NPS Form 10-900 OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in National Register Bulletin, *How to Complete the National Register of Historic Places Registration Form.* If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions. **Place additional certification comments, entries, and narrative items on continuation sheets if needed (NPS Form 10-900a).**

1. Name of Property

Historic name Grand Auglaize Bridge

Other names/site number Glaize Bridge; Big Swinging Bridge

Name of related Multiple Property Listing N/A

2. Location

Street & number Swinging Bridges Road spanning Grand Auglaize Creek | N/A | not for publication

City or town Brumley | x | vicinity

State Missouri Code MO County Miller Code 131 Zip code 65017

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended,

I hereby certify that this _X_ nomination ___ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60.

In my opinion, the property _X_ meets ___ does not meet the National Register Criteria. I recommend that this property be considered significant at the following level(s) of significance:

___ national ___ statewide _X_ local

Applicable National Register Criteria: ___A ___B _X_C ___D

Signature of certifying official/Title — Date 8/18/2020

Missouri Department of Natural Resources
State or Federal agency/bureau or Tribal Government

In my opinion, the property _X_ meets ___ does not meet the National Register criteria.

Signature of commenting official — Date

Title — State or Federal agency/bureau or Tribal Government

4. National Park Service Certification

I hereby certify that this property is:

_____ entered in the National Register

_____ determined eligible for the National Register

_____ determined not eligible for the National Register

_____ removed from the National Register

_____ other (explain:) _____

Signature of the Keeper — Date of Action

4. National Park Service Certification

I hereby certify that this property is:

_____ entered in the National Register

_____ determined eligible for the National Register

_____ determined not eligible for the National Register

_____ removed from the National Register

_____ other (explain:) _____

Signature of the Keeper

Date of Action

5. Classification

Ownership of Property
(Check as many boxes as apply.)

	private
x	public - Local
	public - State
	public - Federal

Category of Property
(Check only **one** box.)

	building(s)
	district
	site
x	structure
	object

Number of Resources within Property
(Do not include previously listed resources in the count.)

Contributing	Noncontributing	
0	0	buildings
0	0	sites
1	0	structures
0	0	objects
1	0	**Total**

Number of contributing resources previously listed in the National Register

0

6. Function or Use

Historic Functions
(Enter categories from instructions.)

TRANSPORTATION/road-related

Current Functions
(Enter categories from instructions.)

TRANSPORTATION/road-related

7. Description

Architectural Classification
(Enter categories from instructions.)

Other: Wire-Cable Suspension bridge

Materials
(Enter categories from instructions.)

foundation: Concrete

walls: N/A

roof: N/A

other: Steel

Timber

x **NARRATIVE DESCRIPTION ON CONTINUTATION PAGES**

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing.)

- [ ] A Property is associated with events that have made a significant contribution to the broad patterns of our history.
- [ ] B Property is associated with the lives of persons significant in our past.
- [x] C Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
- [ ] D Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark "x" in all the boxes that apply.)

Property is:

- [ ] A Owned by a religious institution or used for religious purposes.
- [ ] B removed from its original location.
- [ ] C a birthplace or grave.
- [ ] D a cemetery.
- [ ] E a reconstructed building, object, or structure.
- [ ] F a commemorative property.
- [ ] G less than 50 years old or achieving significance within the past 50 years.

Areas of Significance
ENGINEERING

Period of Significance
ca. 1920 – ca. 1931

Significant Dates
N/A

Significant Person
(Complete only if Criterion B is marked above.)
N/A

Cultural Affiliation
N/A

Architect/Builder
Dice, Joseph A.

[x] **STATEMENT OF SIGNIFICANCE ON CONTINUTATION PAGES**

9. Major Bibliographical References

Bibliography (Cite the books, articles, and other sources used in preparing this form.)

