# Warsaw, Missouri
# Osage Trail

## Traffic Engineering Assistance Program
## Preliminary Engineering Report

**Prepared for:**
**The City of Warsaw**
**181 Harrison Street**
**Warsaw, MO 65355**
**(660) 438-5522**

**Prepared by Charles LePage, P.E.**
**CFS Engineers**
**119 W. Pacific Street**
**Branson, MO 65616**

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# INTRODUCTION

Warsaw Missouri has come to be known as one of the great communities in the country for experiencing outstanding bike and trail networks. Since 2003, CFS Engineers has provided numerous engineering studies, reports and design for multiple trail projects in Warsaw. For this Traffic Engineering Assistance Program (TEAP) report, CFS was hired by the City to study the feasibility of connecting trail extensions along the easterly portions of the City that would provide connectivity to existing and future bike/pedestrian routes, and provide access to scenic vistas along the waterfront as well as activities in the Warsaw region.

**Background**

The City of Warsaw adopted policies that follow the *Warsaw Livable Streets Transportation Improvement Plan,* which focused on the following components of the transportation network:

- Primary Connectors
- Secondary Connectors
- Future Connectors
- Sidewalk, Trails and Multi Use Paths
- Signing and Way-finding
- Parking
- Transportation Maintenance Plan

Main Street is the primary gateway into Warsaw from both US 65 and from Route 7. Travelers coming from the East or West access Warsaw from MO Route 7. US 65 is the gateway for those coming from the North or South. As outlined in the City of Warsaw Transportation Improvement Plan, Main Street is a priority route to improve. The route runs through prime real estate that has high potential for redevelopment, but many deficiencies prohibit it's best and highest uses. Public investment along Main Street would encourage private investment from the Eastgate area along Main Street to the downtown and stimulate further business development.

CFS recently completed a Preliminary Engineering Report (PER) for Warsaw for the Main Street corridor from Highway 7 to Walnut Street. The TEAP study starts where that PER ended. With the completion of the TEAP, the study of the Main Street Corridor will be complete and the city will be able to move forward with the pursuit of funding for infrastructure improvements.

The approach to the design components for Primary Connectors follows the six Livability Principles established by USDOT, HUD the EPA **Partnership** for Sustainable Communities:

- Provide more transportation choices
- Promote equitable, affordable housing
- Enhance economic competitiveness
- Support existing communities
- Coordinate and leverage federal policies and investment

- Value community neighborhoods


East end of Main Street Improvements from PER Study

This study will aide the City with completing another phase of their comprehensive approach to providing livable streets and enhancing the quality of life in their community.

The *Warsaw Trails Master Plan* identified the Osage Trail as extending from downtown Warsaw to the Lost Valley Fish Hatchery. Two trails were identified for making this connection; the Interconnecting Bike Trail along old 65 Highway and the Sedalia-Warsaw and Southwestern Railroad Trail. The current Osage Trail connects to downtown and ends at the US 65 bridge over the Osage River. Continuing the Osage Trail network to the Lost Valley Fish Hatchery is the ultimate goal of the Osage Trail extensions.

The limits of the TEAP study include East Main Street from just west of US 65 to where the existing bike lanes end on Route 7. The project limits also include extending the Osage Trail from under the US 65 bridge northerly to the Medic Drive intersection with East Main Street. This report also looks at future extensions of the two bike/pedestrian trail routes that would ultimately provide connectivity to the Lost Valley Fish Hatchery and the northern limits of the City.

The **East Main Street** bike/pedestrian facility begins in the south part of town at the east end of


the Eastgate Shopping Center, which is where 1st Street intersects with Main Street. From there the route continues along East Main Street to the east across US 65 Highway and then northerly for about 0.80 miles along the outer road for approximately to the Route 7 intersection. The future extension of this route continues northward for another 1.9 miles to its endpoint at the northern road into the Lost Valley Fish Hatchery. This trail route includes connections to existing bike routes at the intersection of MO Route 7 Highway.

The **Osage Trail** portion of this project begins at the east end of the existing Osage Trail, under the US 65 Highway bridge at the north bank of the Osage River. From this location the trail extends northward along the easterly perimeter of the US 65 Highway right-of-way, crosses a short portion of backwater from the Osage River, which is Ameren property and connects to City property near the City's maintenance building. The trail extends northward to Medic Drive and connects to East Main Street. The total length of this trail extension is approximately 3,370 feet.

The future phases of the Osage Trail head easterly along the perimeter of the sewage lagoon. Beyond the lagoons, the trail begins to follow the abandoned **Sedalia-Warsaw and Southwestern Railroad line** which parallels the backwater channel of the Osage River. The trail continues northeasterly past Tamara Dive and Braden Park, crossing small backwater inlets and coves along the way. As the proposed trail reaches Grandview Beach it travels along existing roadways and turn northwesterly crossing over a backwater cove and onto land owned by the Missouri Conservation Department. Extending northwesterly, the trail connects with the Lost Valley Road and heads westerly from there utilizes the existing road network, ultimately connecting to the east frontage road.

Osage Trail Extensions


Osage Trail Extension

Improvements to the trails network will continue to promote multi-modal capabilities within the community that will access parks, commercial and residential areas and community services and amenities. In addition, these trails will promote tourism and encourage healthier lifestyles for the citizens of Warsaw and beyond.

This study will address the existing condition of the routes, opportunities for providing muti-modal routes, access and amenities, as well as identifying challenges and potential impacts of the proposed improvements.

This report will explain the rational for the trail alignment and type and will also define the design criteria that the proposed improvements will be based upon.

# EXECUTIVE SUMMARY

The Osage Trail TEAP study addresses the feasibility of constructing two bike/pedestrian route extensions of the existing Osage Trail from US 65 to the Route 7 and ultimately to the Lost Valley Fish Hatchery. The existing Osage Trail is located along the southern edge of Warsaw, paralleling the Osage River from Drake Harbor and Steamboat Landing easterly to US 65 Highway. For the purposes of this report, bike/pedestrian route and trail route will be synonymous.

This report:

- addresses the challenges and opportunities for providing bike/pedestrian routes and access within the identified corridors for the proposed improvements.
- provides definitions and design parameters for the various ecosystems and trail types that will be considered
- provides the status of the existing infrastructure including limitations and substandard conditions are presented in the analysis
- discusses the environmental concerns, permitting process and probable issues that will need to be addressed and possibly mitigated before agency approval
- provides recommendations for infrastructure improvements
- provides conceptual design with cost estimates for engineering and surveys, utility adjustments, easements and construction related expenses for various alternatives and includes recommendations for proposed improvements

**East Main Street Bike/Pedestrian Trail**

For the first phase of the Osage Trail extension, CFS is recommending improvements to the existing shoulders and adding signage and pavement markings along 1.05 miles of **East Main Street and the East Frontage Road** to provide a safe bike/pedestrian route within the existing right of way. These improvements would include reconstructing shoulders where needed to provide a minimum 6 foot wide, hard surface path on both sides of the road. Most of the existing shoulder from 1st Street, through the interchange are 10 feet wide. Bike route signage and warning signage should be added to the roadway to alert motorists of bikes and pedestrian that may be present on the shoulder. Reflective pavement marking and rumble strips should be placed along the inside edge of the shoulders. At street crossings, consideration should be given for adding crosswalk markings. Consideration should also be given for lowering the posted speed along the east frontage road, especially where sight distance is limited.

There are some locations along this route where grading will be required to create a 6 foot wide shoulder. There do not appear to be any utility adjustments or easements needed for these improvements.

The estimated cost to construct the improvements for East Main Street/Old 65 Highway is approximately $471,376. This estimate includes engineering and construction administration and inspection. No easements or utility adjustments are anticipated with this improvement.

An alternate improvement would be to repair and reconstruct shoulders from 1st Street to just east of the northbound off-ramp, then construct an 8 foot wide, off-road, mult-use path for the remainder of the corridor to the Route 7 intersection. This pathway could be constructed without the need for easements or utility adjustments.

The estimated cost to construct the alternate improvements for East Main Street/Old 65 Highway is approximately $678,151. This estimate includes engineering and construction administration and inspection. No easements or utility adjustments are anticipated with this improvement.

Recommended future improvements would include providing a paved 6 foot shoulder on both sides of East Main Street from Route 7 to the Lost Valley Road/Truman Dam Access Road interchange at US 65 Highway.

**Osage Trail**

The initial phase of construction should focus on constructing the trail from the end of the existing trail at US 65 to Medic Drive and the East Main Street connection. This 0.64 mile route would require easements along MoDOT right of way and a small piece of Ameren property. The trail should be a minimum of 8 feet wide with a 2 foot clear shoulder on each side. A preferred trail width is 10 feet to allow for the occasional light-duty vehicles to access sewer manholes and maintenance of the trail. The trail should be routed to minimize tree removal and earthwork grading. In order to balance the amount of fill placed in the floodway that is needed to construct the trail, dredging and excavating to deepen the backwater areas such as the slough should be pursued. Large portions of these backwater areas have silted in and are dry when river levels are down. Dredging along the Osage River/Lake of the Ozarks backwaters can be permitted and would enhance the proposed improvements by providing waterfront views for longer periods during the year. A large drainage structure would be required to span the backwater area where storm water runoff from across US 65 enters the slough.

Lighting selected sections of the trail is recommended, but due to the densely wooded area, continuous lighting would not be effective and would add significant cost to the project.

The trail could be constructed in phases as funds become available. For instance, the trail could initially be constructed as more of a natural trail or with an aggregate surface with minimal signage and lighting and be paved at a later date. The estimated cost to construct the minimal improvements is approximately $643,529.

The estimated cost to construct the optimum improvements is approximately $ $1,312,878. This would include a minimum 10 foot paved trail, parking, lighting, a fishing pier and abundant trail signage.

