Appendix D. Investigations and Analyses Report

Watershed Plan – Environmental Assessment

For the

Lick Creek and Dudley Main Ditch Watershed
Stoddard County, Missouri

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D1. INTRODUCTION

This Investigations and Analyses Report provides relevant resource research, investigation, and analysis details for the Lick Creek and Dudley Main Ditch Watershed, proposed actions, and proposed alternatives.

D1.1. Summary of Principles, Requirements, and Guidelines

The following PR&G Guiding Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future. These Principles are presented in no particular order and their organization denotes no hierarchy or rank.

- **Healthy and Resilient Ecosystems**. Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems.
- **Sustainable Economic Development**. Federal investments in water resources should encourage sustainable economic development.
- **Floodplains**. Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.
- **Public Safety**. Threats to people, including both loss of life and injury, from natural events should be assessed in the determination of existing and future conditions, and ultimately, in the decision-making process.
- **Watershed Approach**. A watershed approach to analysis and decision making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed.

In accordance with Executive Order 14173, Environmental Justice has been removed from consideration in this Plan-EA and Appendices.

Federal investments in water resources should strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and nonmonetary effects and allow for the consideration of both quantified and unquantified measures (USDA 2017).

D2. LAND USE

Land use and land cover were estimated using the U.S. Geological Survey (USGS) National Land Cover Database (NLCD) (USGS 2021) aerial photography and field observations (**Table D2-1).** Cropland, grassland, and forestland are the major land uses, and comprise 60, 15, and 12 percent of the watershed respectively. Bloomfield, Dexter, and Dudley, Missouri are the towns in the watershed and account for most of the 8 percent developed land. Cultivated crops dominate the land cover in the Project Area, comprising over 86 percent of the watershed. Woody wetlands (9 percent) and developed land (3 percent) comprise the second and third largest land cover classes in the Project Area.

The proposed Project Area is comprised of ditch and levee banks with a small buffer of land from the top of slope outward, typically about 50 feet. Some of this top of slope buffer is farmed; however, much of the riparian corridor along the ditches is herbaceous. Scattered trees and small forest stands exist along the project corridor; however, these areas are generally outside of the herbaceous riparian corridor. Larger forested tracts exist adjacent to the Project Area within managed conservation areas. Banks of the ditches in the Project Area are generally vegetated with herbaceous and scrubby vegetation. See observed vegetation in Section D6. The watershed has been dominated by crop farming for generations and is anticipated to continue in agricultural use.

Table D2-1. Land Cover in the Watershed and Project Area

Land Cover Classification	Watershed		Project Area	
	Acres	**Percent**	**Acres**	**Percent**
Barren Land	262	0.3%	0	0.0%
Cultivated Crops	60,000	59.7%	671	86.4%
Deciduous Forest	10,532	10.5%	3	0.4%
Developed, High Intensity	314	0.3%	0	0.0%
Developed, Low Intensity	2,796	2.8%	11	1.4%
Developed, Medium Intensity	1,335	1.3%	3	0.4%
Developed, Open Space	3,577	3.6%	6	0.7%
Emergent Herbaceous Wetlands	343	0.3%	8	1.0%
Evergreen Forest	13	0.0%	0	0.0%
Hay/Pasture	14,810	14.7%	2	0.3%
Herbaceous	236	0.2%	0	0.0%
Mixed Forest	1,480	1.5%	0	0.0%
Open Water	988	1.0%	1	0.1%
Shrub/Scrub	95	0.1%	0	0.0%
Woody Wetlands	3,665	3.6%	72	9.3%
Total	**100,447**	**100%**	**777**	100.0%

Source: USGS 2021.

Farming is the primary land use in the watershed. **Table D2-2** lists the number and income of farms in Stoddard County. Soybeans are the top commodity for the county. Generally, within the bootheel region of Missouri, farms are larger and thus produce more income per farm than the typical farm income average across the state.

Table D2-2. Number of Farms and Average Farm-related Income per Farm by County, Census of Agriculture 2022

County	Number	Farm-Related Income	Top Commodity
Stoddard	637	$31,029	soybeans

Source: NASS 2022.

D3. SOILS

Soils information for the watershed and Project Area was obtained from Web Soil Survey. The soils in the watershed and Project Area are predominantly loamy or clayey. Table D3-3 describes the soil map units, proportions in the watershed and Project Area (respectively), drainage class, and hydrologic soil group (HSG).

D3.1. Drainage Class and Hydrologic Soil Group

The soils in the watershed range from poorly drained to well drained, while the soils in the Project Area are only poorly drained to somewhat poorly drained. Drainage class accounts for the occurrence and length of wet periods comparable to the conditions the soils were formed under. **Table D3-1** defines the drainage classes.

Table D3-1. Drainage Classes Definitions (USDA 2018).

Drainage Class	Definition
Well drained	Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit root growth for significant periods during most growing seasons. The soils are mainly free of, or are deep or very deep to, redoximorphic features related to wetness.
Moderately well drained	Water is removed from the soils somewhat slowly during some periods of the year. Internal free water occurrence is commonly moderately deep and transitory through permanent. The soils are wet only for a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low to lower saturated hydraulic conductivity in a layer within the upper 1 meter, periodically receive high rainfall, or both.
Somewhat poorly drained	Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. Internal free water occurrence is commonly shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall.

Drainage Class	Definition
Poorly drained	Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Internal free water occurrence is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow depth. Free water at shallow depth is common. The water table is commonly the result of low or very low saturated hydraulic conductivity, nearly continuous rainfall, or a combination of these.

Much of the soils in the watershed (67 percent) and Project Area (56 percent) are mapped as hydrologic soil group C, D or C/D. Hydrologic soil groups are based on runoff potential and describe the rate of water infiltration when soils are not protected by vegetation, are thoroughly wet and receive precipitation from long-duration storms. **Table D3-2** defines the hydrologic soil group. Where soils are assigned to a dual group (e.g. C/D), the first letter refers to drained areas and the second to undrained.

Table D3-2. Hydrologic Soil Group (USDA 2018).

Group	Definition
A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Table D3-3. Soil Map Units in the Watershed and Project Area with Drainage Class and Hydrologic Soil Group (HSG).

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Amagon silt loam, 0 to 1 percent slopes	25.5	0.0%	0	0.0%	Poorly Drained	C/D
Amagon silt loam, 0 to 1 percent slopes, frequently flooded	10.6	0.0%	0	0.0%	Poorly Drained	C/D
Amagon silt loam, 0 to 1 percent slopes, occasionally flooded	6,320.10	6.3%	408.3	52.6%	Poorly Drained	C/D
Amagon silt loam, 0 to 1 percent slopes, rarely flooded	438.6	0.4%	1.4	0.2%	Poorly Drained	C/D
Askew silt loam, 1 to 5 percent slopes	91.6	0.1%	0	0.0%	Moderately Well Drained	C
Askew silt loam, 1 to 5 percent slopes, rarely flooded	325.2	0.3%	0	0.0%	Moderately Well Drained	C
Bosket fine sandy loam, 1 to 5 percent slopes, eroded	12.6	0.0%	0	0.0%	Well Drained	B
Brandon silt loam, 3 to 8 percent slopes	168	0.2%	0	0.0%	Well Drained	B
Brandon silt loam, 8 to 15 percent slopes	1,087.40	1.1%	0	0.0%	Well Drained	B
Calhoun silt loam, 0 to 1 percent slopes	5,211.00	5.2%	0	0.0%	Poorly Drained	C/D

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Calhoun silt loam, 0 to 1 percent slopes, occasionally flooded	4,667.70	4.6%	0.1	0.0%	Poorly Drained	C/D
Calhoun silt loam, 0 to 1 percent slopes, rarely flooded	677	0.7%	0	0.0%	Poorly Drained	C/D
Calhoun silt loam, 0 to 3 percent slopes	326.5	0.3%	0	0.0%	Poorly Drained	C/D
Collins silt loam, 0 to 1 percent slopes, occasionally flooded, brief duration	450.8	0.4%	0	0.0%	Moderately Well Drained	C
Collins silt loam, 0 to 3 percent slopes	83.3	0.1%	0	0.0%	Moderately Well Drained	C
Deanburg fine sandy loam, 1 to 5 percent slopes, eroded	28.3	0.0%	0	0.0%	Well Drained	B
Dubbs silt loam, 1 to 5 percent slopes	130.3	0.1%	0	0.0%	Well Drained	B
Dubbs silt loam, 1 to 5 percent slopes, rarely flooded	403	0.4%	0	0.0%	Well Drained	B
Dundee loam, 0 to 1 percent slopes	1,528.50	1.5%	0	0.0%	Somewhat Poorly Drained	C/D
Dundee loam, 0 to 1 percent slopes, rarely flooded	176.6	0.2%	0	0.0%	Somewhat Poorly Drained	C/D
Dundee silt loam, 0 to 3 percent slopes	100.2	0.1%	0	0.0%	Somewhat Poorly Drained	C/D

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Eustis-Memphis complex, 15 to 35 percent slopes	21.9	0.0%	0	0.0%	Somewhat Excessively Drained	A
Falaya silt loam, 0 to 1 percent slopes, frequently flooded	4.7	0.0%	0	0.0%	Somewhat Poorly Drained	B/D
Falaya silt loam, 0 to 1 percent slopes, occasionally flooded	10,374.50	10.3%	3.5	0.5%	Somewhat Poorly Drained	B/D
Falaya silt loam, 0 to 1 percent slopes, rarely flooded	585.9	0.6%	0	0.0%	Somewhat Poorly Drained	B/D
Falaya silt loam, 0 to 3 percent slopes	3,899.00	3.9%	9.1	1.2%	Somewhat Poorly Drained	B/D
Falaya silt loam, 0 to 3 percent slopes, occasionally flooded	2,738.80	2.7%	0	0.0%	Somewhat Poorly Drained	B/D
Foley silt loam, 0 to 1 percent slopes	35.4	0.0%	0	0.0%	Poorly Drained	D
Foley silt loam, 0 to 1 percent slopes, rarely flooded	363.6	0.4%	0	0.0%	Poorly Drained	D
Forestdale silty clay loam, 0 to 1 percent slopes, occasionally flooded	207.5	0.2%	0	0.0%	Poorly Drained	C/D
Forestdale silty clay loam, 0 to 1 percent slopes, rarely flooded	28.6	0.0%	0	0.0%	Poorly Drained	C/D