Previous documentation on file (NPS):
- ___ preliminary determination of individual listing (36 CFR 67 has been requested)
- ___ previously listed in the National Register
- ___ previously determined eligible by the National Register
- ___ designated a National Historic Landmark
- ___ recorded by Historic American Buildings Survey #_____
- ___ recorded by Historic American Engineering Record #_____
- ___ recorded by Historic American Landscape Survey #_____

Primary location of additional data:
- x State Historic Preservation Office
- ___ Other State agency
- ___ Federal agency
- x Local government
- ___ University
- x Other

Name of repository: **Miller County Historical Society Library**

Historic Resources Survey Number (if assigned): _____

10. Geographical Data

Acreage of Property Less than one acre

Latitude/Longitude Coordinates
Datum if other than WGS84:_____
(enter coordinates to 6 decimal places)

1	+38.07744 (Latitude:)	-92.52668 (Longitude:)	3	_____ (Latitude:)	_____ (Longitude:)
2	_____ (Latitude:)	_____ (Longitude:)	4	_____ (Latitude:)	_____ (Longitude:)

UTM References
(Place additional UTM references on a continuation sheet.)
_____ NAD 1927 or _____ NAD 1983

1	15 (Zone)	541512 (Easting)	4214512 (Northing)	3	_____ (Zone)	_____ (Easting)	_____ (Northing)
2	_____ (Zone)	_____ (Easting)	_____ (Northing)	4	_____ (Zone)	_____ (Easting)	_____ (Northing)

Verbal Boundary Description (On continuation sheet)

Boundary Justification (On continuation sheet)

11. Form Prepared By

name/title Kelly Warman-Stallings, Jacob Morris, Missouri State Historic Preservation Office

organization Mid-Missouri Historian date February 24, 2020

street & number 3310 Route CC telephone 573-821-0191

city or town Jefferson City state Missouri zip code 65109

e-mail kelstal@hotmail.com

Additional Documentation

Submit the following items with the completed form:

- **Maps:**
  - A **USGS map** (7.5 or 15 minute series) indicating the property's location.
  - A **Sketch map** for historic districts and properties having large acreage or numerous resources. Key all photographs to this map.
- **Continuation Sheets**
- **Photographs**
- **Owner Name and Contact Information**
- **Additional items:** (Check with the SHPO or FPO for any additional items.)

Photographs

Submit clear and descriptive photographs. The size of each image must be 1600x1200 pixels (minimum), 3000x2000 preferred, at 300 ppi (pixels per inch) or larger. Key all photographs to the sketch map. Each photograph must be numbered and that number must correspond to the photograph number on the photo log. For simplicity, the name of the photographer, photo date, etc. may be listed once on the photograph log and doesn't need to be labeled on every photograph.

Photo Log:

Name of Property: **Grand Auglaize Bridge**

City or Vicinity: **Brumley**

County: **Miller** State: **Missouri**

Photographer: **Kelly Warman-Stallings**

Date Photographed: **February 15, 2020**

Description of Photograph(s) and number, include description of view indicating direction of camera:

1 of 15: Camera pointing south at north side of bridge
2 of 15: Camera pointing north at south side of bridge
3 of 15: Camera pointing west at east side of bridge
4 of 15: Camera pointing east at west side of bridge
5 of 15: Camera pointing southwest at east pedestals/piers
6 of 15: Camera pointing east at east abutment
7 of 15: Camera pointing south at east cable deadmen
8 of 15: Camera pointing east at timber roadway
9 of 15: Camera pointing west at timber roadway
10 of 15: Camera pointing west at west piers-abutment
11 of 15: Camera pointing south at west piers-abutment
12 of 15: Camera pointing west at west cable deadmen (buried in concrete underground)
13 of 15: Camera pointing northwest at metal rails
14 of 15: Camera pointing southeast at length of bridge underneath.
15 of 15: Camera pointing west at length of bridge underneath

Figure Log:

Included figures on continuation pages at the end of the nomination.