**Future Osage Trail** extensions along the **Sedalia-Warsaw and Southwestern Railroad Trail** (SW-SWRR) line will take several years to implement. This trail will require considerable environmental review and approvals and will require the acquisition of permanent easements from multiple agencies and property owners. There are a large number of stakeholders that should participate in the development of this project, including Ameren, the US Army Corps of Engineers, FEMA, the Missouri Department of Natural Resources, the Missouri Department of Conservation, The Missouri Department of Transportation, Benton County, the Grandview Beach Property Owners Association, the Braden Park Home Owners Association and affected individual home owners. The National Environmental Protection Act (NEPA) will necessitate that initial planning and design of a proposed trail will likely require an Environmental Assessment. This process is lengthy and could add 18 months or more to the permitting schedule.

This future route extension of the Osage Trail could encounter resistance from the lake communities it crosses, so early engagement and public involvement will be essential to the success of this project. Strong opposition to the route's location through Grandview Beach or Braden Park will require that alternate routes through supportive properties are selected. The route alignment should be flexible with alternates provided before submitting the location study and environmental documents to agencies for approval.

The SW-SWRR trail will be costly to construct due to construction access along the waterfront and wooded riparian environment. Multiple pedestrian bridge crossings over backwater areas and elevated boardwalks through floodways or wetlands will add significant costs to the project. In addition, there will be strict limitations to the footprints made by construction equipment in the environmentally sensitive areas.

Despite the many challenges, the benefits of implementing this future extension of the Osage Trail would be immeasurable. The natural beauty of this environment will attract users to this trail system from all over the region. Surrounding lake communities would have more direct access to the trails network via Lost Valley Road, Grandview Beach and Braden Park.

Opportunities for bird watching, fishing and enjoying the local flora will be abundant. Local citizens as well as visitors to the region would have use of a trail network that allows them to safely circumnavigate a 10 to 12 mile loop of the entire Warsaw region. There will be major benefits to health and the environment of the region from less motorized vehicle usage and more physical exercise. Added tourism and local revenue will help to continue funding future bike/pedestrian improvements and further fulfill Warsaw's goal for becoming a more livable community.

CFS recommends that the City continue to plan for the future SW-SWRR trail extension. Public involvement and a location study and environmental documentation should be the initial phases of implementation. Getting environmental clearance for the entire route will allow the City to fund capital improvements to construct the trail extension. The infrastructure improvements would likely be done in stages or with interim connections as the availability of funding for the entire route may take many years to accomplish.

Another relatively easy trail extension would be from Medic Drive, around the southeast edge of the sewage lagoons and heading northward to terminate at Tamara Lane. A parking lots could be easily added at this northern terminus and this route would be entirely on City property. Tamara Lane could have signage added to direct trail users to and from the frontage road.

Subsequent phases should consider making a connection between Grandview Beach and Lost Valley Road, which would provide access to waterfront views and could loop through the existing neighborhood roads and the county road access back to the East Frontage Road. This would include an interim route with signage along low traffic volume roadways. Potential challenges would be acceptance of the route by the Home Owners Association and the cost of a bridge crossing over a backwater area. This route would be along existing roadways and through Missouri Department of Conservation property, but would not require easements across individual property owners. Improvements along Lost Valley Road would require adding a paved shoulder, pavement markings and signage. Signage could also be added through the local road that traverse through the Lost Valley Fish Hatchery, providing connectivity to the north end of the east outer road.

Future phases would provide waterfront trail connections between the terminus at Tamara Lane and Braden Park and from Braden Park to Grandview Beach. These phases would be the most challenging, due to environmental sensitivity, construction costs and potential easements required.

# EXISTING CONDITIONS

## EAST MAIN STREET BIKE/PED

### General Characteristics

The East Main Street Bike/Ped facility utilizes the existing East Main Street and east outer roadway infrastructure and right of way. The total length of this trail route is approximately 1.0 mile. The limits extend from East Main Street, west of US 65 Highway (about 1st Street) to the intersection of Route 7 Highway. The roadway is typically 22 to 24 feet wide with variable width shoulders. The travel lanes along the entire route are generally in good condition. The shoulders vary from narrow turf shoulders to aggregate to asphalt to concrete.

East Main Street facing west toward 1st Street

The East Main Street/Frontage Road route is considered a primary connector. There is currently no on-street parking allowed. No pedestrian or bicycle infrastructure currently exists along this route.

### Shoulders

Beginning approximately 1,000 feet west of US 65 on East Man Street, asphalt shoulders are 10 feet wide and in very poor condition up to the Walnut/Dogwood intersection. From Walnut eastward through the US 65 interchange, the shoulder is 10 feet wide on the north side. The shoulder on the south side is 6 feet wide from Walnut to the southbound on-ramp to US 65. The south shoulder is 10 feet wide through the remainder of the interchange. Across the bridge over US 65 the shoulders are concrete in good condition with a concrete barrier at the outside

edge. Elsewhere through the interchange the shoulders are asphalt and in poor condition with guardrail at the outside edge.

East Main Street approaching US 65 from the west

Between the north off-ramp of US 65 to about 250 feet north of Medic Drive the asphalt shoulders are 6 feet wide and in good condition. Guardrail exists along the outside edge of the east shoulder for a distance of approximately 850 feet. The west shoulder going northward to Tamara Lane maintains at least 8 feet of with, while the east shoulder narrows to 4 feet or less. Both sides are asphalt and in good condition. North of Tamara Lane to the intersection of Mo Route 7, the shoulders are variable width turf and aggregate. Shoulder cross-slopes vary and are substandard through much of this portion of the route.


East Main Street/East Frontage Road east and north of US 65 Interchange

At the Route 7 intersection shoulders to the west are 10 foot wide asphalt in very good condition and are marked as bike lanes. North of Route 7, the shoulders are aggregate and 10 feet wide for about 450 feet to the intersection of the Grandview Beach Road. Beyond this intersection northward to end of the route there are only minimal width, typically 2 foot wide, turf shoulders.

The following table lists more details for the East Main Street shoulders from west of US 65 Highway to the Route 7 intersection. Existing 10 shoulders marked as bike bike lanes extend eastward along Route 7 from Commercial Street, across US 65 and ending at East Main Street.

| Side | Distance (ft) | Width (ft) | Material | Condition | Comment |
|---|---|---|---|---|---|
| LT & RT | 275 | 10 | Asphalt | Poor | Beginning to Walnut |
| LT | 270 | 10 | Asphalt | Poor | East of Walnut |
| RT | 175 | 6 | Asphalt | Poor | RT Turn Taper |
| LT | 150 | 8 to 0 | Asphalt | Poor | Concrete Taper |
| RT | 120 | 10 | Asphalt | Poor | Ramp to Bridge |
| LT & RT | 345 | 10 | Concrete | Good | Bridge & Approaches |
| LT & RT | 140 | 10 | Asphalt | Poor/OK | East of NB off-ramp |
| LT & RT | 1300 | 6 | Asphalt | Good | US65 to Medic Dr |
| LT & RT | 250 | 6 | Asphalt | Good | 11.5’ travel lanes |
| LT | 615 | 6 | Asphalt | Good | Tamara Lane |
| RT | 545 | 6 | Asphalt | Good | |

| | | | | | |
|---|---|---|---|---|---|
| RT | 70 | 3 to 4 | Asphalt | Fair | Tamara Lane |
| LT & RT | 1900 | 4 | Turf | Fair | End at Rte 7 |

Existing Shoulder Condition from west of Walnut to Route 7

**Traffic Volumes**

The average annual 24-hour, two-way traffic on Main Street to the west of US 65 interchange is approximately 7,800 to 8,000 vehicles per day. At the US 65 interchange, the latest traffic counts from 2011 recorded 1,563 vehicles per day utilizing the northbound off ramp to Main Street and 1,553 vehicles per day utilizing the southbound on ramp to US 65. Approximately 1,500 vehicles per day travel the east frontage road between East Main Street and MO Route 7. This traffic is predominantly headed to the Route 7 northbound on-ramps to US 65 and to the North Towne Center shopping district.

2014 traffic volumes on Route 7 to the west of US 65 were 4,895 vehicles per day. The overwhelming amount of this traffic is continuing along Route 7 via US 65 Highway, or traveling along Commercial Street to and from downtown Warsaw or the shopping centers to the north. A low percentage of the traffic continues easterly, beyond the interchange to the east frontage road.

Traffic volumes were not available for the east frontage road between Route 7 and the Truman Dam Access Road. This road provides access to several small lake communities, US 65, Truman Dam, North Towne Center, the Lost Valley Fish Hatchery as well as a number of small businesses.

North of the Truman Dam Access/Lost Valley Road intersection, traffic volumes are very low with just a handful of small businesses and alternate access to the Lost Valley Fish Hatchery.

**Traffic Speeds**

The posted speed limit on East Main Street, west of US 65 is 25 mph. The posted speed limit along the east frontage road is 50 mph.

Traffic control along East Main Street consists of stop signs for the on and off ramps at US 65 Highway and for the Walnut/Dogwood approach to Main Street. In this area Main Street vehicles have the right of way. The east frontage road has the right of way at the Route 7 intersection, where the east and westbound approaches are controlled by stop signs.

**Sight Distance**

The stopping sight distance for a posted speed limit of 50 mph is 425 feet minimum. There are no horizontal or vertical sight distance issues along this stretch of the east frontage road.

**Roadway Grades**

The roadway profile grade for East Main Street and the frontage road is less than 5%.

**Access Points**

There are many access points from side roads and driveways along the route. Over the 1.0 mile corridor there are 7 side road accesses and 10 driveways. Many of these commercial and private entrances are poorly defined and could be better managed to benefit bike/pedestrain users.

**Street Lighting**

Street lights exists at the northeast corner of the East Main and Route 7 intersection and on the north side of Tamara Lane, just east of Main Street. Street lighting exists at the southwest and northeast side of the southbound on-ramp at US 65, but nothing is present at the northbound off-ramp. Street lights exist on the north and south side of the Walnut Street intersection. Additional street lighting would be recommended at the northbound off-ramps and at Medic Drive.

**Utilities**

There do not appear to be any issues that would require adjustment or relocation of utilities. Use of the shoulder or adding an off-road pathway could be accomplished without utility impact.