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Goss gravelly silt loam, 15 to 35 percent slopes	32.9	0.0%	0	0.0%	Well Drained	C
Goss gravelly silt loam, 8 to 15 percent slopes, warm	27.1	0.0%	0	0.0%	Well Drained	C
Levees-Borrow pits complex, 0 to 25 percent slopes	1071.5	1.1%	327.8	42.2%	na	na
Lilbourn fine sandy loam, 0 to 1 percent slopes	44.6	0.0%	0	0.0%	Somewhat Poorly Drained	B/D
Loring silt loam, 1 to 5 percent slopes	10,446.90	10.4%	0	0.0%	Moderately Well Drained	C
Loring silt loam, 3 to 8 percent slopes, eroded	9,688.90	9.6%	0	0.0%	Moderately Well Drained	C
Loring silt loam, 3 to 8 percent slopes, severely eroded	2,056.60	2.0%	0	0.0%	Moderately Well Drained	C
Loring silt loam, 3 to 8 percent slopes, west, upland phase	1104.5	1.1%	0	0.0%	Moderately Well Drained	C
Loring silt loam, 8 to 15 percent slopes, eroded	34.2	0.0%	0	0.0%	Moderately Well Drained	C
Loring silt loam, 8 to 15 percent slopes, severely eroded	482	0.5%	0	0.0%	Moderately Well Drained	C
Memphis silt loam, 15 to 35 percent slopes	170.1	0.2%	0	0.0%	Well Drained	B
Memphis silt loam, 3 to 8 percent slopes, eroded	3,348.30	3.3%	0	0.0%	Well Drained	B

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Memphis silt loam, 3 to 8 percent slopes, severely eroded	66	0.1%	0	0.0%	Well Drained	B
Memphis silt loam, 8 to 15 percent slopes, severely eroded	7,218.40	7.2%	0	0.0%	Well Drained	B
Miscellaneous Water	53.4	0.1%	0	0.0%	na	na
Overcup silt loam, 0 to 1 percent slopes	4,297.50	4.3%	0	0.0%	Poorly Drained	D
Overcup silt loam, 0 to 1 percent slopes, occasionally flooded	7,543.60	7.5%	16.2	2.1%	Poorly Drained	D
Overcup silt loam, 0 to 1 percent slopes, rarely flooded	3,215.30	3.2%	0.2	0.0%	Poorly Drained	D
Overcup silt loam, 0 to 3 percent slopes	69.7	0.1%	0	0.0%	Poorly Drained	D
Pits-Dumps complex	400.3	0.4%	0	0.0%	na	na
Water	1117.8	1.1%	0	0.0%	na	na
Waverly silt loam, 0 to 1 percent slopes, occasionally flooded	237.1	0.2%	0	0.0%	Poorly Drained	B/D
Zachary silt loam, 0 to 1 percent slopes	745.1	0.7%	0	0.0%	Poorly Drained	C/D

Map Unit Name	Watershed		Project Area		Drainage Class	HSG
	Acres	Percent	Acres	Percent		
Zachary silt loam, 0 to 1 percent slopes, occasionally flooded	5,107.40	5.1%	9.7	1.3%	Poorly Drained	C/D
Zachary silt loam, 0 to 1 percent slopes, rarely flooded	712.1	0.7%	0	0.0%	Poorly Drained	C/D
Zachary silt loam, 0 to 3 percent slopes	633.6	0.6%	0	0.0%	Poorly Drained	C/D
Total	**100,447.6**	**100%**	**776.3**	**100%**		

D3.2. Prime and Unique Farmland and Farmland Soils of Statewide Importance

NRCS classifies soil map units based on soil characteristics that are best suited to growing food, feed, fiber, forage, and oilseed crops. Fifty-one percent of the ARA and 54 percent of the Project Area are classified as prime farmland, prime farmland (if drained), and farmland of statewide importance (**Table D3-4**).

Table D3-4. Farmland Classification in the Watershed and Project Area

Classification	Watershed		Project Area	
	Acres	Percent	Acres	Percent
All Areas Prime Farmland	1,525	2%	0	0%
Farmland of Statewide Importance	11,888	12%	0	0%
Not Prime Farmland	49,431	49%	353.9	46%
Prime Farmland if Drained[1]	37,603	37%	422.4	54%
Totals	**100,448**	**100**	**777**	**100**

Source: NRCS 2024a-d.

[1] Nearly all the project area is drained.

D4. GEOLOGY

D4.1. Geologic Setting

The Lick Creek – Dudley Main Ditch Watershed is located in portions of the Bluff Hills ecoregion situated within the larger Mississippi Valley Loess Plains ecoregion which extends in a band from near the Ohio River in western Kentucky to southern Louisiana on the east side of the Mississippi River and in a narrow band from southeastern Missouri through northeastern Arkansas on the west side of the Mississippi River. The Mississippi Valley Loess Plains ecoregion consists of irregular plains, gently rolling hills and bluffs. More specifically, the Bluff Hills ecoregion consists of sand, clay, silt and lignite which is capped with a thick loess deposit. In the early 20th century, portions of the Bluff Hills in Missouri were extensively cleared of timber, removing most natural bottomland deciduous forest, and draining the region for agriculture. In this drained area, relief is provided by natural and man-made levees as well as river terraces. Species of more northern distributions occur in this region far to the south of their limits. Major crops include rice, cotton, and soybeans (Chapman et al. 2002 and Chapman et al. 2004).

The watershed falls within the Major Land Resource Area (MLRA) of the South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region and includes the Southern Mississippi Valley Loess (134). This region consists of loess bluffs and dissected hills of loess and includes the Crowley's Ridge feature which runs through the watershed. The portion of the MLRA in the watershed consists of an undulating landscape of highly fertile soils. The loess mantle of the region is up to 75 feet thick and is underlain by fluvial deposits from the Late Tertiary and Quaternary age while the Crowley's Ridge area is underlain by sand and gravel of the Pliocene (NRCS 2022b). Bedrock in the watershed is generally 25 feet deep in upper reaches of the watershed and deeper than 125 feet in the Project Area (MODNR 2024d). Surface elevations are generally below 600 feet mean sea level (msl) in the upper reaches of the watershed and are below 350 feet msl in the Project Area (MODNR 2002).

D4.2. Geology

The Geologic Map of Stoddard County, (Farrar and McManamy 1937) shows the Lick Creek and Dudley area as Cenozoic era (66 million years ago to present) alluvium. The alluvium is composed of clay, silt, sand and gravel. The "BEDROCK GEOLOGIC MAP OF THE POPLAR BLUFF 30' x 60' QUADRANGLE, MISSOURI" (Weary et al 2014), shows the bedrock geology in the project area to consist of McNairy, Midway Group, and Wilcox Group formations. The McNary formation is composed of sand, sandstone, and lignitic silt and is up to 138 feet thick. The Midway Group contains green calcareous and fossiliferous glauconite-bearing sand and clay with varying amounts of limonite as well as dark gray partly silty or sandy clay and can be as much as 650 feet thick. The Wilcox Group is composed of beds and lenses of sand and clay that are limited horizontally and vertically. Some chert and heavy mineral grains are also present within the formation. Gravels are present as rounded clear to milky quartz and polished black chert granules. The Wilcox Group is as much as 1300 feet thick.

D4.3. Geologic Investigations

A geotechnical investigation was not conducted as part of this watershed planning process.

D5. ENGINEERING

D5.1. Land Rights Assessment of Project Area

Land rights maps were created for the Project Area (see **Appendix C**). These maps provide a visual representation of ownership of land parcels adjacent to the Project Area and the relationship of these parcels to easements maintained by Drainage District 12 along the ditches that they manage. These maps were created utilizing ArcGIS software, incorporating overlays from National Agricultural Imagery Program aerial imagery (USDA 2024b), nationwide parcel data (Regrid 2024), and drainage district easements. The drainage district easements were created utilizing the descriptions contained in legal documents of the ditch easements maintained by Drainage District 12 (Drainage District 12 2024). This legal document is available in **Appendix A**.

D5.2. Geotechnical

D5.2.1. Slope Stability Analyses

The existing slopes appear to be stable with respect to general balance of the forces tending to cause failure versus the forces resisting failure. That balance indicates a general factor of safety against slope failure of at least 1.0. A slight change in the forces that drive failure, such as wetting of the slope or freeze-thaw action, could overwhelm the resisting force and result in a slope failure.

In general, most geotechnical engineers would consider a slope inclination of 2:1 to be adequately stable, presuming soil strength properties are within typical parameters. "Adequately stable" would imply that the factor of safety is at least 1.3 (resisting force/driving force) for a 2:1 slope inclination.

We understand that the existing slopes have been in their current configuration for many years and have experienced many freeze-thaw cycles, many wetting-drying cycles, and, most likely, several earthquakes.