Figure 1 - Photo Site Map
Figure 2 - Main Suspension Cables
Figure 3 - Hanger Cables
Figure 4 - Floor Beams
Figure 5 - Towers
Figure 6 - Stringers
Figure 7 - East end of bridge (before) - East end of the bridge (after)
Figure 8 - West end of bridge (before) - West end of bridge (after)
Figure 9 - Brumley, Missouri (left); Miller County, Missouri (right), highlighted in red
Figure 10 - Lake of the Ozarks State Park boundary, with highlighted red star of bridge's location
Figure 11 - Mill Creek Bridge (Miller County, Missouri)
Figure 12 - Map of Lake of the Ozarks, with red arrow pointing to Grand Glaize Arm location
Figure 13 - Warsaw Upper Bridge (Benton County, Missouri)
Figure 14 - Tuscumbia Swinging Bridge (Miller County, Missouri)
Figure 15 - Kemna Bridge (Miller County, Missouri)
Figure 16 - Buechter Bridge (Miller County, Missouri)
Figure 17 - Kliethermes Bridge (Miller County, Missouri)

Summary:

The Grand Auglaize Bridge, also known as Glaize Bridge and Big Swinging Bridge, is a 500-foot wire cable suspension bridge that crosses over the Grand Auglaize Creek in east-west direction about 2.8 miles southwest of Brumley in Miller County, Missouri. **(Figure 1)** Designed and constructed by Joseph A. Dice sometime between 1920-1931, was one of seven suspension bridges built by Mr. Dice in Miller County during the early 20th century.[1] Throughout its history the suspension bridge has served the function of allowing vehicular traffic to conveniently cross Grand Auglaize Creek from eastern Miller County into western Camden County. The eastern access point lies adjacent to private property on the south and Lake of the Ozarks State Park to the north. The western access point lies within the Lake of the Ozarks State Park jurisdiction. Originally built for vehicular use, the bridge continues to carry traffic over the Grand Auglaize Creek in 2020. Routine repairs, such as replacing timber roadway flooring and cable replacement, have been maintained by Miller County over the years, but the basic structural integrity of the bridge remains intact. The retention of its design can still be referred to as a "swinging bridge" as no major modifications have ever been made to the original construction. In this regard, the bridge retains its historic character of the early 20th century. A weight limit of 3 tons was classified in 2017.[2]

Physical Description:

The Grand Auglaize Bridge is an original wire cable suspension bridge with historic concrete abutments, original tower pedestals/piers, and original cable deadmen. It has a 2x10 treated oak timber deck, recently in-kind replaced to match the [original] deteriorated wooden deck, over original steel stringers and connected by original hanger cables to the original floor beams. The bridge houses two original steel towers. The height of the east tower is about 50 feet; the height of the west tower is about 50 feet. The bridge features an original two-span steel cable suspension, supported by the original steel towers. Span one is 85 feet 11 inches; span two has a length of 414 feet 1 inch between towers. The width of the bridge is 14 feet, with a 12-foot roadway.

Most of the Dice suspension-cables consisted of 950 wires each; the distance between the original hanger cables is 5 feet. No original sketches or blueprints of the Grand Auglaize Bridge exist, as Joseph Dice was reputed to use a ball of string/twine to calculate his measurements.[3] The exact sag used by Dice is unknown.

In August of 2018, a comprehension fracture critical inspection was conducted for the suspension bridge by Poepping, Stone, Bach & Associates, Inc. (PSBA) of Quincy, Illinois. This inspection gave an in-depth physical description of the bridge:

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[1] Peggy Smith Hake, "Joseph Dice, Bridge Builder (1866-1947)" An article in "Bridges of Miller County", Miller County Historical Society Research Library. www.millercountymuseum.org/archives/111031.html

[2] Janet Dabbs, "Fate Of Lake Of The Ozarks Historic Swinging Bridge Hangs In The Balance"- Lake Expo, June 14, 2019. https://www.lakeexpo.com/news/lake_news/fate-of-lake-of-the-ozarks-historic-swinging-bridge-hangs/article_3419936c-8e25-11e9-958c-87b026e73774.html

[3] HAER Inventory: Missouri Historic Bridge Inventory. https://historicbridges.org/missouri/grandauglaize/inventory.pdf