**Existing Right of Way**

The existing right of way from west of Walnut, through US 65 to Tamara Lane is owned by MoDOT. The City of Warsaw owns the property east of the right of way, from US 65 east to approximately 540 feet south of Tamara Lane. From Tamara Lane northward, the right of way along the east side varies between 30 to 50 feet off the centerline of the outer roadway. From Tamara Lane northward, the west right of way is approximately 175 feet left of centerline for 370 feet, then transitions from 175 feet to 80 feet over 400 feet. From here to 685 feet north, the right of way offset transitions from 80 feet to 50 feet. From this location northward to Route 7, the west right of way is offset 50 feet from the centerline.

**Additional Information**

The existing interchange at US 65 and Main Street has many substandard elements that should be addressed with a future project to improve safety and encourage new development in the vicinity of the interchange. A big concern is the lack of a northbound on-ramp. Motorists must travel the outer roadway for over a mile to the Route 7 interchange to get access to US 65. This requires several stops, passes by the EMS entrance, and includes maneuvering through a very tight curve where Main Street turns northward. Guardrail at this location bears witness to motorists missing the curve. MoDOT has already constructed most of the embankment necessary to construct this ramp, and MoDOT has made this interchange ramp a “High Priority” in the Southwest District. Adding this on-ramp would greatly reduce traffic along the frontage road, providing a much safer route for bikes and pedestrians.


The lack of a northbound on-ramp has hindered redevelopment along Main Street. If a northbound on-ramp is constructed, the Eastgate Shopping Center Development group has committed to investing an additional $2.1 million in this corridor. This investment would create approximately 25 new jobs for the area and stimulate further business development.

# OSAGE TRAIL

## General Characteristics

The existing Osage Trail is a 10 foot wide aggregate surfaced trail that extends from downtown to US 65 Highway. This trail is built upon the existing levee along the north side of the Osage River. The City intends to pave this trail and add lighting from Drake Harbor to US 65. This improvement will add to the number of users for the trail and subsequent extensions of the trail northeasterly will dramatically increase the trails usage.

The proposed Osage Trail extension has diverse characteristics along its route, including water front, wetlands, woodlands, and local roads. The trail route from US 65 at the Osage River to Medic Drive is mostly located within a riparian woodland area with portions of wetlands along Osage River backwaters and a section that passes through City property. The following table lists the trail segment lengths and characteristics.

| Length mi. | Character | Owner | Potential Impacts |
|---|---|---|---|
| 0.40 | Riparian woodland | MoDOT & Ameren | Wetlands, woodland, stream |
| 0.11 | Rock fill spanning slough/backwaters | City of Warsaw | Minimal |
| 0.13 | Existing road | City of Warsaw | Minimal |

## Environmental Characteristics

*The waterfront and backwater areas along this proposed trail route will be comprised of a number of different habitats, many of which will be encountered. Future planning and environmental studies will further identify these habitats along the future trail route. Examples of these habitats and their definitions are as follows:*

*Wetlands*

The U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA) jointly define a wetland as follows:

> *Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal conditions do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*

Wetlands are the primary habitat of 200 plant and animal species considered rare or endangered in Missouri. Millions of ducks and shorebirds that migrate through the state each year depend on wetlands for food and shelter. Missouri's 43 species of amphibians depend on wetlands for breeding and larval development.

Many people think of marshes when they hear the word "wetlands," but in Missouri we have nine different wetland natural communities (not counting man-made ponds and lakes). They

include marshes, shrub swamps, bottomland prairies, bottomland forests, swamps, sinkhole ponds, oxbow lakes and sloughs, riparian areas and groundwater seeps.

Most natural wetlands change continually, and all have a high degree of biological productivity and diversity. They have soils that develop in saturated conditions and support water-tolerant plants. A wetland's seasonal pattern of water levels drives the establishment and maintenance of specific wetland plants.

From a river's edge to upland slopes, the floodplains of Missouri's rivers and streams contain most of our wetland acreage. Marshes, shrub swamps, bottomland prairies, swamps, oxbow lakes and sloughs, riparian areas and bottomland forests all depend on flowing water and periodic flooding.

Waterfront and riparian woodland along proposed Osage Trail extension

*Marshes*

Natural marshes usually develop in remnant river channels and around oxbow lakes and sloughs in north, west, central and southeast Missouri. They are usually categorized by the depth of the standing water. For example, shallow marsh zones, sometimes called wet meadows or moist-soil

wetlands, have moist to saturated soils with standing water present sporadically during the growing season. Plants growing there include smartweeds, nut sedges and bur marigolds. Shallow marshes provide important foraging habitat for migratory ducks and shorebirds. They also provide habitat for Woodhouse's and spadefoot toads.

Emergent marsh zones have standing water for long periods during the growing season. This allows the establishment of wetland plants like cattails, bulrushes, bur-reed, arrowheads and sedges. They provide habitat for many rare marsh birds, including bitterns, sora and king rails, pied-billed grebes and moorhens, as well as more common species, like redwing blackbirds. Other animals at home in emergent marshes include leopard frogs, muskrats and dragonflies. Periodic fires and flooding help maintain the open, herbaceous (non-woody) nature of emergent marshes.

Deep marsh zones are at the margin between open water and wetland. They almost always are covered with standing water. Here we find aquatic plants such as pondweeds, spatterdock and water lilies. Grebes, ducks, geese, dragonflies and fish rely on these deep marshes for feeding and shelter. Swallows often forage for insects over them.

*Shrub Swamps*

Buttonbush and short-statured willows dominate these often impenetrable wetland thickets. While they may be hard for us to navigate, shrub swamps provide homes for yellow warblers and green herons. Shrub swamps often are found in or near marshes, swamps or bottomland forests.

*Swamps*

These primeval-looking wetlands are found only in the southeastern part of the state in the ancient floodplain of the Mississippi River. Trees that are usually associated with the Deep South, such as bald cypress (some are more than 500 years old), water tupelo and water locust, grow over open water around sloughs and oxbow lakes. These areas contain many interesting plants, such as water canna, swamp rose and water violet. You'll also find black-crowned night herons, green treefrogs and swamp darters.

*Bottomland Forests*

Towering trees and vine lattices characterize mature bottomland forests. In the lowlands bordering a river are forests of cottonwood, willow, ash, elm, sycamore, silver maple and hackberry.

Periodic flooding keeps the understory of these riverfront bottomland forests fairly open.

They provide habitat for gray treefrogs, red-shouldered hawks and northern parula warblers, as well as nesting trees for bald eagles and great blue herons.

On terraces farther from the river, a number of oak species (e.g., pin oak), shellbark hickory and pecan dominate the forest. The understory of these areas contains shrubs such as pawpaw, spicebush and deciduous holly. Sedges often cover the ground.

Animal inhabitants of these forests include rare cerulean warblers, barred owls, prothonotary warblers, small-mouthed salamanders, mole salamanders and wood ducks. Bottomland hardwood forests most often are found in the southeast Missouri lowlands.

*Oxbow Lakes & Sloughs*

These wetlands have open standing water less than seven feet deep and scattered aquatic plants, such as water lilies. They are found in the large river floodplains of the state and provide important habitat for fish, crayfish, turtles and water snakes. Great blue herons and egrets often

hunt at their edges. These backwaters are important larval fish nurseries when they are connected to a river.

*Riparian Areas*

Throughout the Ozarks, spring-fed streams flow through a network of gravel bars, pools and riffles.

In a riparian zone extending from the main channel to about 50 feet on the land to either side of the stream, you'll find willows, sycamore, witch hazel and blue beech, along with water willow, mistflower, cardinal flower and, blue lobelia. Characteristic animals include belted kingfishers, river otters, Blanchard's cricket frogs and Fowler's toads.

*Bottomland Prairies*

These prairies are dominated by prairie cordgrass, or ripgut (named for its sharp leaf edges). These plants form a thick sod that covers terraces on floodplains above marshes in north and west-central Missouri. Bottomland prairies are subject to flooding, but standing water is present only briefly during the growing season.

In addition to flooding, bottomland prairies require periodic fires to prevent being overwhelmed by woody vegetation. Intermixed with the dense cover of cordgrass are sedges, milkweeds, wild iris and sawtooth sunflower. The northern harrier, western chorus frog, northern crawfish frog and grassland crayfish all use bottomland prairies.

**Traffic Volumes**

Traffic volume along Medic Drive is only that of City employees. As the existing Osage Trail is closed east of Drake Harbor for much of the year and dead ends at US 65, it does not get used a lot. No counts were available for pedestrian or bicyclist on the existing Osage Trail, but it is anticipated that the number of users will dramatically increase after the trail provides connectivity to East Main Street and Route 7.

**Roadway Sections**

Medic Road is comprised of an 18 foot wide asphalt roadbed with turf shoulders and open ditches. There is room to widen for a trail or bike lane. The rock fill peninsula south of Medic Drive has a graded aggregate flat surface area about 28 feet wide.

**Sidewalks**

The currently no sidewalks or trails along the existing route.

**Storm Water**

Storm water drains diagonally through an 11 foot by 7 foot box culvert, across US 65 from west to east and outlets where the large rock fill peninsula into the slough was constructed. Backwater from the Lake of the Ozarks ponds water in the slough for much of the year. The

regulated floodway elevation for the Osage River is 662 feet. The proposed trail would need to maintain elevations above this threshold, ideally 2 feet or more of free board is preferred.

**Access Points**

The frequency of driveways and side roads is no applicable.

**Sight Distance**

The horizontal and vertical stopping sight distance is not an issues as no obvious problems exist.

**Street Lighting**

No street lighting exists along the alignment of this proposed trail extension.

**Utilities**

An existing sewer main with manholes is located within the limits of the Osage Trail extension. Ideally the trail can be located such that it provides access to the sewer main for inspection and maintenance. There do not appear to be any issues that would require adjustment or relocation of utilities. Power poles exist in several locations that would make it convenient to add lighting.

Sanitary sewer manhole located in the slough along the Osage Trail pathway

**Right of Way**

The first 2,200 feet of the proposed trail is mostly on MoDOT right of way, with portions encroaching on Ameren. The remainder of the proposed trail is within City of Warsaw property.

# DESIGN PARAMETERS

## Shared Use Paths and Trails

The design standards for shared use paths and trails are specific to the function of the path or trail. Shared use paths and pedestrian trails that function as sidewalks shall meet the same requirements as sidewalks. Where shared use paths and pedestrian trails cross highways or streets, the crossing also shall meet the same requirements as street crossings, including the provision of detectable warnings.