D5.3. Conclusions

To correctly define the factor of safety against slope failure, the proper steps should be taken to test, analyze, and document the areas soil strength parameters and perform slope stability analyses. These steps should include:

- Survey the existing slope configurations
- Sample a sufficient number the soils within the expected failure zones and foundations of the slopes (i.e., drilling and sampling)
- Test a sufficient number of samples to assess the project area's soil strength properties
- Analyze a sufficient number of the existing and proposed slope configurations
- Prepare a report to document those result.

Depending upon the Owner's or Regulator's aversion to risk and the consequences of slope failure, the cost and time required to perform a suitable study seems to be evenly balanced with taking an observational approach. The observational approach would be to assume that the 2:1 design slope is adequate and budget for annual maintenance cost for minor repairs of small slides and sloughs. If the SLO or NRCS has a greater aversion to risk than that, a design can be created for flatter

slopes, say 2.5:1 or 3:1 and budget for annual maintenance cost for minor repairs of small slides and sloughs. The final choice would be to take the analysis steps listed above.

D5.4. Hydrology and Hydraulics

D5.4.1. Hydrology and Hydraulic Analyses

Hydrologic Engineering Center River Analysis System (HEC-RAS) version 6.3.1, published by the United States Army Corps of Engineers, was utilized for hydrologic and hydraulic modeling purposes. Each model incorporated terrain, soil, landcover, and Manning's grids as well as MSE5 rainfall distributions for each frequency event. The terrain used is high-resolution (one-meter) bare-earth lidar datasets that provide precise and comprehensive information on the topography of the study area. Soil spatial data was obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey which includes an aggregate hydrologic soil group for individual soil series. Landcover data was taken from the 2016 National Land Cover Database. The soils and landcover data were then combined to determine the infiltration using the Curve Number method developed by USDA National Resources Conservation Service (NRCS) formerly the Soil Conservation Service (SCS). The SCS Curve Number method estimates the runoff as a function of the total precipitation, hydrologic soil group, and land use with an antecedent runoff condition of II assumed as it is representative of typical conditions. In addition to the landcover being used in the infiltration, it is also a contributing factor in the determination of Manning's roughness coefficients. Manning's roughness coefficients are a numerical representation of the ease at which water flows over a surface, with the higher the value signifying a greater resistance to flow.

Hydraulic structures were added to the models based on field surveys that were conducted. Field notes consisting of structure dimensions, channel geometry, and structure material (i.e. corrugated metal pipe, concrete box culvert, etc.) were used to accurately represent the structures within the HEC-RAS models. Channel elevation data gathered during the field surveys was also utilized in estimating the reduction in channel capacity due to sedimentation.

2D HEC-RAS Rain on Mesh modeling was used to compare and evaluate flood reduction benefits of the works of improvement. This was accomplished by completing a flood frequency study with channel improvements compared to estimated channel capacities being reduced by existing sedimentation of the drainage ditches. The flood frequency analysis was completed using the 50%, 20%, 10%, 4%, 2%, 1% and 0.2% (2yr, 5yr, 10yr, 25yr, 50yr, 100yr and 500yr respectively) frequency rainfalls on the watershed. Floodplains for each frequency event were developed to compare the floodplain extents with the project and without the project. The floodplain comparisons were then used in the economics analysis to determine the extent of flood reduction benefits. A summary of how the floodplain area changes at each rainfall frequency for Structural Alternative 3 can be found in Table 5-1. 1% annual chance (100 yr) floodplain comparison maps are located in **Appendix C, Figure 13a through ab**.

Table D5-1. Floodplain area comparison with and without works of improvement

Flood Return Period	Floodplain Without Project Area (Acres)	Floodplain With Project Area (Acres)	Floodplain Reduction Area (Acres)
2yr	15,176.5	13,757.7	1,418.9
5yr	22,725.4	20,737.2	1,988.1
10yr	27,772.9	25,787.3	1,985.6
25yr	33,634.6	32,035.6	1,598.9
50yr	37,276.2	36,186.6	1,089.6
100yr	41,481.2	40,611.6	869.6
500yr	44,987.1	44,135.7	851.5

Table D5-2. Proposed Native Grass and Herbaceous Species and Seeding Matrix

Common Name	Scientific Name	PLS lbs per acre	% of Mixture PLS
Big Bluestem, Roundtree	*Andropogon gerardii*	3.000	24.64%
Indiangrass, Rumsey	*Sorghastrum nutans*	2.000	19.90%
Little Bluestem, Aldous	*Schizachyrium scoparium*	1.250	17.13%
Switchgrass, Alamo	*Panicum virgatum*	0.750	11.06%
Virginia Wildrye	*Elymus virginicus*	0.500	2.85%
Blackeyed Susan	*Rudbeckia hirta*	0.040	3.59%
False or Oxeye Sunflower	*Heliopsis helianthoides*	0.500	2.96%
Foxglove Beardstongue	*Penstemon digitalis*	0.200	4.56%
Grayhead Coneflower	*Ratibida pinnata*	0.200	4.87%
Hoary Vervain	*Verbena stricta*	0.150	5.01%
New England Aster	*Aster novae-angliae*	0.050	3.01%
Swamp Milkweed	*Asclepias incarnata*	0.050	0.44%
	Grasses Total:	7.500	75.58%
	Wildflower/Forb/Legume Total:	1.190	24.42%
	Total Mixture:	**8.690**	**100.00%**

D5.5. Non-Structural

D5.5.1. Wetland Development

Adjacent to Lick Creek toward the center of the project area, a section of farmland periodically floods during the growing season. Furthermore, the regionally high water table and nearby wetland areas indicate wetland-type conditions may be easily obtained. To provide ecological and water quality benefits while removing a semi-productive field from production, a wetland would be a feasible option.

To solidify the hydric soil conditions within the site, the outlets of the smaller interior drainage ditches would be plugged and replaced with water control structures that would allow for water table management and access for high flows from Lick Creek or Cane Creek to inundate the site. To provide additional benefits during lower ditch flows, a pump station would be installed to pull water from the confluence of Cane Creek and Lick Creek then pipe the water to the upper reaches of the site. Pumping ditch water into the site would allow for treatment of the water as well as sustain the wetland vegetation. The flood frequency analysis was completed for this alternative as well, but found to not show enough benefit to be worth pursuing further for reducing flood damages.

D6. BIOLOGY

D6.1. Waters of the U.S. (Streams, Lakes and Wetlands)

Within the watershed, over four thousand three hundred acres of wetland and riverine habitat has been mapped by the National Wetland Inventory (NWI) as depicted in **Table D6-1**. Wetlands were observed adjacent to the project area in floodplains with retained hydrological connection on private property, mostly waterfowl hunting clubs, as well as within Conservation Areas adjacent to the project area. Also, within the project area, a property is being evaluated as a potential wetland development area. A wetland delineation was conducted by Prairie Engineers in November 2023 which identified a 2.5-acre forested wetland within Project Area 3b (Prairie Engineers 2024, **Appendix E**). The wetlands delineation process followed the regional protocol established by USACE (USACE 2010).

Table D6-1. NWI Wetland and Water Features in the Watershed and Project Area

NWI Mapped Feature	Watershed		Project Area	
	Number	Acres	Number	Acres
Freshwater Emergent Wetland	133	108.2	4	3.9
Freshwater Forested/Scrub-shrub Wetland	262	2,648.6	8	9.9
Freshwater Pond	912	737.7	2	2.3
Lake	0	0	0	0
Other	0	0	0	0
Riverine	381	861.6	28	56.9
Total		**4,356.1**		**73.0**

Source: USFWS 2024c.

The Project Area includes nearly 16 miles of specific reaches of at least four perennial streams (drainage ditches) (**Table D6-2**). The ditches are fed by dozens of tributaries in the Project Area. There are several open water ponds and oxbows, as well as a lake adjacent to the project area, particularly toward the southern extents of the project. However, the only open water features within the project area are the perennial ditches themselves.

Table D6-2. WOTUS Features Identified in the Project Area

Feature	Type	Measure	
Streams		**Miles**	**Linear Feet (LF)**
Cane Creek	Perennial	0.1	243
Cypress Lateral No. 1	Perennial	2.0	10,597
Dudley Main Ditch	Perennial	1.1	5,616
Lick Creek	Perennial	5.3	27,831
Unnamed Branches	Perennial	7.4	39,277
Total		**15.8**	**83,564**

D6.2. Surface Water Quality (Clean *Water* Act)

Current water quality conditions of the streams (ditches) in the Project Area were reviewed through Missouri Department of Natural Resources (MODNR) and U.S. Environmental Protection Agency (USEPA) resources. The water quality of the streams in the Project Area is currently either in good or unknown condition with none listed on Missouri's 2020 303(d) list of impaired waters (MODNR 2020b). See **Table D6-3**.

Table D6-3. Water Quality Conditions of Streams in the Project Area

Stream Name	State Waterbody ID	Listed on Missouri 2020 303(d) List[1]	Waterbody Condition[2]
Cypress Ditch Lateral	MO_2981.00	no	unknown
Dudley Main Ditch	MO_2977.00	no	unknown
Otter Lake	MO_7337.00	no	unknown
Dudley Main Ditch	MO_2978.00	no	unknown
Lick Creek Ditch	MO_2980.00	no	unknown
Spring Creek Ditch	MO_2979.00	no	unknown

[1] MODNR 2020b.
[2] USEPA 2024a.

D6.3. Vegetation

Table D6-4 lists plant species identified during biological fieldwork conducted for the project in November 2023 (Prairie Engineers 2024, **Appendix A**). Invasive species were observed in the Project Area. Invasive species of concern include thistle species, sericea lespedeza, foxtail species and johnsongrass.