Main Suspension Cables: "Each main cable is a larger cluster of steel wire strands with a soft wire wrap. The cables are suspended from two steel towers and then anchored into concrete blocks off the bridge. The strands are generally rusty in condition along the outer core, with no significant section loss. The outer strand layers that are exposed to the elements have areas of the strands that have minor pitting. Investigation of the various elements of the main cables, hands-on, reveal that there are varying degrees of loose strands evident around the outer core of the cable. The bulk of the core though appears very solid. In certain areas individual strand breakage is evident. The exact number of strands fractured is difficult to ascertain, but for the most part, judging by the looseness of the strands, and assuming those strands are in fact failed somewhere in the main cable, there are as many as a dozen or more strands ruptured, or at least not functioning in tension. At the far west end, in the segment between the anchor block and last hanger, there is the largest concentration of broken and/or loose strands. The south main cable, approximately 10 feet from the anchor, includes in excess of 40 loose strands which are not bound by any wrapping. In close proximity to that grouping, about 24 strands are observed to be severed. At the anchor itself, the interface looks good, but there are about 12 broken strands noted. In the corresponding cable to the north, approximately 20 feet from the anchor, there are about 15 observed broken strands. The area of draping over the towers looks good. There are few observed broken cables over the saddles. Strands in the saddle have been spliced in the past."[4] **(Figure 2)**

Vertical Members (Hanger Cables): "There are 82 pairs of hanger cables that are oriented vertically from the main suspension cables and wrap around the ends of the floor beams. There are 10 wire twisted strands that form a cable and are looped around the floor beam at each hanger location. Various hangers were observed to be loose and/or untwisted. The hanger cables are generally rusting and have minor to isolated areas of moderate pitting. The moderate pitting is most noticeable in the upper portions of various identified cables; with minor section loss. Where the bottom portion of the cables come into contact with the floor beams, wear is evident at the top flange location. This occurs in the vast majority of the floor beams, with varying degrees of section loss occurring in strands. There are many more documented wire breaks since the last inspection."[5] **(Figure 3)**

Floor Beams: "All of the floor beams look to be in good condition with only general rusting and minor pitting. In addition, the rubbing action of the hanger cables on the top flange of the floor beam is causing minor wear in various locations. A longitudinal cable acts as bracing to tie the floor beam ends together."[6] **(Figure 4)**

Towers: "The suspension towers are not fracture critical. They have general rusting and minor pitting. A cursory review of the towers indicates there are isolated areas of moderate to heavy section loss in plating, lattice and connection angles. The towers are for the most part plumb. There is also a missing anchor bolt in the base of tower 1."[7] **(Figure 5)**

[4] PSBA Fracture Critical Inspection Report, pp. 4-5.
https://docs.wixstatic.com/ugd/cbf041_a3503abf5c79483dabadabf9bbf4a6fc.pdf
[5] Ibin, p. 5.
[6] Ibin, p. 6.
[7] Ibin, p. 7.

4)Stringers: "Stringers, like the floor beams, are in good condition overall, with general rusting and minor pitting. One stringer was observed out of alignment."[8] **(Figure 6)**

Bridge Modifications:

Very few modifications have been made to the Grand Auglaize Bridge over the years. According to the current Presiding Commissioner of Miller County, Thomas Wright, the basic maintenance on the bridge over the last five years has consisted primarily of wire, deck and abutment repair, replacing the original materials with in-kind materials due to deterioration of the original components.[9]

Elaboration

Setting:

The Grand Auglaize Bridge is rurally located in Miller County, Missouri near the town of Brumley on State Highway 42, 2.8 miles southwest. **(Figures 7-9)** The bridge, which is accessible via Swinging Bridges Road (Co. Rd. 42-18), spans the Grand Auglaize Creek, a tributary of Lake of the Ozarks. The west end of the bridge is located on Lake of the Ozarks State Park property. (**Figure 10)** The east end of the bridge is located on Miller County property. Traveling southwest on Swinging Bridges Road from Brumley, the gravel road crosses a smaller and structurally modified suspension bridge known as Mill Creek Bridge, also designed and built by Joseph Dice ca. 1925 and reconstructed in 1978.**(Figure 11)** The Mill Creek Bridge was extensively altered in 1978, when the majority of the original bridge materials and design was lost. According to HistoricBridges.org, the original cable remains on the bridge but is nonfunctional, having been bypassed by a new main cable. All original suspender cables and original floor beams have been replaced. The original anchorages appear to have been replaced or altered to support the new cable. The original wooden deck has also been replaced with modern corrugated metal. Thus, Mill Creek Bridge is given a lower historic significance rating. There is about 1,000 feet distance between the two historic bridges. The Grand Auglaize Bridge is surrounded by deciduous trees on both ends of the structure and the waterway is situated directly below the bridge.