Where trail-related facilities, such as parking, shelters, toilets, drinking fountains, and other features are provided on or along an accessible trail site, they must provide some level of accessibility and be served by an accessible route.

Other facilities, including connections, trailside and trailhead facilities, must be constructed, altered, and operated to be accessible to people with disabilities. Transportation and pedestrian links serving or intersecting accessible recreational trails should contain accessible elements, including sidewalks, curb ramps, detectable warnings, and similar features.

**Trail Design**

Trail design is one of the most important factors to insure that the route offers optimum scenic, geologic, historic, cultural and biological sites to provide a variety of diverse habitats for the trail user to experience. Trail design is the critical connection to make the trail sustainable, to reduce impacts to the natural environment, and to minimize future trail maintenance.

The National Park Service definition of a sustainable trail is:

1. Supports current and future use with minimal impact to the area's natural systems.
2. Produces negligible soil loss or movement while allowing vegetation to inhabit the area.
3. Recognizes that pruning or removal of certain plants may be necessary for proper trail construction and maintenance.
4. Does not adversely affect the area's wildlife.
5. Accommodates existing use while allowing only appropriate future use.
6. Requires little rerouting and minimal trail maintenance.

The trail planner should consider the following features for inclusion.

1. Ridge lines: Ridge lines offer prime opportunities to avoid the high cost of trail construction with steep grades on side slopes. Ridgelines also can provide panoramic views of the surrounding countryside.

2. Bluffs and Cliffs: These steep sided gorge edges offer trail routes with few construction problems except for where large streams cut through the bluff edge. High cliffs, deep ravines and rock outcrops covered with lichens and mosses offer attractive vistas along the trail route. Main trail routes should stay away from the edge of the cliffs with an occasional short side trail to an overlook location. Overlooks should be at one–half mile to one-mile intervals if a good view is available without having to cut any trees.
3. Stream Bottoms: Streams offer both opportunities and challenges. The additional moisture in riparian environments creates conditions suitable for many plants and wildlife species not found in the surrounding upland areas. These high moisture conditions can make the trail tread muddy and will generally require the placement of stepping-stones or raising the trail tread with boardwalk structures. Trails in stream bottoms should avoid thick vegetation areas such as canebrakes, saw briar and grapevine thickets.
4. Areas of wet or poorly drained soils also should be avoided. Advantage should be taken of any natural "benches" or terraces running along the bottoms of a gorge that may be adjacent to a stream.
5. Points of Interest: A well-designed trail should include as many points of interest as practical and feasible along the length of the trail. Some points of interest may include:
   - Geologic features such a bluffs of sandstone or limestone
   - Hydrological features such as ponds or lakes
   - Cascades or waterfalls
   - Historic and cultural features
   - Large or interesting trees

If potential overuse of these sites is an issue, routing the main trail away from the feature and providing access with a spur trail will reduce the amount of impact to these points of interest.
Areas to Avoid: Some problem areas to avoid include:

- Active farmland
- Old home sites with wells or cisterns
- Construction problem areas that include very rocky or steep slopes
- Wetlands or swampy areas
- Areas of exotic invasive vegetation such as privet or multiflora rose thickets
- Stay at least 25' from the edge of a stream to prevent impacting the resource
- Property boundaries – stay 100 feet away from adjacent landowners if possible

**Trail Materials**

*Gravel Trails Pros and Cons*

PROS

- Considered by some to be more natural looking.
- Good for flat areas out of flood plains.
- Softer on joints (running).
- Cheaper initial installation cost.

CONS

- High ongoing maintenance costs.
- Difficult to maintain consistent surface quality.
- Environmental damage caused by gravel erosion.
- More difficult to use in winter due to soft, wet and dirty conditions.
- Gravel migrates on steep trail slopes.
- Difficult to ride bikes on steep slopes and in loose gravel.
- Difficult to remove silt deposits after heavy rains.
- A dirty surface during and many days after rains.
- Very difficult to meet ADA surface standards.
- Less stability for running and walking in loose gravel.

*Asphalt Pros and Cons*

PROS

- Best initial surface (smooth, no cracks)
- Slightly cheaper than concrete in initial cost.

CONS

- Edges crack with vegetation.
- If you want a 10' wide trail, you have to install a 12' wide asphalt trail.
- Constant maintenance of crack filling and sealing with our clay soils.
- Must be completely overlayedapproximately every 8-10 years.
- Little structural strength to span over soil problems below.
- Requires greater initial excavation to provide the required rock base depth.
- Impervious surface.

*Concrete Pros and Cons*

PROS

- Best ADA surface long term
- Best longevity. Should last 20+ years.
- Best consistency of surface.
- Does not wash or break apart.
- Steel in concrete keeps it from deflecting preventing tripping hazards.

- Cleaner surface during and after rains, as well as less wear and tear on bikes.
- Does not require gravel base rock so impact on trees is less than asphalt.

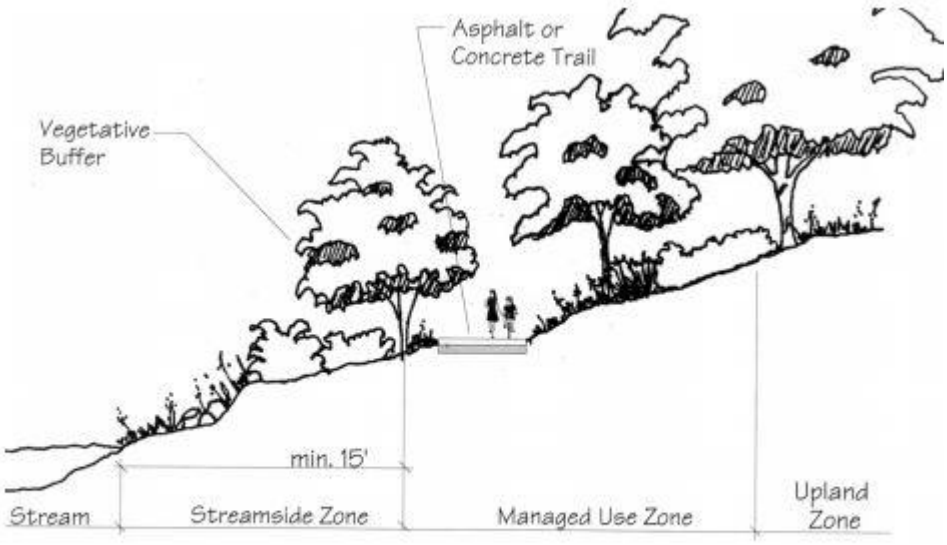
CONS

- More expensive initial installation
- Harder on joints
- less natural looking than gravel
- Impervious surface

**Trail Construction Standards**

Multi-use trails within the floodplain are designed to accommodate a variety of users including walkers, joggers, cyclists, and in-line skaters. These multi-use trails are typically positioned outside the floodway but within the floodplain. Significant vegetative buffers between the stream and trail should be left intact. Multi-use trails within the floodplain are subject to occasional flooding during large storm events. It is recommended that these trails be paved, however an aggregate surface may be adequate in some locations. Multi-use trails in the floodplain should be built to a minimum width of 10', although12' to 14' is preferred.

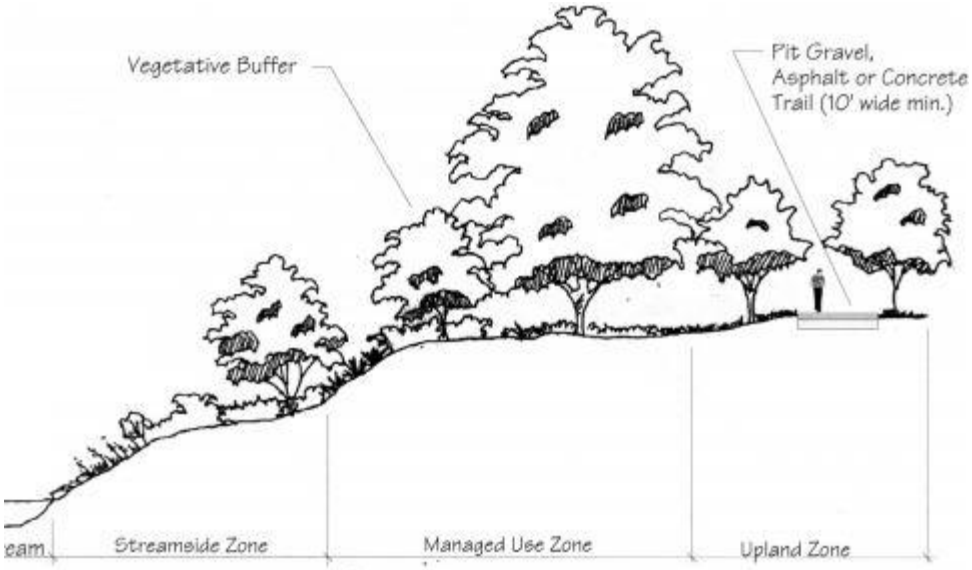
The graphic below illustrates a suitable pavement cross sections that can be used to build multi-use trails within the floodplain.