Table D6-4. Vegetation Observed in the Project Area

Scientific Name	Common Name	Wetland Indicator Status (AGCP Region[1])	Native (N) or Introduced (I)
Scattered tree stands adjacent to or along edge of construction limits and within forest stand in Project Area 3			
Acer saccharinum	silver maple	FAC	N
Eleagnus umbellata	autumn olive	UPL	I
Gleditisia tricanthos	honey locust	FAC	N
Juniperus virginiana	eastern red cedar	FACU	N
Populus deltoides	cottonwood	FAC	N
Quercus palustris	pin oak	FACW	N
Quercus shumardii	19humard's oak	FAC	N
Quercus phellos	willow oak	FACW	N
Salix nigra	black willow	OBL	N
Taxodium distichum	bald cypress	OBL	N
Herbaceous vegetation along ditch slopes – includes scrub-shrub species and young saplings			
Amaranthus spinosus	spiny amaranth	FACU	N

Scientific Name	Common Name	Wetland Indicator Status (AGCP Region[1])	Native (N) or Introduced (I)
Ambrosia trifida	**ragweed**	**FAC**	**N**
Andropogon gerardii	big bluestem	FAC	N
Anoda cristata	crested anoda	FAC	N
Apocynum cannabinum	Indian hemp	FACU	N
**Arundinaria gigantea*	giant cane	FACW	N
Asclepias syriaca	common milkweed	UPL	N
Campsis radicans	trumpet creeper	FAC	N
Cephalanthus occidentalis	buttonbush	OBL	N
Cirsium sp.	thistle	FACU	I
Desmanthus illinoensis	Illinois bundleflower	FAC	N
Fallopia scandens	**climbing false buckwheat**	**FAC**	**N**
Gleditsia triacanthos	honeylocust	FAC	N
Helianthus hirsutus	hairy sunflower	UPL	N
Humulus japonicus	Japanese hop	FAC	I
Lespedeza cuneata	**sericea lespedeza**	**FACU**	**I**
Oenothera pilosella	meadow evening primrose	FACU	N
Panicum virgatum	switchgrass	FAC	N
Paspalum pubiflorum	hairyseed paspalum	FACW	N
**Persicaria amphibia*	water smartweed	OBL	N
**Persicaria hydropiperoides*	swamp smartweed	OBL	N
**Persicaria pensylvanica*	pinkweed	FACW	N
Phalaris arundinacea	reed canarygrass	OBL	N
Rhus glabra	**smooth sumac**	**UPL**	**N**
Rosa multiflora	multiflora rose	FACU	I
Rubus occidentalis	black raspberry	UPL	N
Schizachyrium scoparium	little bluestem	FACU	N
Setaria faberi	**giant foxtail**	**UPL**	**I**
Setaria pumila	yellow foxtail	FAC	I
Solidago altissima	tall goldenrod	FACU	N
Sorghum halepense	**johnsongrass**	**FACU**	**I**
Toxicodendron radicans	poison ivy	FAC	N
Trifolium pratense	**red clover**	**FACU**	**I**
Trifolium repens	**white clover**	**FACU**	**I**
Verbesina helianthoides	yellow crownbeard	UPL	N
Verbesina virginica	white crownbeard	FACU	N

Scientific Name	Common Name	Wetland Indicator Status (AGCP Region[1])	Native (N) or Introduced (I)
Vernonia missurica	Missouri ironweed	FAC	N
**Typha latifolia*	broadleaf cattail	OBL	N

Bold text = dominant species, FAC = facultative, FACU – facultative upland, FACW = facultative wetland, UPL = upland, OBL = obligate
*Primarily found at toe of ditch slope or in erosive areas of sloughing.
[1] AGCP = Atlantic and Gulf Coastal Plain Region (USACE 2010)

D6.4. Threatened and Endangered Species

Both the overall Lick Creek and Dudley Main Ditch watershed and the Project Area were reviewed via USFWS Information for Planning and Consultation (IPaC) to obtain federally listed threatened and endangered (T&E) species that are protected under the Endangered Species Act (see **Tables D6-5)**. Each query resulted in the same species list. Critical habitat for listed species was not identified in the IPaC reports. Further, the state status of listed species was reviewed on MODC's *Missouri Species and Communities of Conservation Concern Checklist* (MODC 2024b).

Through interagency scoping for the project, the Missouri Department of Conservation (MODC) provided a Natural Heritage Review Report (NHRR) for the overall Lick Creek and Dudley Main Ditch Watershed on October 5, 2023. According to the NHRR, the St. Francis River, which lies on the southwest edge of the project area, is designated as a critical habitat because it is home to many aquatic species of concern including fish, mussels, and crayfish. While no work is planned to occur on the river itself, every effort should be made to avoid introducing pollution, sediment, or higher volumes of stormwater runoff from the project site, both during construction and after development. The NHRR also indicates that the alligator snapping turtle (*Macrochelys temminckii*) is located less than one mile from the watershed and that this species is proposed for ESA listing. In addition, the report specifies that although Indiana and Northern Long-eared bats are not known to occur in the project area, these species should be assumed present wherever suitable habitat occurs. The NHRR also noted that two species of state-listed endangered freshwater mussels have been identified near the project site: the Pink Mucket (*Lampsilis abrupta),* within three miles, and the Rabbitsfoot (*Quadrula cylindrica cylindrica*), within two miles. The report also shows that the state-listed endangered American Bittern has been identified within one mile of the project site. The state status of each listed species is also identified in the tables below. The IPaC and MODC reports are included in **Appendix A**.

A limited field assessment of potentially suitable habitat of listed species was conducted in November of 2023. During the field assessment, trees exhibiting characteristics of potentially suitable habitat for each of the listed bat species were observed.

Table D6-5. Threatened and Endangered Species Listed in the Watershed and Project Area with Study Findings

Scientific Name	Common Name	Federal Status	State Status	Findings	Potential Habitat or Population Present	Carried Forward for Analysis
Mammals						
Myotis grisescens	gray bat	E	E	Caves are not present in the project area; this species is unlikely to occur.	no	no
Myotis sodalis	Indiana bat	E	E	Trees exhibiting characteristics of potentially suitable habitat for roosting were observed within and adjacent to the project area.	yes	yes
Perimyotis subflavus	tricolored bat	PE	N/A	Trees exhibiting characteristics of potentially suitable habitat for roosting were observed within and adjacent to the project area.	yes	yes
Reptiles						
Macrochelys temminckii	alligator snapping turtle	PT	N/A	Species unlikely to occur due to the degradation and sedimentation of the drainage ditches within the project area.	no	no
Birds						
Botaurua lentiginosus	American bittern	N/A	E	Potential habitat for this species, which includes heavily vegetated wetlands, was observed within and adjacent to the project area.	yes	yes
Clams						
Epioblasma triquetra	snuffbox mussel	E	E	Species unlikely to occur due to absence of small, fast flowing, rocky streams in the project area.	no	no

Scientific Name	Common Name	Federal Status	State Status	Findings	Potential Habitat or Population Present	Carried Forward for Analysis
Cyprogenia aberti	western fanshell	T	N/A	Species unlikely to occur due to absence of large, swift streams with gravel and sand substrate.	no	no
Lampsilis abrupta	pink mucket	E	E	Species prefers small to medium streams with sand, gravel, or cobble substrate. The drainage ditches in the project area could fit these criteria.	yes	yes
Insects						
Danaus plexippus	monarch butterfly	C	N/A	Individual monarchs as well as suitable habitat were observed in the project area.	yes	yes

Sources: USFWS 2025 and MODC 2023.
E = endangered, T = threatened, C = candidate species; PE = proposed endangered; PT = proposed threatened

D6.5. Migratory Bird Treaty Act/Bald and Golden Eagle Protection Act

During the field assessment, limited habitat for migratory birds was observed in the Project Area. Bald and golden eagles are both known to exist in the watershed. Other migratory birds protected under the MBTA were identified as potentially occurring in the watershed. Eagle and migratory bird species potentially occurring in the Project Area as identified in the USFWS IPaC review are listed in **Table D6-6**. Bald eagle individuals were observed within or adjacent to the Project Area.

Table D6-6. Eagles and Migratory Birds Listed in the Project Area

Scientific Name	Common Name	Breeding Season
Haliaeetus leucocephalus	bald eagle	breeds Sep 1 to Jul 31
Pluvialis dominica	American golden-plover	breeds elsewhere
Chaetura pelagica	chimney swift	breeds Mar 15 to Aug 25
Ammodramus henslowii	Henslow's sparrow	breeds elsewhere
Oporornis formosus	Kentucky warbler	breeds Apr 20 to Aug 20
Rallus elegans	king rail	breeds May 1 to Sep 5
Tringa flavipes	lesser yellowlegs	breeds elsewhere
Egretta caerulea	little blue heron	breeds Mar 10 to Oct 15
Calidris melanotos	pectoral sandpiper	breed elsewhere
Dendrioica discolor	prairie warbler	breeds May 1 to Jul 31
Protonotaria citrea	prothonotary warbler	breeds Apr – Jul 31
Melanerpes erythrocephalus	red-headed woodpecker	breads May 10 – Sep 10

Scientific Name	Common Name	Breeding Season
Euphagus carolinus	rusty blackbird	breeds elsewhere
Hylocichla mustelina	wood thrush	breeds May 10 – Aug 31

Source: USFWS 2025

Due to the presence of a bald eagle within the Project Area, an incidental take permit may be needed from the USFWS, even if any nest will be avoided and undisturbed. **Table D6-7** outlines the distance, time of year, activities, and recommendations for eagle permitting and **Table D6-8** outlines bald eagle breeding season timeframes.