Integrity:

The Grand Auglaize Bridge conveys its historic significance through expression of all seven aspects of integrity.

The bridge remains in the original location of construction and its setting is very similar to when the bridge was built. The rural roadway remains, and continues to be an unpaved, narrow gravel road. The surrounding landscape retains its relatively undeveloped wooded character. The bridge spans the creek, as it did when the bridge was originally built.

The Grand Auglaize Bridge's design, materials and embodied workmanship are retained. The bridge retains its original design, retaining the form of its

[8] Ibin, p. 7.

[9] Thomas Wright in a personal interview with Kelly Warman-Stallings, October 17, 2019. Thomas Wright is the current Miller County Presiding Commissioner. Wright confirms only minor repairs have been made to the Grand Auglaize Bridge over the years.

vernacular technology and materials. In contrast to the other suspension bridges in Miller County, which have either been torn down or have been exceedingly modified from their original designs, the Grand Auglaize retains its original structural system as Dice designed it. Major retained character-defining features include, but are not limited to, the original towers, cables, railings, piers and floor beams and their configuration. Repairs to any deteriorated perishable components, such as wooden planks, were limited to in-kind replacement. The Grand Auglaize Bridge is the last swinging bridge that retains its original design and structural system in Miller County.

The bridge retains integrity of feeling and association. The bridge continues its original usage as a means of crossing the Grand Auglaize Creek by automobile. When driving across this historic bridge, as has been the case for almost a century, one can almost retain the feeling of being transported back to the early 1900s. Likewise, the presence of the bridge's physical features and surrounding natural elements has retained the property's historic association, conveying a distinctive character to the bridge and its rustic environment. Crossing the Grand Auglaize Bridge is the same experience as it has always been … including the slight swinging motion as one slowly drives over the bridge, which can be a novel and distinctive experience for the public due to the increasing rarity of this type of bridge.

Summary:

The Grand Auglaize Bridge, spanning the Grand Auglaize Creek, near Brumley, Miller County, Missouri is locally significant under the National Register of Historic Places Criteria C in the area of Engineering. As a relatively economical design, suspension (also called "swinging") bridges were very common in Missouri during the early 20th century. Most have since been demolished or adapted to another structural system. The Grand Auglaize Bridge was designed and built by Joseph A. Dice (1866-1947) sometime between ca. 1920-1931. Dice was one of the most prolific regional bridge builders who designed and constructed about 40 suspension bridges throughout central Missouri between 1895-1940. He used a relatively conventional, yet simplified design relying on his informal knowledge gained through apprenticeship. The Grand Auglaize is the only remaining intact suspension bridge in Miller County and continues to carry vehicular traffic over the Grand Auglaize Creek.[10] **(Figure 12)** He was frequently commissioned by the road district because of cost and efficiency of materials.[11] Changing in engineering standards and formal qualification requirements would later make Dice's vernacular approach to engineering obsolete. The Grand Auglaize bridge retains all aspects of integrity, and continues to provide the same experience to those crossing the bridge as when it was constructed.