**Typical Multi-Use Trail Cross Section (Within the Floodway)**

Upland multi-use trails are designed to accommodate a variety of users including walkers, joggers, cyclists and in-line skaters. These upland multi-use trails are typically positioned completely outside designated floodplains. Significant vegetative buffer between any streams and the trail should be left intact. It is recommended that these trails be built with paved asphalt

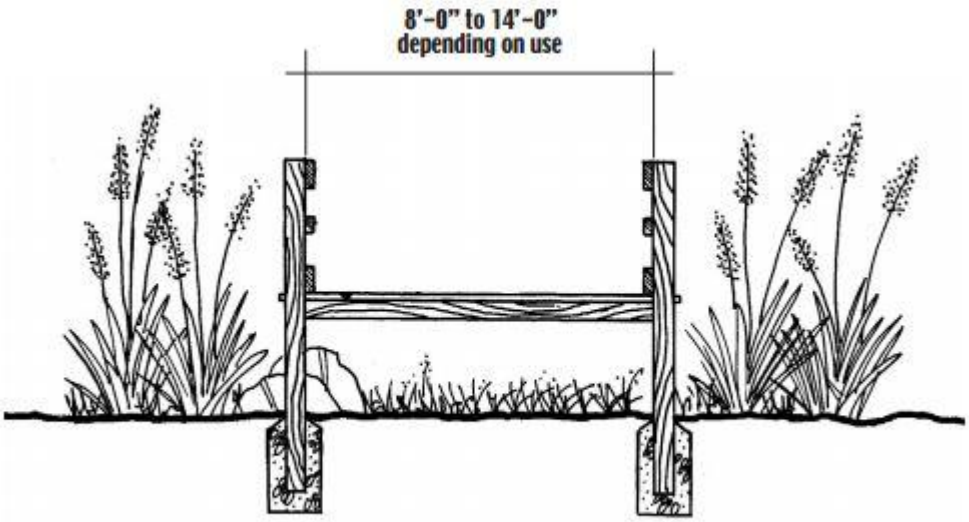
or aggregate stone, depending on the preference of local user groups. Upland multi-use trails should be built to a minimum width of 10', though 12' is preferred.




**Upland Trail Cross Section**

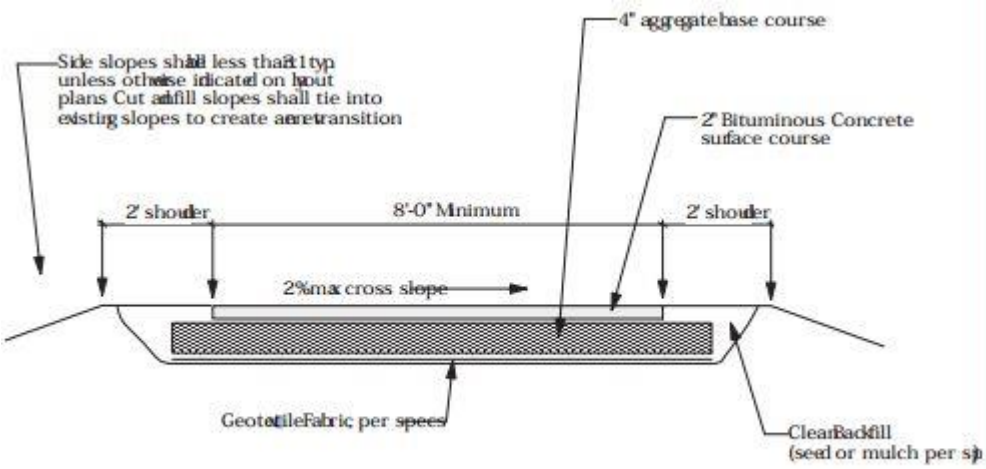
Boardwalks, or wood surface trails, are typically required when crossing wetlands or poorly-drained areas. While boardwalks can be considered multi-use trails, the surface tends to be slippery when wet and not best suited for wheeled users. Boardwalks intended for use by bikes, pedestrians, in-line skaters and others should be a minimum of 14 feet wide. However, boardwalk trails limited to pedestrian use can be as narrow as 8 feet. If maintenance vehicles use the boardwalk for access, it should be a minimum of 14 feet. Wood surfaced trails are usually composed of sawed wooden planks or lumber that forms the top layer of a bridge, boardwalk or deck.

The most commonly used woods for trail surfacing are exposure- and decay- resistant species such as pine, redwood, fir, larch, cedar, hemlock and spruce. Wood is a preferred surface type for special applications because of its strength and comparative weight, its aesthetic appeal and its versatility. Synthetic wood, manufactured from recycled plastics, is now available for use as a substitute in conventional outdoor wood construction. While these products are more expensive than wood lumber, recycled plastic lumber lasts much longer, does not splinter or warp and will not discolor.




Boardwalk Cross Section

Typical pavement design for paved, off-road, multi-use trails should be based upon the specific loading and soil conditions for each project. These trails, typically composed of asphalt or concrete, should be designed to withstand the loading requirements of occasional maintenance and emergency vehicles. In areas prone to frequent flooding, it is recommended that concrete be used because of its excellent durability. One important concern for asphalt, multi-use trails is the deterioration of trail edges. Installation of a geotextile fabric beneath a layer of aggregate base course (ABC) can help to maintain the edge of a trail. It is important to provide a 2'- wide graded shoulder to prevent trail edges from crumbling. The minimum width for two-directional trails is 10', however 12'-14' widths are preferred where heavy traffic is expected. Centerline stripes should be considered for paths that generate substantial amounts of pedestrian traffic. Possible conflicts between user groups must be considered during the design phase, as cyclists often travel at a faster speed than other users.




**Multi-Use Trail Cross Section**

Radii minimums should also be considered depending on the different user groups. Asphalt is a hard surface material that is popular for a variety of rural, suburban and urban trails. It is composed of asphalt cement and graded aggregate stone. It is a flexible pavement and can be installed on virtually any slope. Concrete surfaces are capable of withstanding the most powerful environmental forces. They hold up well against the erosive action of water, root intrusion and subgrade deficiencies such as soft soils. Most often, concrete is used for intensive urban applications. Of all surface types, it is the strongest and has the lowest maintenance requirement, if it is properly installed.

Trail Construction Standards have been developed by the USDA, US Forestry Service for a multitude of trail classifications for urban and rural systems. Warsaw's trails would typically apply to the urban standards, however some sections could classify as rural, where they are located in the county or in forest lands. The standards for the Osage Trail extension would be based on the following:

Clearing Width – 10 to 14 feet, includes 2-foot graded shoulders
Tread Width – 6 to 10 feet
Tread Surface – 4 inch compacted crushed rock base (minimum), 4 inch concrete (ideal)
Percent Grade – Desired 0% to 5%, Maximum 5% to 10%
Clearing Height – 8 feet for bicyclist, 10 to 12 feet if allowing horseback riding
Trail Layout – avoid wet areas and steep slopes, add curvature, minimize motorized crossings
Turning Radius – 10 feet (minimum), 25 feet (recommended)
Sight Distance - 50 feet (minimum), 100 feet (preferred)

**Bridge Design**

A bridge will probably constitute the single most expensive item for a local bike way and pedestrian system. Choosing the right bridge for crossings and understanding the trade-offs between bridge types, may have a great impact on your short and long term costs.

There are three basic types of bridge structures:

1. cast-in-place or pre-cast concrete
2. pre-fabricated steel
3. wood bridges

The most appropriate type of structure for your crossing depends on numerous factors, including local construction costs, aesthetics, schedule, and overall and clear span requirements.

Prefabricated steel bridges are perhaps the most common type of pedestrian/bicycle bridge used throughout the United States. The greatest advantage cited by pre-fab manufacturers is the low cost and speed of fabrication, often between 8 and 10 weeks (excluding abutments and piers).

The required span of the crossing, and related factors such as height, pier restrictions, and soil conditions, can be met with either a concrete or steel truss bridge, with clear spans up to 200 to 250 feet.

The bridge designer should consider wood, steel truss, and concrete cast in place or pre-cast options. They are various pros and cons for each type.

Prefabricated bridges save engineering expense, require small installation crews and are ready for use faster than conventional bridges.

Pre-fab bridges can carry live loads equivalent to concrete structures (up to 60 psf for structures over 50 feet long), enough to support a 10,000 pound vehicle plus 30% impact.

Long term maintenance of steel structures is often quoted by concrete bridge engineers as a liability and major consideration. Most steel bridges are made of a self-weathering steel called CorTen, which oxidizes to form a protective surface not requiring painting. While CorTen offers low long term maintenance, it does have the appearance of rusted steel and may stain abutments. Painted steel structures do require on-going maintenance, and may cause environmental concerns over wetlands.

**Design Considerations**

Aside from maintenance, other considerations include aesthetics and requirements of local and state highway departments. A thorough knowledge of encroachment permits and lead time on easements is critical to maintaining project schedule.

## Cost Comparisons

Construction costs for bike and pedestrian bridges are influenced by many external factors, especially the number and workload of local contractors. Bridge construction costs generally range between $80 to $100 per square feet for cast in place concrete, to $70-$90 per square foot for prefabricated bridges. Based on a recent quote from Excel Bridge Manufacturing, a prefabricated steel structure (shown below) 10 feet wide by 120 feet long could be built and delivered to Warsaw for about $102,700. The cost of abutments, footings, crane and other mobilization costs would be extra.

**Size:** 120' long x 10' wide (Clear OR 2 Span Cont.)
**Truss Type:** H-section Pratt truss
**Material:** Self Weathering Steel (ASTM 847 Tubular Steel)
**Decking Options:** 3" Southern Yellow Pine - Treated Wood Deck
**Safety System:** <4" horizontal safety rails up to 42"
**Above Deck Rail Height:** approx. 48-54"
**Live Load:** 90 psf
**Vehicle Load:** 10,000 lb.
**Design Criteria:** AASHTO design code.
**Delivery:** This bridge would be delivered in 2 pieces as close to the site as allowed. Bridge to be offloaded, bolted together, erected and installed onsite all by others.

**Budget Pricing:**
Clear Span: F.O.B.. Warsaw, MO .....$ 102,700.
No sales tax included in this price (if applicable). No special weld tests included.
OR 2 Span Continuous: F.O.B.. Warsaw, MO .....$ 98,700.

**Signs**

Trailhead signs should include information on the length of the trail or trail segment; surface type; typical and minimum tread width; typical and minimum running slope; and typical and minimum cross slope. This information enables individuals with disabilities to decide whether to hike the trail based on the characteristics of the trail. Entities should also provide information about the accessibility of trails on websites.


Entry Signage Proper trail identification at trail terminal point and major intersections is important in the development of a comprehensive trail network. A system of signage is important throughout Wake County to ensure that information is provided to trail users regarding the safe and appropriate use of all facilities. Greenway entry signage may also include mileage to provide users with a reference as to how far he or she has traveled, and the remaining distance to specific destinations.


Examples of multi-use pathway signage.

# DESIGN PARAMETERS

## Bike Lanes and Road Shoulders

Road shoulders are often a preferred treatment to accommodate bicyclists and pedestrians on rural roads. Sidewalks and bike lanes are treatment alternatives in more urban and suburban environments where there is typically more traffic.