Table D6-7. Activity Specific Guidelines for Work near Nesting Bald Eagles

Distance	Time of Year	Activity	Recommendation
> 660 feet	Any time	All (except blasting and other extremely loud activities	No incidental take permit
330 to 660 feet (if eagles are tolerant)[1]	Breeding Season	All	Incidental take permit may not be recommended if eagles tolerant of past disturbance. Contact USFWS.
330 to 660 feet (if eagles are not tolerant)[2]	Breeding Season	All	Incidental take permit recommended. Contact USFWS.
330 to 660 feet	Outside of breeding season	Activity that will not be noticeable when the eagles return (tree trimming, pipe installation, etc.)	Incidental take permit likely not recommended. Contact USFWS.
< 330 feet	Outside of breeding season	Tree clearing, building structures	Incidental take permit likely recommended. Contact USFWS.
< 330 feet	Breeding season	All	Incidental take permit recommended. Contact USFWS.

Source: USFWS 2007.

1- If similar construction activity has occurred within 1 mile of the nesting eagles, and has been tolerated, future activity at least 330 ft from the nest (if activity will not be visible from the nest) or 660 ft (if the activity will be visible from the nest) may not necessitate an incidental take permit.
2- If similar activity has not occurred within 1 mile of the nesting eagles, and future activity is at least 330 ft from the nest (if activity will not be visible from the nest) or 660 ft (if the activity will be visible from the nest), an incidental take permit is recommended.

Table D6-8. Nesting Bald Eagle Activities, Timeframes, and Sensitivity Magnitudes

Reproductive Activity	Timeframe for Northern U.S., including Missouri	Sensitivity to Human Activity
Courtship and nest building	November through March	Most sensitive period; likely to respond negatively
Egg laying and incubation	January through May	Very sensitive period

Reproductive Activity	Timeframe for Northern U.S., including Missouri	Sensitivity to Human Activity
Egg hatching and young rearing	February through July	Very sensitive period
Nestling period, 4 to 8 weeks	February through July	Moderately sensitive period
Nestling 8 weeks through fledging	May through August	Very sensitive period

Source: USFWS 2007.

D6.6. Fish and Wildlife Habitat

The drainage ditches and their vegetated banks within the project area, while not typically high-quality habitat, serve as corridors for many species of mammal, bird, reptile, etc. in a landscape which is otherwise predominantly cultivated crop fields. Wetland areas within and adjacent to the project area were observed supporting many thousands of migratory waterfowl, shore birds, and several bald eagles.

Forest stands occur adjacent to the project area on private land and Conservation Areas; however, as the project area consists of drainage ditches, as well as their associated banks and levees, no impacts to forest resources are anticipated.

D6.7. Invasive Species

Several invasive plant species were identified within the project area. These plants will be removed during construction and replaced with a cover of native warm-season grasses and forbs. Once native grasses have been established, mowing and herbicide application will be used to control vegetation and help to deter invasive species.

D7. ECONOMICS

D7.1. General

The project economic evaluation is summarized in this section.

Economic benefits gained by implementing the preferred alternative were calculated to determine the relative benefit/cost ratio (B/C) for the preferred alternative. This was accomplished by comparing the average annual benefit with the average annual costs.

The benefit cost analysis (BCA) indicated that the B/C ratio for this proposed project is estimated to be 8.5:1.0 for the proposed project life of 50 years with a net annual beneficial of $6,265,300 as compared to the No Action Alternative. The project is expected to reasonably maximize net national economic benefits consistent with protecting the Nation's environment. This report provides an explanation of the BCA process and results.

The results of this project benefit analysis were used to determine the relative benefit/cost ratio for each project alternative by comparing the average annual benefit with the average annual costs.

The following is brief outline of the Project Benefit Analysis:

- Inventory the impact area and determine benefits and damages attributable to with and without project scenarios (described in the following text).
- Estimate costs for channel improvement measures (construction, engineering, operation and maintenance, etc.)
- Determine the flood damage reduction benefits allocated to the project.

D7.2. Determining Project Damages

Flood damage reduction benefits were calculated consistent with Principles, Requirements and Guidelines for Federal Investments in Water Resources (PR&G) and National Resources Economics Handbook (NREH) part 611 (USDA 2013).

Two types of flood damages were used to compute losses for the multiple areas within the project area: structures/infrastructure damages and agricultural cropland damages. The process of determining damages for both types are explained in the following sections.

D7.2.1. Structural Damages

For structure/infrastructure losses, the Federal Emergency Management Agency (FEMA) Hazus Flood Assessment Structure Tool (FAST) was utilized to provide an estimate of risk. Hazus FAST predicts damages based on depth/damage curves derived by depth grids from the HEC-RAS modelling discussed in the H&H details in Section D.5.4. Hazus FAST relies on the National Structure Inventory (https://nsi.sec.usace.army.mil/downloads/) developed by USACE which provides building characteristics including location, lowest adjacent grade, and estimated finished floor elevations. Losses assessed by Hazus FAST include building damage, inventory loss and content loss.

For this analysis, Hazus FAST was run for 2 scenarios (With Project and Without Project). The With Project scenario primarily uses the existing conditions hydraulic model to assess damages. The Without Project scenario was modelled with the assumption that conditions will continue to deteriorate with regard to stream bank erosion and channel degradation. Damages for both alternatives were calculated for various recurrence intervals (2-, 10-, 25-, 50-, 100-, and 500-year events). Results from the Hazus analysis in the form of annualized damages for each scenario are provided in **Table D7-1**.

Table D7-1. Annual Damages from Hazus Analysis

Loss Type	With Project	Without Project	Alternative 4 - Nonstructural Buyouts
Total Loss	$16,053,900	$22,442,300	$3,850,100
Building (Structure) Loss	$6,592,700	$8,784,700	$2,515,500
Content Loss	$8,979,700	$12,948,000	$1,333,100
Inventory Loss	$481,500	$709,600	$1,500
Count of Damaged Structures	991	993	874

D7.2.2. Agricultural Damages

For the agriculture evaluation, the USDA National Agricultural Statistics Service (NASS) 2024 Cropland Data Layer was downloaded. This data was used in combination with the With Project and Without Project scenario floodplains to develop agricultural grids necessary to calculate flood damage. Crops with more than 2 acres within the benefit area were evaluated. **Table D7-2** provides the data used to estimate the value of lost crops. This data was compiled using the National Agricultural Statistics Service Quick Stats (*https://quickstats.nass.usda.gov/*), the University of Missouri Cooperative Extension planning budgets based on 2024 price forecasts (*https://extension.missouri.edu/media/wysiwyg/Extensiondata/Pub/pdf/agguides/agecon/g00653.pdf*), and local input. **Table D7-3** details the single-event crop damage information for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events. The benefit shown in the last column represents the difference between With Project and Without Project implementation. Annualized damages were derived by multiplying the total damage value for each interval by the probability of recurrence and then summing the interval damages (**Table D7-4**). Annual damages and benefits of agricultural damages and structural damages are provided in **Table D7-5**.

Table D7-2. Data used to Calculate Agricultural Losses

Crop	Cost of Production (per acre)	Income (per Acre)	Market Price ($ Per Unit)	Unit	Yield (per acre)	Income over total cost (per acre)
Soybeans	$585.53	$698.50	$12.70	BU	70	$112.97
Corn (assume irrigated)	$1,214.61	$1,268.50	$5.90	BU	220	$53.89
Other Hay/Non Alfalfa	$159.60	$172.90	$133.00	ton	1.3	$13.30
Cotton	$816.33	$1,070.40	$0.80	lb	1750	$254.07
Rice	$847.99	$1,230.46	$0.15	lb	7990	$382.47
Winter Wheat	$518.50	$542.50	$7.75	BU	70	$24.00

Sources used:

https://quickstats.nass.usda.gov/
https://extension.missouri.edu/media/wysiwyg/Extensiondata/Pub/pdf/agguides/agecon/g00653.pdf

Table D7-3. Agricultural Losses per single event

	With Project (Acres)	With Project Loss ($)	Without Project / No Action (Acres)	Without Project / No Action Loss ($)	Total Benefit
2-Yr Crops in Floodplain	**10,933**	**$12,413,080**	**12,000**	**$13,623,302**	**$1,210,222.05**
Soybeans	4,789	$4,257,439	5,235	$4,653,637	
Corn (irrigated)	2,649	$3,438,603	3,092	$4,012,915	
Other Hay/Non-alfalfa	15	$2,575	19	$3,260	
Cotton	2,563	$3,587,631	2,703	$3,783,602	
Rice	915	$1,125,456	950	$1,168,584	
Winter Wheat	3	$1,373	2	$1,301	
5-Yr Crops in Floodplain	**16,322**	**$18,562,737**	**17,802**	**$20,233,922**	**$1,671,184.85**
Soybeans	6,986	$6,210,211	7,664	$6,812,987	
Corn (irrigated)	4,314	$5,599,783	4,738	$6,150,550	
Other Hay/Non-alfalfa	32	$5,553	34	$5,829.59	
Cotton	3,595	$5,032,839	3,917	$5,484,346	
Rice	1,392	$1,712,389	1,445	$1,778,373	
Winter Wheat	4	$1,959	3	$1,835	
10-Yr Crops in Floodplain	**20,190**	**$23,063,196**	**21,702**	**$24,765,968**	**$1,702,772**
Soybeans	8,469	$7,528,597	9,149	$8,133,307	
Corn (irrigated)	5,364	$6,962,125	5,718	$7,421,601	
Other Hay/Non-alfalfa	42	$7,265	46	$7,936	
Cotton	4,698	$6,576,642	5,028	$7,039,870	
Rice	1,614	$1,986,334	1,756	$2,160,601	
Winter Wheat	4	$2,230	5	$2,649	
25-Yr Crops in Floodplain	**24,943**	**$28,432,424**	**25,946**	**$29,530,837**	**$1,098,412**
Soybeans	10,535	$9,365,294	11,040	$9,814,579	
Corn (irrigated)	6,657	$8,640,821	6,826	$8,860,211	
Other Hay/Non-alfalfa	61	$10,483	64	$11,134	
Cotton	5,644	$7,901,933	5,816	$8,143,079	
Rice	2,040	$2,510,739	2,193	$2,698,308	
Winter Wheat	6	$3,153	6	$3,522	
50-Yr Crops in Floodplain	**28,053**	**$31,970,161**	**28,698**	**$32,680,534**	**$710,373**
Soybeans	11,816	$10,504,286	12,136	$10,788,867	
Corn (irrigated)	7,517	$9,756,903	7,634	$9,909,333	
Other Hay/Non-alfalfa	89	$15,465	96	$16,578	
Cotton	6,359	$8,902,632	6,512	$9,116,970	

