at the Big Oaks National Wildlife Refuge to provide breeding habitat for the Crawfish Frog and a diversity of native plant and animal species. The wetlands would provide a reliable source of water for wildlife, improving habitat for waterfowl and shorebirds. Opportunities for observing wildlife would be greatly improved by the project. The wetlands would be built to require no maintenance, filling naturally with precipitation and groundwater.

About the Designer

Tom Biebighauser has restored over 2,850 wetlands and streams across Canada, in 26-States, New Zealand, Puerto Rico, and Taiwan since 1979. Tom designs and builds over 120-wetlands and streams each year. He has developed highly effective techniques for building naturally appearing and functioning wetlands in arid regions for endangered amphibians. Having built over 1,400-dams, he has since decommissioned over 300-dams. He retired in 2013 after working 34-years for the US Forest Service as a Wildlife Biologist, where he initiated wetland and stream restoration programs across the United States. Tom has served as an instructor for the British Columbia Wildlife Federation Wetlands Institute for 17-years, restoring over 250-wetlands and streams across Alberta and British Columbia since 2003. He instructs a Graduate-level class on Wetland Design for Engineers at the University of Louisville Speed School of Engineering, along with classes for the University of Alberta and the British Columbia Institute Technology. Tom has developed highly effective and low-cost techniques for building wetlands

and streams for rare species across North America. The habitats he builds require little, if any maintenance, and do not involve the use of diversions, dams, dikes, pipes, or pumps. Tom has written 4-books about wetland restoration, and has received 44-awards for his outstanding contributions.

This design report was prepared at no charge to the U.S. Fish and Wildlife Service by:

Thomas R. Biebighauser
Treasurer
Wildlife Biologist and Wetland Ecologist
Sheltowee Environmental Education Coalition
3415 Sugar Loaf Mountain Road
Morehead, KY 40351 USA

Home phone: (606) 784-6175
Cell phone: (606)356-4569
www.wetlandrestorationandtraining.com
tombiebighauser@gmail.com