If a shoulder is intended to be used by pedestrians or bicyclists, it should be paved and a minimum of four feet wide. This improves the safety for those users by helping provide separation between the fast moving motorized traffic and the slower bikes and pedestrians. Faster confident bicyclists may tend to travel in the main lanes, but this is not true for younger or less confident bike rider

The Vehicle and Traffic law definition of a bike lane is:
A portion of the roadway, which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicycles. If rural road shoulders are to be used by bicyclists and pedestrians, it is advisable to not mark it as a bike lane. Doing so would pose a safety hazard, implying that bikes and pedestrians would be required (illegally) to share a bike lane. A better choice is to place a sign advising folks to share the road. (Sign can be yellow or fluorescent yellow-green.)

Bicyclists (and in-line skaters) have the legal right to share the road on most public roadways. (They are prohibited on interstate highways, expressways, and some other limited access highways.) Consequently, bicyclists cannot be required to use separate facilities such as a separate pathway. They may choose to use a separate path, if provided. If properly designed and placed in a good location, many bicyclists will use the trail, but if inconvenient, they will just stay on the highway

**Shared Lane Markings** should not be placed on roadways that have a speed limit above 35 mph. Option: The Shared Lane Marking may be placed on roadways that have a speed limit above 35 mph, where there is bicycle travel and there is no marked bicycle lane or shared-use path and the right-hand traffic lane is too narrow to allow automobiles to safely pass bicyclists. In addition to the above, the roadway should be a designated bike route.

In rural and semi-rural areas where roads have (and are likely to continue to have) low traffic volumes, narrow travel lanes, narrow (or no) shoulders, no sidewalks, and typically drainage ditches rather than curb, gutters and even storm drains, bicycle and pedestrian accommodation can be challenging. Although the numbers of bicycles and pedestrians may appear insignificant, studies have shown that many more individuals will choose to walk and bike if they perceive that there are safe options. There is often existing and latent demand for walking and bicycling by adults as well as children to such destinations as schools, parks, neighbors' houses, and local businesses. There is also existing and latent bicycling demand to travel along these public roads by both residents and visitors (including tourists).

AASHTO and others recognize that low volume roads (<2000 vpd) do not need as wide shoulders as roads with higher traffic. Table 7-1 depicts the recommended minimum shoulder widths for rural roads under three volume conditions.

**Table 7-1**
**Minimum Lane and Shoulder Widths for Two Lane Rural Highways Recommended by AASHTO**

| | | <10 % trucks AASHTO/1/ | | | AASHTO Greenbook Table 7-3 Rural Arterials /2/ /3/ | |
|---|---|---|---|---|---|---|
| Vehicles per Day (vpd) | Running Speed /1/ Design Speed /2/ | Lane Width (normal terrain) | Shoulder Width (normal terrain) | Shoulder Width (mountainous terrain) | Travel Lane Width | Shoulder Width |
| <750 | Under 50 mph | 9 ft. | 2 ft. | 1 ft. | 11 ft. (12 for speed of 60+) | 4 ft. |
| | 50+ mph | 10 ft. | 2 ft. | 1 ft. | 11 ft. (12 for speed of 60+) | 4 ft. |
| 750-2000 | Under 50 mph | 10 ft. | 2 ft. | 1 ft. | 11 ft. | 6 ft. |
| | 50+ mph | 11 ft. | 3 ft. | 2 ft. | 11 ft. (up to 1500 vpd) | 6 ft. |
| 2000+ | All | 11 ft. | 6 ft. | 5 ft. | 12 ft. (over 1500 vpd) | 8 ft. |

/1/ AASHTO Highway Safety Design and Operations Guide, Table 4-1, 1997

/2/ AASHTO Policy on Geometric Design of Highways and Streets, 2011, Table 7-3.

/3/ No variations were presented for different terrains or percent trucks other than to state in Chapter 4 that 2 ft min shoulder should be considered for low volume highways, and 4 ft shoulders should be considered where bicycles and pedestrians are to be accommodated on the shoulder.

The two main ways of accommodating pedestrians and bicycles in a rural or semi-rual context are on the shoulders or on a pathway separated from the road. In some contexts, both may be appropriate. The chosen solution should be determined in conjunction with the local community, and should be based on a number of factors including:

- Environmental: terrain, adjacent vegetation, location of mature trees and riparian areas;
- Man-made: land use frontage and density, the proximity and location of elementary, middle and high schools, width of the right of way, ease of acquiring additional right of way; and
- Demographic: the number of school-age pedestrians and bicyclists, the existing and potential number of bicyclists and pedestrians and existing and projected motor vehicle traffic volumes and speeds.

In addition, if night time use by pedestrians is anticipated, every attempt should be made to provide a wide shoulder or separate walkway, as the fatality rates for pedestrians walking on rural roadways is disproportionately high and shoulders can reduce this crash type by between 71% and 88%.

In general, in rural areas with low traffic volumes, wide (four to eight foot) shoulders are not necessary and may also be infeasible for economic topographic and environmental reasons. Where volumes, speeds and topography allow, then wider shoulders are preferable.

Where shoulders are wide enough to meet bike lane width standards, it is often appropriate and preferable that they remain undesignated, i.e. not be signed and striped as Bike Lanes, as long as they are paved and maintained. Given that there are legal differences and practical differences between shoulders and bike lanes, the engineer must consider all factors before deciding to implement one versus the other.

Legal positioning of bicycles in bike lanes vs. shoulders

- Bicyclists riding at less than the speed of traffic must use the bike lane
- Bicyclists (and other slow moving vehicles) may use the shoulder but are not required to
- Bicyclists may also use the shoulder even when they are not traveling slowly.
- Bicyclists on shoulders must be operated in the same direction as vehicles.

Legal positioning of motor vehicle with respect to the shoulder stripe/ bike lane stripe

- Motorists may not drive in the shoulder unless they are “traveling so slowly as to impede the normal movement of traffic”.
- Motor vehicles in a shared through/right turn lane must enter the bike lane in order to make a right-turn. However, motor vehicles are not allowed to enter a shoulder to turn right.
- Parking is allowed on shoulders unless specifically prohibited by signing. If parking is common, then a shoulder does not provide a good bike facility.

- The shoulder striping at the approach to intersections follows the curb return around the corner or serves as the curb return. Bike lane striping is either dashed or terminated completely 100 - 200 feet in advance of the intersection.
- Shoulders remain on the right side of right turn lanes; whereas bike lanes are placed to the left of right-turn lanes. Pedestrians and Joggers
- Pedestrians are allowed to use the shoulder.

Pedestrians are only allowed to use a bike lane when there is no adjacent pedestrian facility. This is likely to be the case in the locations where shoulders are preferable to bike lanes.

The shoulder width should increase with the posted speed, similar to bike lane widths. As presented in Table 7-2, optimally, the minimum shoulder width is 4 feet and is 6 feet for speeds between 35 and 40 mph, and 8 feet for speeds greater than or equal to 45 mph. Rumble strips must only be placed on shoulders five feet or wider.

**Table 7-2**
**Optimum Shoulder Widths**

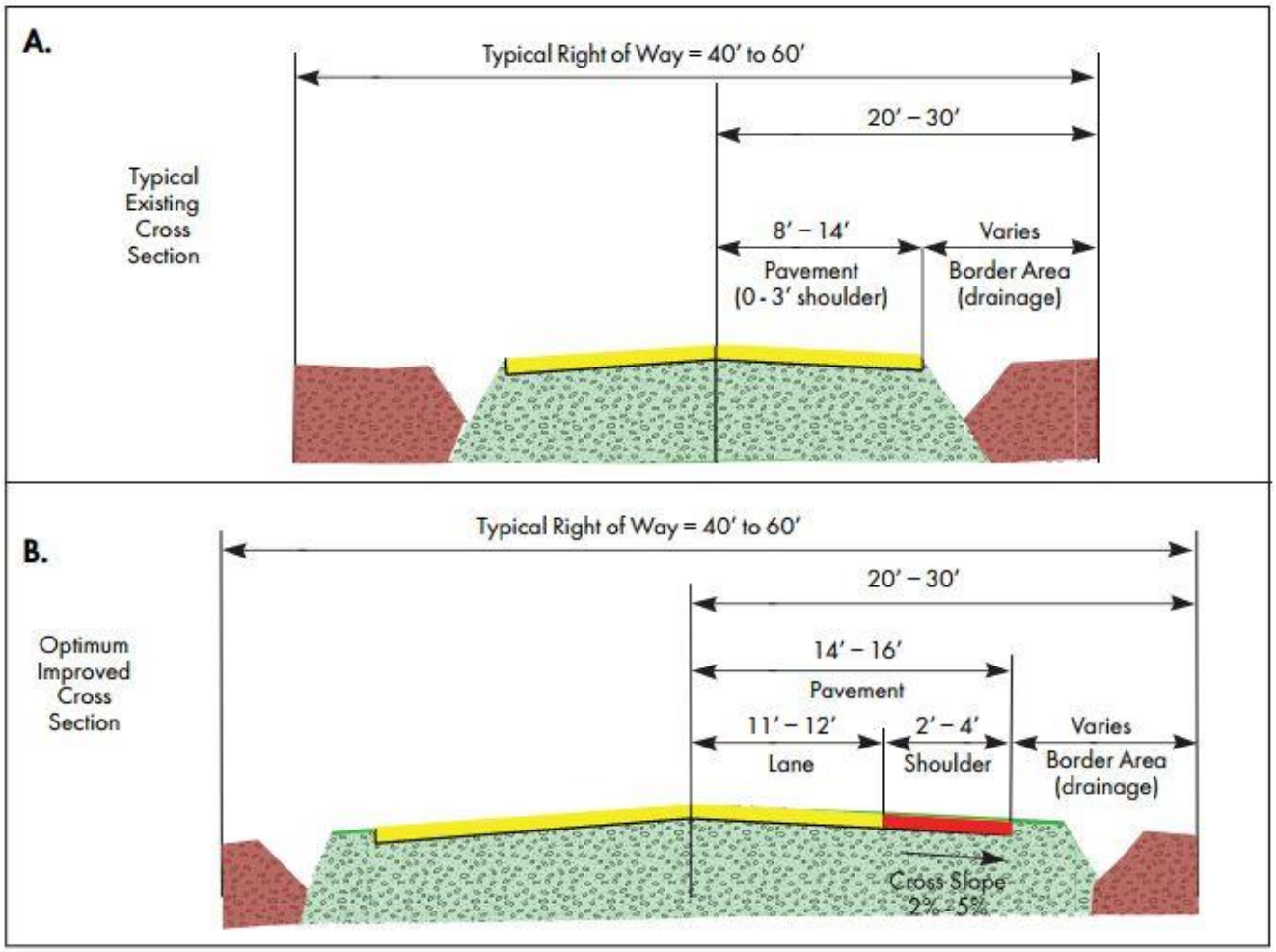
| Posted Speed (mph) | Width (feet) |
|---|---|
| 0 - 30 | 4 |
| 35 - 40 | 6 |
| 45 or more | 8 |