	With Project (Acres)	With Project Loss ($)	Without Project / No Action (Acres)	Without Project / No Action Loss ($)	Total Benefit
Rice	2,265	$2,787,021	2,312	$2,844,882	
Winter Wheat	7	$3,850	7	$3,902	
100-Yr Crops in Floodplain	**31,186**	**$35,511,393**	**31,689**	**$36,066,162**	**$554,769**
Soybeans	13,178	$11,715,031	13,406	$11,918,297	
Corn (irrigated)	8,215	$10,663,657	8,251	$10,709,325	
Other Hay/Non-alfalfa	123	$21,234	137	$23,622	
Cotton	7,184	$10,058,276	7,339	$10,274,811	
Rice	2,478	$3,049,059	2,548	$3,135,658	
Winter Wheat	8	$4,133	8	$4,447	
500-Yr Crops in Floodplain	**33,552**	**$38,134,587**	**6,372.61**	**$38,843,785**	**$709,197**
Soybeans	14,247	$12,665,370	14,467	$12,860,747	
Corn (irrigated)	8,836	$11,468,758	8,966	$11,637,901	
Other Hay/Non-alfalfa	167	$28,948	170	$29,392	
Cotton	7,681	$10,753,790	7,910	$11,074,614	
Rice	2,611	$3,212,545	2,630	$3,235,912	
Winter Wheat	10	$5,174	10	$5,217	

Table D7-4. Agricultural Annual Flood Damage Calculation (With & Without Project)

Agricultural Flood Damage Estimate - With Project						
Flood Return Interval	**Probability**	**Probability Interval**	**Damages per Single Event ($)**	**Damages ($)**	**Interval Damage Calculation ($)**	**Summary Expected Annual Damages ($)**
2-YR	0.5		$12,413,080.69			
		0.3		$15,487,909.12	$4,646,372.74	$4,646,372.74
5-YR	0.2		$18,562,737.54			
		0.1		$20,812,966.77	$2,081,296.68	$6,727,669.41
10-YR	0.1		$23,063,196.00			
		0.06		$25,747,810.46	$1,544,868.63	$8,272,538.04
25-YR	0.04		$28,432,424.93			
		0.02		$30,201,293.16	$604,025.86	$8,876,563.90
50-YR	0.02		$31,970,161.38			
		0.01		$33,740,777.39	$337,407.77	$9,213,971.68
100-YR	0.01		$35,511,393.40			
		0.008		$36,822,990.66	$294,583.93	**$9,508,555.60**
500-YR	0.002		$38,134,587.91			

Agricultural Flood Damage Estimate - Without Project						
Return Interval	**Probability**	**Probability Interval**	**Damages per Single Event ($)**	**Interval Average Damages ($)**	**Interval Damage Calculation ($)**	**Summary Expected Annual Damages ($)**
2-YR	0.5		$13,623,302.74			
		0.3		$16,928,612.57	$5,078,583.77	$5,078,583.77
5-YR	0.2		$20,233,922.39			
		0.1		$22,499,945.26	$2,249,994.53	$7,328,578.30
10-YR	0.1		$24,765,968.13			

Agricultural Flood Damage Estimate - Without Project						
Return Interval	**Probability**	**Probability Interval**	**Damages per Single Event ($)**	**Interval Average Damages ($)**	**Interval Damage Calculation ($)**	**Summary Expected Annual Damages ($)**
		0.06		$27,148,402.72	$1,628,904.16	$8,957,482.46
25-YR	0.04		$29,530,837.30			
		0.02		$31,105,685.87	$622,113.72	$9,579,596.18
50-YR	0.02		$32,680,534.43			
		0.01		$34,373,348.63	$343,733.49	$9,923,329.66
100-YR	0.01		$36,066,162.82			
		0.008		$37,454,974.23	$299,639.79	**$10,222,969.46**
500-YR	0.002		$38,843,785.64			

Table D7-5. Annual Damages and Benefits [1]

Scenario	Est. Annual Damage	Est. Annual Damage Benefit [2]
Without Project	$32,665,300	
With Project	$25,562,500	$7,102,800

Analysis Period: *50 years*
Discount Rate: *0.0275 (National Bulletin 200-23-2)*

[1] Price Base 2024

[2] Difference between damages occurring under each alternative minus the damages occurring under No Action.

D7.3. Benefit-Cost Analysis

Following the calculation and annualization of damages for each alternative, construction cost estimates, project administration costs, and operation and maintenance costs were incorporated into a comprehensive benefit-cost analysis (BCA) for the proposed 50-year project life plus one year for design and one year for construction. This analysis evaluates each alternative by comparing its total benefits to its total costs. While a Benefit-Cost Ratio (BCR) of 1.0 or greater generally indicates that an alternative is cost-effective, it is important to note that BCRs alone do not determine the relative cost-efficiency among alternatives. Other factors—such as feasibility, environmental impact, and alignment with project objectives—must also be considered. See **Table D7-6** for detailed results of the analysis.

Table D7-6. Benefit/Cost Ratio

Scenario	Est. Annual Damage	Est. Annual Damage Benefit	Average Annual Costs	B/C Ratio (50 Year)
Without Project	$32,665,300	-	-	-
With Project	$25,562,500	$7,102,800	$837,500	8.5
Analysis Period: *50 years* *Discount Rate:* *0.0275 (National Bulletin 200-23-2)*				

D7.4. Alternative Cost Estimates

The Project Team prepared predictions of probable costs for all alternatives. The predictions of probable costs are intended for comparing the alternatives. Unless otherwise noted, predictions of probable costs were prepared using the RS Means method for engineering cost estimation. **Table D7-7** summarizes the raw Project Alternative Cost Estimates. All costs will be rounded to the nearest $100 for subsequent analyses in this study. Engineering cost estimates for each area included in the With Project alternative are provided in Section D.7.6.

Table D7-7. Project Alternative Cost Estimates

ITEM		Project Alternatives [1]		
	No Action/Future Without Federal Investment	**Alternative 2 (Structural – Wetland Creation)**	**Alternative 3 (Structural – Channel Work)**	**Alternative 4 (Non-Structural Buyouts)**
Total Construction Cost	-	$ 2,640,100	$ 17,140,600	-
NRCS - Construction	-	$ 2,640,100	$ 17,140,600	-
Sponsor - Construction	-	-	-	-
NRCS - Easements		$ 3,128,500		$ 2,250,000
Sponsor - Easements	-	$ 1,042,800	-	$ 750,000
NRCS - Project Design, Construction Engineering	-	$ 528,000	$ 3,428,100	-
Sponsor - Project Design, Construction Engineering	-	-	-	-
Sponsor – Real Property	-	-	-	$ 150,971,800
NRCS - Project Administration	-	$ 132,000	$ 857,000	-
Sponsor - Project Administration	-	-	-	$ 7,698,600
Federal, State and Local Permits	-	$ 10,000	$ 60,000	-
Total Installation Cost	$ 62,000	$ 7,481,400	$ 21,485,700	$ 161,670,400

[1] Price base 2024
[2] All costs are Average Annual Costs. No installation costs are associated with this alternative.
[3] Assumes 75% NRCS /25% Sponsor cost share for floodplain conservation easement (share determined by State Conservationist based on comparison with other federal programs.)

D7.5. Comparative Cost Analysis

A comparative cost analysis was completed for alternative plans carried forward for detailed study, which is shown in **Table D7-8**. Cost items include:

- Construction-related activities such as mobilization, clearing and grubbing, erosion and sediment control, site work, earthwork, fencing, and seeding.
- Engineering activities such as completing design, surveys, construction observations, and Project administration.

Table D7-8. Comparative Cost Analysis of Alternative Plans

Item	Project Alternatives [1]			
	No Action/Future Without Federal Investment[3]	**Alternative 2 (Structural – wetland creation)**	**Alternative 3 (Structural – ditch work)**	**Alternative 4 (Non-Structural Buyouts)**
Total Investment	$ -	$ 7,481,400	$ 21,485,700	$161,670,400
P.L. 83-566 Funds	$ -	$ 6,428,600	$ 21,485,700	$ 2,250,000
Other Funds	$ -	$ 1,052,800	$ 60,000	$159,420,400
Average Annual Benefits	$ -	$ -	$ 7,102,800	$ 12,374,100
Average Annual Costs [2]	$ -	$ 283,100	$ 837,5000	$ 6,762,800
Net Beneficial	$ -	$ (283,100)	$ 6,265,300	$ 5,611,300
Average Annual O&M Costs	$ 62,000	$ 11,000	$ 56,000	$ -

[1] Price base 2024

[2] Amortized over 52 years at a discount rate of 2.75 percent. Amortization includes Average Annual O&M Costs in presented in table.

[3] All costs are Average Annual Costs. No installation costs are associated with this alternative.