Suspension Bridge Historic Context:
National Context:
Suspension bridges have been prevalent for centuries, but it was not until the mid-19th century that they were used for "anything heavier than horse-and-foot traffic".[12] In 1801, James Finley (1756-1828) built the first iron chain suspension bridge in the United States over Jacob's Creek near Mt. Pleasant, Westmoreland County, Pennsylvania. The bridge was situated on the road between Uniontown and Greensburg. Finley was a justice of the peace and a judge in Fayette County, Pennsylvania and held an 1808 patent on a wooden suspension bridge that was suspended from wrought iron chains. However, Finley's bridges were reputed to deteriorate after only a few years of use. Not long afterwards, the introduction of metal cables was promoted.[13]

By 1816, wrought iron wire manufacturers, Josiah White (1780-1850) and Erskine Hazard (1790-1865), constructed a metal pedestrian suspension bridge that spanned 410 feet across the Schuylkill River near Philadelphia, Pennsylvania. Although short-lived, this is considered the first metal suspension bridge in the country.[14]

In 1841, Charles Ellet, Jr. (1810-1862) started construction on America's first wire cable suspension bridge to carry horse-and-buggy traffic over the Schuylkill River in Philadelphia, Pennsylvania. The bridge, which was designed by Ellet, was 358 feet between the towers, supported by five cables on each

[10] Obituary of Joseph A. Dice, printed in Robert Hayden's historical study, "Joseph A. Dice, Bridge Builder," p. 48.
[11] HAER Inventory: Missouri Historic Bridge Inventory.
[12] Joseph Gies, Bridges and Men (Garden City, New York: Doubleday & Co., 1963), pp. 179-180
[13] "A Context For Common Historic Bridge Types" NCHRP Project 25-25, Task 15, Prepared for The National Cooperative Highway Research Program Transportation Research Council National Research Council, Prepared By Parsons Brinckerhoff and Engineering and Industrial Heritage, October 2005, p. 3-132.
http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(15)_FR.pdf
[14] Ibin, p. 3-132.

side, with a deck width of 25 feet and opened on January 1, 1842.[15] Ellet's suspension bridge, also known as a "swinging bridge", in Philadelphia was regarded with due-respect, and thus began the encouragement of constructing other wire cable suspension bridges around the nation.

Another renowned bridge expert of that era was John Roebling, who built the first railroad bridge to carry trains over the Niagara Gorge at Niagara Falls in 1851. This railway suspension bridge, which connected New York Central and Great Western Railway of Canada over the Niagara River, had a clear span of 825 feet and was supported by four ten-inch wire cables, and had two levels - one for rail traffic and the other for antiquated vehicles.[16] Encyclopedia Britannica states, "He developed his own method for stranding and weaving wire cables, which proved to be as durable as he had predicted. The demand for such cable soon became so great that he established a factory to manufacture it in Trenton, New Jersey. This was the beginning of an industrial complex that finally was capable of producing everything from wire cloth to enormous suspension bridge cables…"[17]

Both Ellet and Roebling chose the use of iron wire and stone towers over the use of chains and wooden towers. Roebling, who introduced the "stiffening truss" [a bridge that was endowed with improved strength and aerodynamic stability], constructed many heavy-duty suspension bridges, but he is best known for erecting the Brooklyn Bridge in New York City, New York.[18]

By the late 1800s, the suspension bridge increased its popularity and many bridge builders soon discovered it was extremely economical; the swinging bridge was well suited to wide clearances and could be constructed of readily available materials, such as local timber and creek gravel. The concept of the suspension bridge was simple and could be easily duplicated by local builders. Suspensions, also known as "swingers", were notably popular for the small town and county bridges in areas of rough terrain such as the southern Appalachian and Ozark Highlands. Donald C. Jackson notes the "swingers'' were prevalent in the South and West.[19] The common version of these vernacular bridges often lacked the technologies of the era, such as twisted wire and steel beams, but by the early 1900s, suspension bridges had become commonplace for vehicular traffic.

Missouri Suspension Bridge Context:

As a hilly region with many rivers and creeks, central and southern Missouri was well suited terrain for construction of suspension bridges. Three builders constructed most of the suspension bridges in Missouri. Two were relatively substantial companies, and the third was Joseph A. Dice.