Where right of way and topography permit, consideration should be given to providing both well designed shoulders for road cyclists and a wide roadside path for others. The roadside path will serve pedestrians and those cyclists who are not comfortable riding on the shoulder, even on roads with low traffic volumes. The wide shoulder will be used by road cyclists and it will also provide all the other benefits of shoulders outlined in the AASHTO Greenbook. This cross section is most appropriate where there is a latent demand for bike travel due to the origin(s) and destination(s) along the corridor that would attract more than just the “through” cyclists.

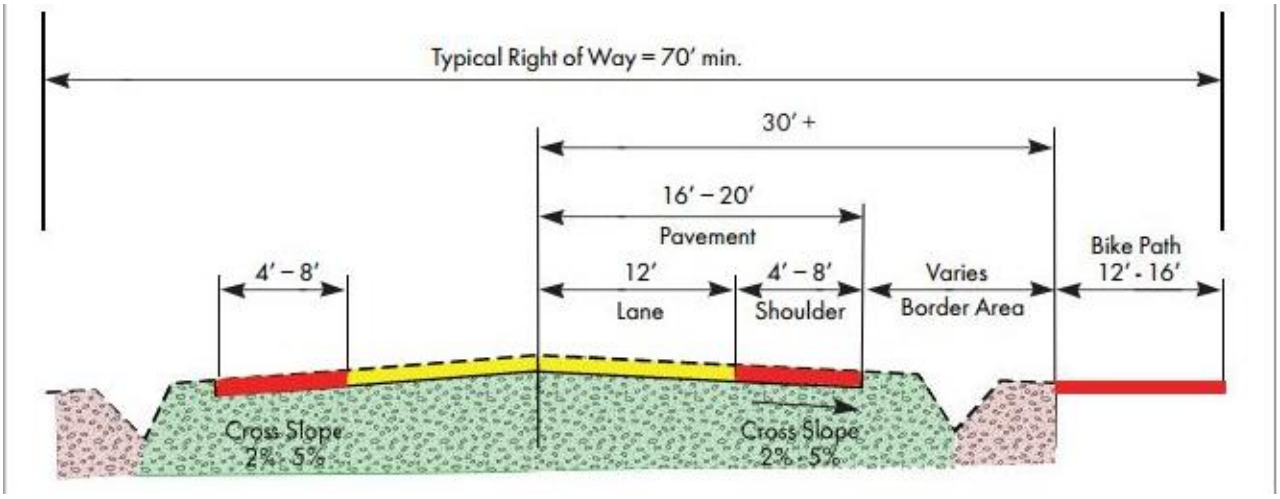
Where there is a need to warn motorists to watch for bicyclists traveling along the highway, the SHARE THE ROAD (W16- 1P) plaque may be used in conjunction with the W11-1 sign. If used, other advance bicycle warning signs should be installed at least 50 feet in advance of the beginning of the condition. Share the Road sign apply where the following conditions exist:

- On rural roads, where bicyclists are more frequent than land use would indicate and the shoulder is less than 4 feet wide; post approximately every 1 mile.
- Where the shoulder is four or more feet wide but is unridable for a bicyclist, e.g. the shoulder is unpaved or the pavement is cracked or uneven.
- Where the shoulder varies such that at times cyclists can ride within the shoulder and at other times the shoulder is less than 4 feet and bicyclists must ride in the travel portion of the roadway, post the share the road sign at the point where the shoulder narrows.
- In advance of the shoulder narrowing, consider posting the W8-25 Shoulder Ends sign with a bicycle plaque to warn bicyclists of the upcoming condition; this is similar to

warning signs W8-15 and W8-16 and plaque warning motorcyclists of conditions that are of particular concern to their vehicle.




Typical Cross Section for Shoulder Application for Bike Use




Typical Cross Section with shoulders and a separated Bike path

Parking - When a designated bike route has shoulders, No Parking signs should be installed if traffic volumes exceed 4000 vpd and parking in the shoulder would otherwise be expected.

Pedestrians - If there is a reasonable expectation that there will be pedestrian activity, an all-weather pedestrian pathway should be provided so that bicyclists and pedestrians do not share the shoulder.

Shoulder Cross Slope - The cross slope for a paved highway right shoulder in normal tangent sections, is between 2% and 5 % away from the traveled way; AASHTO cites 2- 6%. In contrast, the standard cross slope for a bike lane is 1.5 to 3%, (2% for new construction) since it is part of the travel way). According to the FHWA, there was a concern that the minimal cross slope (i.e. 2% vs 6%) could impede water flow across the shoulder allowing sediment to accumulate, but evaluation of paved shoulders over time has alleviated these concerns. In addition, the maximum cross slope of an ADA facility is 2%, so by meeting the cross slope standard for a travel lane in new construction, the shoulder becomes an ADA-compliant facility.

Intersections - On roads with significant bicycle traffic, the shoulder stripe should be dropped in 100 feet in advance of the intersection, just as a bike lane stripe is.

Right-Turn Lanes - While right-turn lanes are not common in the settings where shoulders are used, there may be instances where a roadway with a shoulder also has a dedicated right-turn only lane. In these cases, the shoulder stripe should terminate in advance of the right-turn lane so that bicyclists are not tempted to proceed straight through the intersection from the shoulder area. They should merge left into the through lane, according to the rules of the road. Providing a bike lane-type treatment between the through lane and the right-turn lane is recommended.

Left-Turn Lanes - Where left-turn lanes are provided at intersections or driveways by narrowing the roadway shoulders, the shoulder width should not be reduced to less than 48 inches.

Driveway Aprons - Unpaved driveways should be paved for the first 15 feet from the roadway to minimize dirt and gravel migration onto the shoulder.

Shoulder Rumble Strips - On shoulders, rumble strips are typically depressed grooves rather than raised pavement markers. Such rumble strips are typically needed only on highways with few interchanges and long tangents to reduce drift-offroad accidents. If a location is experiencing such accidents and rumble strips are being considered, shoulder rumble strips are an appropriate counter measure. However, they must be designed and installed so that they do not adversely impact bicyclists using the shoulder. Where bicycles are permitted, shoulder rumble strips should not be used unless approximately 1.5 m (5 ft) of clear shoulder width for bicycle use is available between the rumble strips and the outer edge of the shoulder.

## DESIGN CHALLENGES

**East Main Street**

There are a few design challenges with adding a separated bike/ped facility along East Main Street. There is no room to add a separated facility from Walnut Street through the US 65 interchange, due to the existing guardrail. North and east of the US 65 interchange, guardrail and a steep slope prohibits adding a separated pathway along the east side nearly all the way to Medic Drive. Between Medic Drive and Tamara Lane, an open ditch would have to be enclosed or relocated in order to provide a separated path along the east side, or the path would need to be located on the back side of the ditch.

From Tamara Lane northward for about 250 feet, a steep upslope and utilities would make adding a separated path difficult on the east side. For the next 800 feet northward, overhead power, buried phone and water at the back of the east right of way line, along the backslope of the ditch would also make it difficult to add an off-road muti-use path unless it was place on private easement.

Continuing northward to Route 7, the roadway side slopes drop-off steeply along the east side, thus requiring a multi-use path on permanent easement.

The west side of the road from east of the US 65 interchange to Route 7 is open and fairly easy to accommodate an off-road pathway. This would require moving a shallow ditch or placing the path at the back side of the ditch.

**Osage Trail**

The Osage Trail extension presents several design challenges. Environmental permitting will be required for any construction done within the wetlands, riparian woodlands, stream crossings or backwater crossings as well as anything within the floodway. Multiple agencies including MoDOT, FEMA, MoDNR, USACOE, US Fish & Wildlife and possibly FHWA will need to be involved in the permitting process.

Easements will likely be needed from Ameren and MoDOT.

Design of trail elements within the floodway will need to consider all of the issues with water levels rising and subsiding. This would include erosion and sediment, upheavals of pavement, wash outs of trail sections, periods when the trail is inaccessible and methods of providing access for maintenance.

The Storm Water Pollution Prevention Plan (SWPPP) and all efforts to contain sediment and erosion during construction will be critical in this highly sensitive environment.

Connecting the trail in areas where backwaters and wetland conditions are present will require and elevated trail, which would be costly. The best option is to route the trail to avoid as much of these areas as possible.


US Fish & Wildlife National Wetland Inventory for Osage Trail (Green Shading)

Drainage out-letting from US 65 will require the trail to include bridges, culverts and french drains to allow storm water to cross the trail. Storm water from a large drainage basin passes through a large box culvert (11' x 7') under US 65 and empties into the slough along the west side of the rock embankment area shown in this photo.

In addition backwater will need to rise and fall through these structure.

Constructing in the floodway will require a zero net increase in the fill material placed along the trail. Minimal grading should ensure that earthwork moving balances, including the additional trail material. Rock fill where possible, is preferred to allow water passage and because the voids in the fill would create less rise in the floodway.

Many trees are present along this route and clearing of mature trees will need to be minimized. The best option will be to meander the trail around trees as much as possible and locate a route that minimized tree and vegetation disturbance. The photo above shows an example of where the trail could be placed with minimal tree removal.