D7.5.1. Alternative 2 Installation Cost

Table D7-9. Estimated Installation Cost – Alternative 2 - Area 3b

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Wetland Pump Sta.	1	LS	$ 1,179,600.00	$ 1,179,600
3	Pipe 24" Dia. Smooth Interior	6150	LF	$ 100.00	$ 615,000
4	Water Control Structures	6	EA	$ 25,000.00	$ 150,000
5	Wetland Seeding	300	AC	$ 1,200.00	$ 360,000
				Subtotal 1 :	**$ 2,354,600**
				Erosion and Sediment Control : 5%	$ 117,730
				Dewatering : 5%	$ 117,730
				Construction Contingency : 15%	$ 353,190
				Subtotal 2 :	**$ 2,943,250**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 2,640,095**
				Subtotal 3 :	**$ 2,640,095**
				Permitting :	$ 10,000
				Easement Acquisition (Construction Easements) :	**$ 4,171,250**
				Subtotal 4 :	**$ 6,821,345**
				Project Design, Construction Engineering, Contracting, Inspection : 20% of Subtotal 3	$ 528,019
				Project Administration : 5% of Subtotal 3	$ 132,005
				Total :	**$ 7,481,369**

D7.5.2. Alternative 3 Installation Cost

Tables D7-10 through **D7-16** present the estimated installation costs for all areas included within Alternative 1.

Table D7-10. Estimated Installation Cost – Alternative 3- ALL AREAS

Item	Quantity	Unit	Unit Cost	Total
Mobilization	6	LS	$ 50,000.00	$ 300,000
Riprap	559897	TN	$ 20.00	$ 11,197,931
Excess Earthwork	454471	CY	$ 0.77	$ 349,943
Rock Bedding	125333	TN	$ 20.00	$ 2,506,659
Erosion Matting, TRM	311500	SY	$ 2.00	$ 622,999
Seeding	162	AC	$ 1,200.00	$ 194,586
			Subtotal 1:	**$ 15,172,118**
		Erosion and Sediment Control:	5%	$ 758,606
		Dewatering:	5%	$ 758,606
		Construction Contingency:	15%	$ 2,275,818
			Subtotal 2:	**$ 18,965,148**
		2024 RS Means Location Factor (Sikeston, MO)**	0.897	**$ 17,011,738**
			Subtotal 3:	**$ 17,011,738**
		Permitting:		$ 10,000
		Easement Acquisition (Construction Easements):		-
			Subtotal 4:	**$ 17,021,738**
		Project Design, Construction Engineering, Contracting, Inspection:	20% of Subtotal 3	$ 3,402,348
		Project Administration:	5% of Subtotal 3	$ 850,587
			Total:	**$ 21,274,672**

Table D7-11. Estimated Installation Cost – Alternative 3- AREA 1

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	121045	TN	$ 20.00	$ 2,420,893
3	Excess Earthwork	87728	CY	$ 0.77	$ 67,550
4	Rock Bedding	432	TN	$ 20.00	$ 8,640
5	Erosion Matting, TRM	14630	SY	$ 2.00	$ 29,260
6	Seeding	23	AC	$ 1,200.00	$ 28,021
				Subtotal 1:	**$ 2,604,363**
				Erosion and Sediment Control: 5%	$ 130,218
				Dewatering: 5%	$ 130,218
				Construction Contingency: 15%	$ 390,655
				Subtotal 2:	**$ 3,255,454**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 2,920,142**
				Subtotal 3:	**$ 2,920,142**
				Permitting:	$ 10,000
				Easement Acquisition (Construction Easements):	-
				Subtotal 4:	**$ 2,930,142**
				Project Design, Construction Engineering, Contracting, Inspection: 20% of Subtotal 3	$ 584,028
				Project Administration: 5% of Subtotal 3	$ 146,007
				Total:	**$ 3,660,178**

Table D7-12. Estimated Installation Cost – Alternative 3- AREA 2

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	73859	TN	$ 20.00	$ 1,477,176
3	Excess Earthwork	73998	CY	$ 0.77	$ 56,978
4	Rock Bedding	21501	TN	$ 20.00	$ 430,020
5	Erosion Matting, TRM	41061	SY	$ 2.00	$ 82,122
6	Seeding	33	AC	$ 1,200.00	$ 39,267
				Subtotal 1:	**$ 2,135,564**
				Erosion and Sediment Control: 5%	$ 106,778
				Dewatering: 5%	$ 106,778
				Construction Contingency: 15%	$ 320,335
				Subtotal 2:	**$ 2,669,454**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 2,394,501**
				Subtotal 3:	**$ 2,394,501**
				Permitting:	$ 10,000
				Easement Acquisition (Construction Easements):	-
				Subtotal 4:	**$ 2,404,501**
				Project Design, Construction Engineering, Contracting, Inspection: 20% of Subtotal 3	$ 478,900
				Project Administration: 5% of Subtotal 3	$ 119,725
				Total:	**$ 3,003,126**

Table D7-13. Estimated Installation Cost – Alternative 3- AREA 3a

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	65420	TN	$ 20.00	$ 1,308,401
3	Excess Earthwork	52830	CY	$ 0.77	$ 40,679
4	Rock Bedding	19109	TN	$ 20.00	$ 382,174
5	Erosion Matting, TRM	51611	SY	$ 2.00	$ 103,221
6	Seeding	40	AC	$ 1,200.00	$ 8,047
				Subtotal 1 :	**$ 1,932,522**
				Erosion and Sediment Control : 5%	$ 96,626
				Dewatering : 5%	$ 96,626
				Construction Contingency : 15%	$ 289,878
				Subtotal 2 :	**$ 2,415,653**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 2,166,841**
				Subtotal 3 :	**$ 2,166,841**
				Permitting :	$ 10,000
				Easement Acquisition (Construction Easements) :	-
				Subtotal 4 :	**$ 2,176,841**
				Project Design, Construction Engineering, Contracting, Inspection : 20% of Subtotal 3	$ 433,368
				Project Administration : 5% of Subtotal 3	$ 108,342
				Total :	**$ 2,718,551**

Table D7-14. Estimated Installation Cost – Alternative 3- AREA 4

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	181957	TN	$ 20.00	$ 3,639,140
3	Excess Earthwork	145447	CY	$ 0.77	$ 111,994
4	Rock Bedding	50758	TN	$ 20.00	$ 1,015,168
5	Erosion Matting, TRM	132939	SY	$ 2.00	$ 265,877
6	Seeding	96	AC	$ 1,200.00	$ 114,892
				Subtotal 1:	**$ 5,197,071**
				Erosion and Sediment Control: 5%	$ 259,854
				Dewatering: 5%	$ 259,854
				Construction Contingency: 15%	$ 779,561
				Subtotal 2:	**$ 6,496,339**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 5,827,216**
				Subtotal 3:	**$ 5,827,216**
				Permitting:	$ 10,000
				Easement Acquisition (Construction Easements):	-
				Subtotal 4:	**$ 5,837,216**
				Project Design, Construction Engineering, Contracting, Inspection: 20% of Subtotal 3	$ 1,165,443
				Project Administration: 5% of Subtotal 3	$ 291,361
				Total:	**$ 7,294,020**

Table D7-15. Estimated Installation Cost – Alternative 3- AREA 5

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	116604	TN	$ 20.00	$ 2,332,079
3	Excess Earthwork	93649	CY	$ 0.77	$ 72,110
4	Rock Bedding	33234	TN	$ 20.00	$ 664,684
5	Erosion Matting, TRM	70722	SY	$ 2.00	$ 141,443
6	Seeding	66	AC	$ 1,200.00	$ 78,843
				Subtotal 1:	**$ 3,339,159**
				Erosion and Sediment Control: 5%	$ 166,958
				Dewatering: 5%	$ 166,958
				Construction Contingency: 15%	$ 500,874
				Subtotal 2:	**$ 4,173,948**
				2024 RS Means Location Factor (Sikeston, MO)** 0.897	**$ 3,744,032**
				Subtotal 3:	**$ 3,744,032**
				Permitting:	$ 10,000
				Easement Acquisition (Construction Easements):	-
				Subtotal 4:	**$ 3,754,032**
				Project Design, Construction Engineering, Contracting, Inspection: 20% of Subtotal 3	$ 748,806
				Project Administration: 5% of Subtotal 3	$ 187,202
				Total:	**$ 4,690,039**

Table D7-16. Estimated Installation Cost – Alternative 3- AREA 6

Line	Item	Quantity	Unit	Unit Cost	Total
1	Mobilization	1	LS	$ 50,000.00	$ 50,000
2	Riprap	1012	TN	$ 20.00	$ 20,243
3	Excess Earthwork	819	CY	$ 0.77	$ 631
4	Rock Bedding	299	TN	$ 20.00	$ 5,973
5	Erosion Matting, TRM	538	SY	$ 2.00	$ 1,076
6	Seeding	0	AC	$ 1,200.00	$ 409
				Subtotal 1:	**$ 78,331**
			Erosion and Sediment Control:	5%	$ 3,917
			Dewatering:	5%	$ 3,917
			Construction Contingency:	15%	$ 11,750
				Subtotal 2:	**$ 97,914**
			2024 RS Means Location Factor (Sikeston, MO)**	0.897	**$ 87,829**
				Subtotal 3:	**$ 87,829**
			Permitting:		$ 10,000
			Easement Acquisition (Construction Easements):		-
				Subtotal 4:	**$ 97,829**
			Project Design, Construction Engineering, Contracting, Inspection:	20% of Subtotal 3	$ 17,566
			Project Administration:	5% of Subtotal 3	$ 4,391
				Total:	**$ 119,786**

D7.5.3. Alternative 4 Non-Structural Buyout Costs

Table D7-17 presents the estimated Non-Structural Buyout costs.

Table D7-17. Estimated Non-Structural Buyout Costs

Line	Item	Quantity	Unit	Unit Cost	Total
1	100-Year Floodplain Area of Agriculture protected by With Project	600	Ac	$ 5,000	$ 3,000,000
2	Structure Buyouts (Structures with depth of flooding greater than 0.5 ft for 100-yr event)	1	Total	$ 150,971,800	$ 150,971,800
				Subtotal 1:	**$ 153,971,800**
				Project Administration: 5%	$ 7,698,590
				Total:	**$ 161,670,390**

D8. HUMAN ENVIRONMENT

D8.1. Socioeconomic Issues

The economy of Stoddard County is based primarily on office & administrative support (10.8 percent) and management occupations (Data USA 2022). Agriculture is the predominant land use in Stoddard County, comprising over 70 percent. Over 87 percent of the land in the Project Area is devoted to agriculture (cultivated crops and pastureland), and most of the land adjoining the Project Area is in cultivated crop production. Agriculture contributes greatly to local county economies. In 2021, agriculture contributed to household income by over 77 percent in Stoddard County (MODA 2021, USCB 2019a-f).

The U.S. Census Bureau (USCB) American Community Survey (ACS) was reviewed for demographic information for the state and the county of the watershed. **Table D8-1** and **Table D8-2** summarize the region's median age, number of households, per capita income, median household income and the percentage of the population living below the poverty line. Data is provided by the USCB ACS estimates for years 2015 through 2019. Based on the USCB data, the Project Area is in a county with a relatively small population. Per capita income and median household income are lower in the county than the state median. Further, the percentage of persons living below the poverty line in the county exceeds the state percentage.

Table D8-1. Household Age and Income; Persons Below Poverty Line

Geography	Population	Median Age	Number of Households	Per Capita Income	Median Household Income	Persons Below Poverty Line
State of Missouri	6,154,913	39.2	2,468,726	$34,593	$61,847	12.7%
Stoddard County	28,812	41.3	11,293	$24,295	$46,052	17.2%
Bloomfield	1,755	41.5	829	$20,858	$39,881	25.2%
Dexter	7,927	38.8	3,290	$17,978	$35,551	22.1%
Dudley	194	43.7	73	$22,922	$37,083	22.7%

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates.

Table D8-2. Per Capita and Median Household Income (MHI)

Geography	Per Capita Income	MHI	MHI < $50,000	MHI $50,000-$100,000	MHI $100,000-$200,000	MHI > $200,000
State of Missouri	$34,593	$61,847	40.7%	31.7%	21.3%	6.4%
Stoddard County	$24,295	$46,052	52.8%	32.2%	13.5%	1.5%
Bloomfield	$20,858	$39,881	66.7%	24.1%	8.8%	0.5%
Dexter	$17,978	$35,551	71.4%	22.7%	5.7%	0.3%
Dudley	$22,922	$37,083	64.4%	21.9%	13.7%	0.0%

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates.

Regarding educational attainment, populations in the county have less higher education than the state average (see **Table D8-3**).

Table D8-3. Educational Attainment

Geography	Population	High School Diploma or Higher	Bachelor's Degree or Higher
State of Missouri	6,154,913	91.6%	31.7%
Stoddard County	28,812	81.1%	13.6%
Bloomfield	1,755	35.8%	10.8%
Dexter	7,927	43.6%	13.0%
Dudley	101	64.5%	11.8%

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates.

Regarding housing, the percentage of owner-occupied housing in Stoddard County and the town of Bloomfield is generally in line with the state average. However, Dexter and Dudley both have a lower owner-occupied rate (see **Table D8-4**).

Table D8-4. Occupied Housing Units by Tenure

Geography	Households	Owner Occupied	Renter Occupied
State of Missouri	2,468,726	68.8%	31.2%
Stoddard County	11,293	69.6%	30.4%
Bloomfield	829	66.7%	33.3%
Dexter	3,193	53.3%	46.7%
Dudley	73	42.5%	57.5%

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates.

Regarding race in the watershed, the area is predominantly white with little diversity (see **Table D8-5).**

Table D8-5. Racial and Ethnic Composition

Geography	Population	White	Black	Hispanic	Other
State of Missouri	6,154,913	4,740,335	699,840	281,445	433,293
Stoddard County	28,812	26,610	298	566	1,338
Bloomfield	1,755	1,692	15	29	67
Dexter	7,927	7,217	90	251	369
Dudley	101	93	2	0	6

Source: U.S. Census Bureau, 2020 DEC Redistricting Data (PL 94-171).

Regarding age in the watershed, the median age of the population is in line with state averages; however, the population of those 65 years and older is slightly higher in the county. The town of Dudley is the exception, with a lower proportion under 18 years and 65 years and over compared to the other towns, Stoddard County, and the State of Missouri (see **Table D8-6**).

Table D8-6. Age Distribution

Geography	Median Age	Under 18 Years	18 Years and Over	65 Years or Over
State of Missouri	39.2	22.7%	77.3%	16.8%
Stoddard County	41.3	22.2%	77.8%	19.7%
Bloomfield	41.5	25.0%	75.0%	19.9%
Dexter	38.8	23.9%	76.1%	21.4%
Dudley	43.7	14.4%	85.6%	8.2%

Source: U.S. Census Bureau, 2015-2019 American Community Survey 5-Year Estimates.

In summary, counties and towns within the watershed are generally less populated, less educated, less diverse, and have a higher percentage of individuals living below the poverty level than state averages.

D9. CULTURAL RESOURCES

D9.1. Survey Methodology

The Area of Potential Effect (APE) contains a series of ditches, ditches and levees surrounded by cropland with some forestland and wetlands. Elevations are between 307 to 337 feet above mean sea level. As the area has been continually disturbed since the drainage features were installed in the early 1900's, a literature review and reconnaissance pedestrian survey were conducted within the APE to document current conditions and previous disturbances. Approximately 29 acres of the 392-acres Project APE, selected in consultation with NRCS staff and the Missouri State Historic Preservation Office (MO SHPO), were targeted for field investigation as most of the survey area involved non-ground disturbing activities or exempted activities of soil spreading and reseeding.

D9.2. Phase I Archaeological Survey

A Phase I Archaeological Survey was completed to locate, identify, and record all archaeological resources within the Project Area on December 5-8, 2023. The archaeological survey consisted of a reconnaissance survey within designated areas of importance in the APE as defined by proximity to nearby archaeological sites and estimated level of disturbance needed for the potential project activities. As the proposed project activities were to be within 60 feet from the centerline of the ditches, the pedestrian survey was limited to this area. The APE was either covered in tall grasses and mixed herbaceous vegetation, devoid of vegetation or surrounded by dense forest. No cultural features or structures were encountered within the APE.

D9.3. Historic Resources Survey

A reconnaissance-level historic resources survey was conducted for historic-age buildings, structures and site features within the APE and was conducted alongside the archaeological survey. This work involved archival investigation and field verification. No NRHP-eligible or listed historic properties were identified within a 1-mile radius of the APE. One historic-age resource was located, Cypress Lateral No. 1. This ditch adjoins one of the ditches that is proposed for improvement in this project, Lick Creek ditch. The period of significance for this feature ranges from 1915 to 1974 and represents the historical development for reclamation of swamplands.

D9.4. Background Research

An archaeological review of literature was conducted to determine if National Register of Historic Properties (NRHP), NRHP districts or archaeological sites had already been documented in the APE or if any recent disturbances had occurred that may have affected cultural resources. This review included consultation with the Missouri Cultural Resources Inventory and Historic Districts and Sites Map as well as historical maps and aerial photographs on Google Earth Pro, Nationwide Environmental Title Research Online, the Missouri Geological Survey, and State Historical Society of Missouri. In support of the NRHP-eligibility recommendations, historical and archival research was also conducted, specifically for Cypress Lateral No. 1.

Previous investigations and surveys have been recorded. Seven archaeological investigations have been documented within a 250-ft radius of the APE. Two archaeological sites have been documented within the APE and an additional eleven sites within the 250-ft radius of the APE. The two sites within the APE included a historic surface scatter and a prehistoric isolated find, but

no eligibility determination was on file for either site. No Historic Points of Interest were located within the APE.

D9.5. Summary

The cultural resources investigation for the Project APE included both a Phase I reconnaissance survey and an archaeological review of literature. During the pedestrian surveys, no cultural features or structures were encountered within the APE beyond the ditches themselves, specifically Cypress Lateral No. 1. The literature review revealed that previous investigations and surveys have been recorded. However, no NRHP-eligible or listed historic properties were identified within a 1-mile radius of the APE. The research and field evaluation of Cypress Lateral No. 1 revealed details that document it as a historic-age resource. NRCS recommends that Cypress Lateral No. 1 be eligible for the *National Register of Historic Properties* based on the findings of the literature and field surveys. SHPO concurred with this determination in letters dated 10/24/24 and 6/12/25 (see documents in Appendix A). Two Archaeological sites were identified adjacent to the APE, however pedestrian surveys of the APE concluded that no cultural features or structures were in the APE and, based on a visual inspection of the site conditions, NRCS made a recommendation that both sites be determined Not Eligible for the NRHP. SHPO disagreed with this determination for the two adjacent sites. Because of the significant and regular ditch maintenance activities that have changed the original construction of Cypress Lateral No. 1 and because the preferred alternative will not change the general character of the ditch but will allow it to continue operating as it was originally designed and intended, however, the NRCS recommendation is a finding of *No Adverse Effect to Historic Properties* for Cypress Lateral No. 1 with SHPO concurrence in the 6/12/25 letter mentioned above.