Providing access for parking along the trail, will present challenges for finding suitable locations where environmental impacts are less and significant grading will not be required. Providing motorized vehicle access and parking along a portion of the trail would allow for users with disabilities to get closer to the Osage River for fishing.

## Recommendations and Conceptual Design

### East Main Street Bike Trail

For the first phase of the Osage Trail extension, CFS is recommending improvements to the existing shoulders and adding signage and pavement markings along **East Main Street and the East Frontage Road** to provide a safe bike/pedestrian route within the existing right of way. These improvements would include reconstructing shoulders where needed to provide a minimum 4 inch thick, 6 foot wide, asphalt surface path on both sides of the road. Some of the existing shoulder along East Main Street is in good condition and may be suitable for use with sealing.

Bike route signage and warning signage should be added to the roadway to alert motorists of bikes and pedestrian that may be present on the shoulder. Reflective pavement marking and rumble strips should be placed along the inside edge of the shoulders. At street crossings, consideration should be given for adding crosswalk markings. Consideration should also be given for lowering the posted speed along the east frontage road to 35 mph. Lowering the speed limit would allow the rumble strips to be omitted.

| Side | Distance (ft) | Width (ft) | Material | Improvement | Comment |
|---|---|---|---|---|---|
| LT & RT | 275 | 10 | Asphalt | Reconstruct | Beginning to Walnut |
| LT | 270 | 10 | Asphalt | Reconstruct | East of Walnut |
| RT | 175 | 6 | Asphalt | Reconstruct | RT Turn Taper |
| LT | 150 | 8 to 0 | Asphalt | Reconstruct | Concrete Taper |
| RT | 120 | 10 | Asphalt | Reconstruct | Ramp to Bridge |
| LT & RT | 345 | 10 | Concrete | Use in Place | Bridge & Approaches |
| LT & RT | 140 | 10 | Asphalt | Reconstruct | East of NB off-ramp |
| LT & RT | 1300 | 6 | Asphalt | Seal Coat | US65 to Medic Dr |
| LT & RT | 250 | 6 | Asphalt | Seal Coat | 11.5' travel lanes |
| LT | 615 | 6 | Asphalt | Seal Coat | Tamara Lane |
| RT | 545 | 6 | Asphalt | Seal Coat | |
| RT | 70 | 3 to 4 | Asphalt | New Shldr | Tamara Lane |
| LT & RT | 1900 | 4 | Turf | New Shldr | End at Rte 7 |

Recommended Shoulder Construction Details

The estimated cost to construct the improvements for the Interconnecting East Main Street/Old 65 Highway is approximately $471,375. This estimate includes engineering and construction administration and inspection.

Alternate improvements would be to repair and reconstruct shoulders from west of Walnut to just east of the northbound off-ramp, then construct an 8 foot wide, off-road, mult-use path for the remainder of the corridor to the Route 7 intersection. This pathway could be constructed without the need for easements or utility adjustments.

The estimated cost to construct the alternate improvements for East Main Street/Old 65 Highway is approximately $774,000. This estimate includes engineering and construction administration and inspection. No easements or utility adjustments are anticipated with this improvement.

Recommended future improvements would include providing a paved 6 foot shoulder on both sides of East Main Street from Route 7 to the Lost Valley Road/Truman Dam Access Road interchange at US 65 Highway.

**Osage Trail**

The Osage Trail extension and future extensions present many challenges, including the construction costs. CFS recommends that the City of Warsaw pursue extending the trail from US 65 to Medic Drive in some fashion. At a minimum, an 8 feet wide, natural path should be constructed (See Exhibit A-0). The path would include 2 foot shoulders on either side to provide a 12 foot clear zone. Areas would also be selected to provide room for vehicles to pull over and avoid blocking the trail. This initial phase would still require a bridge, large box culvert, or multiple pipe culverts to span the narrow backwater area of slough. Initial analysis and cost estimating indicates that a pedestrian bridge would be the best option for spanning this section of the trail.

Due to rising and subsiding water levels and stability, rock fill would be recommended for this section of the trail. A bridge would require significantly less fill than either of the other options and would thus have less of an environmental impact.

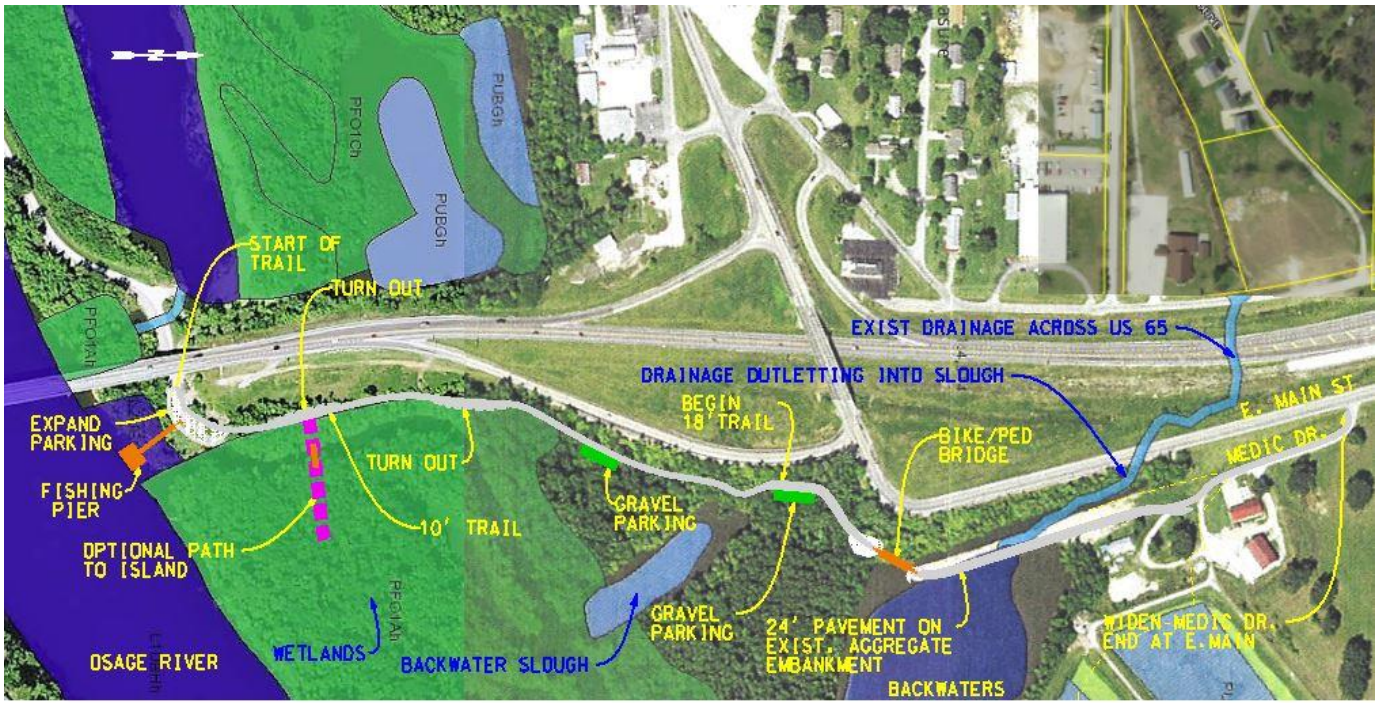
Excavation/dredging of the slough should be performed before the trail construction begins. Dredging during the winter is permitted by Ameren and the COE and would allow the slough area to hold water for most of the year. The amount of material dredged from the slough should offset any fill placed within the floodway, as well as future extensions of the trail that would add fill to the floodway. This dredged material would be stockpiled and dried and could be used as fill for the trail where needed. The length of dredging within the slough would begin approximately 1,000 to 1,400 feet downstream from the trail and extend to the pedestrian bridge. Additional survey and studies would be needed to determine elevations of the slough and where the limits of the extreme low backwater elevations stop. Additional future studies

should take into account the City's desire to add a marina near this location and determine how best to excavate this area to make it navigable in the future.

This trail extension will require easements along MoDOT right of way and a small piece of Ameren property. The trail could be routed to minimize tree removal and grading. The estimated cost to construct this phase of the improvements is approximately $643,529.

The ultimate improvement for the Osage Trail extension would also extend from US 65 to Medic Drive. This preferred trail design would be a minimum 10 feet wide, 6 inch thick paved concrete path from US 65 extending 1,630 feet northward and would then transition to an 18 foot wide path. The 18 foot wide path would continue northerly for about 340 feet. A 120 foot long, 12 foot wide pedestrian bridge would cross over the backwater of the slough and connect to the existing rock fill on the City property. From here the trail would continue on as a 24 foot wide paved trail to Medic Drive. Medic Drive would then be widened by 8 feet to provide a 24 foot roadway the intersection of East Main Street (See Exhibit A-1, B-1 & A-2).

Excavation/dredging of the slough would still be required. Lighting would be included in this project, but would likely need to be high wattage lights on wooden poles to provide sufficient lighting. The usual ornamental lights that the City is using on its existing trails in the harbor will not be suitable for this location. Additional trail signage and some pavement marking would also be included.




Ultimate Design of Osage Trail Extension

Clean gravel parking areas would be provided at multiple locations, including expanding the rock fill to allow parking at the US 65 bridge. A fishing pier would be included with a gangway leading from the parking lot.

This area at US 65 could be expanded for parking and a fishing pier added

This alternate would require considerable more tree removals due to the width of the trail and the parking areas. Excavation and fill within the floodway would also be greater. There may be some areas that would require, or be more desirable for elevated boardwalks, but they have not been estimated at this time.

The estimated cost to construct this ultimate improvement is approximately $1,312,878.

The final layout and design of the proposed trail should be performed by walking the general route of the path and flagging or staking a propose alignment. This method would allow the designer to meander between trees and other obstacles to minimize impacts. This would provide a better understanding of the areas that may be holding water and remaining wet, so the profile of the trail could be raised or lowered to allow movement of water. A good exercise would be to visit the area after a rainy period to observe standing water. Sight distance could also be observed between stakes to determine if vegetation or tree branches should be trimmed

or if the pathway alignment should be altered. Surveying should commence after this staking of the route is performed.