The Kansas City Bridge Company [once located in Kansas City, Missouri] was a bridge building company that also constructed many bridges throughout the

[15] Ibin, p. 3-132; and, Joseph Gies, Bridges and Men (Garden City, New York: Doubleday & Co., 1963), pp. 179-180.
[16] Wikipedia.com: John A. Roebling. https://en.wikipedia.org/wiki/John_A._Roebling
[17] Encyclopedia Brittannica: John Augustus Roebling, American Engineer https://www.britannica.com/biography/John-Augustus-Roebling
[18] Joseph Gies, Bridges and Men (Garden City, New York: Doubleday & Co., 1963), pp. 185-186, EncyclopediaBrittannica.com: John Augustus Roebling, American Engineer, and, Wikipedia.com: John A. Roebling.
[19] Donald C. Jackson, Great American Bridges and Dams (New York: Wiley, 1988), p. 35.

Midwest. The company was established in 1893.[20] Many of their bridges, including the suspension and the truss, spanned the Missouri River in Iowa, Kansas, Missouri and Nebraska. A few of their historic bridges made the National Register of Historic Places as well. Kansas City Bridge Company closed their business around 1960. Today, none of the Midland Bridge Company and Kansas City Bridge Company vehicular suspension bridges remain standing.[21]

The Midland Bridge Company is a firm based in Kansas City, Missouri. During the early 1900s, it built numerous bridges, including suspension bridges, in portions of the West and the Midwestern states. Per Bridgehunter.com, Midland Bridge Company is credited with building over 40 bridges with most of their bridges located in Missouri.[22] The Midland Bridge Company primarily built truss bridges and was established around the turn of the 20th century [their earliest truss bridge was erected in Bourbon County, Kansas in 1902]. One of their first suspension bridges, which is still standing today, is a 227 feet footbridge built in 1907. This 1907 bridge, located in present-day Swope Park/Kansas City Zoo, is still open to pedestrian traffic. Several Midland Bridge Company bridges are listed in the National Register of Historic Places, but most are of truss design.

The third builder was Joseph A. Dice, a self-taught engineer, who was reputed to have constructed approximately 40 bridges between 1895 and 1940 in the central Missouri region. Missouri counties that housed the Dice bridges included: Benton, Cooper, Henry, Miller, Maries and St. Clair.[23] Although he was an individual instead of a company, Mr. Dice designed bridges to span substantial streams, creeks and rivers, as well as produced small bridges for farmers on private property. Inherently lacking some technical sophistication, the Dice suspension bridges in central Missouri were built from experience and for the needs of local people, and exhibit a relatively basic design.

According to the 1940 United States Census, Joseph Dice had a limited education that extended to the 4th grade, but this did not hinder him from achieving success.[24] What sets this self-educated engineer apart from his competitors of the early 1900s was that Mr. Dice's informal approach to engineering, no blueprints were involved, instead he ingeniously eyeballed the place where the bridge was to be built and assessed how much material he needed and what configuration the bridge should have.[25]

He started his bridge-building career as a young apprentice to Dr. Daniel M. Eddy in 1895 on the Stockton Bridge in Cedar County.[26] In 1905, the first public toll bridge that spanned the Osage River in Miller County, was built at

[20] Wikipedia.com: Kansas City Bridge Company.
https://en.wikipedia.org/wiki/Kansas City Bridge Company
[21] U.S. Department of the Interior, National Park Service, "Historic American Building Survey-Missouri Historic Bridge Survey" Vol. I (Washington, D.C., 1990).
[22] Bridgehunter.com - Midland Bridge Company.
https://bridgehunter.com/category/builder/midland-bridge-co/
[23] Bridgemiester.com: Suspension Bridges of Missouri
https://www.bridgemeister.com/list.php?type=state&state=Missouri

[24] 1940 United States Census, Joseph A. Dice - https://search.ancestry.com
[25] Peggy Smith Hake, "Joseph Dice, Bridge Builder (1866-1947)"
[26] St. Louis Post-Dispatch, St. Louis, Missouri, 10 Dec 1893.
https://www.newspapers.com/clip/6075837/daniel_m_eddy/

Tuscumbia.[27] Mr. Dice was awarded the contract from the Tuscumbia Bridge Company to erect the 618-foot swinging bridge.[28] In 1932, the Dice bridge was replaced with a modern truss bridge [of that era], which completed State Highway-MO 17 through Miller County.

Joseph A. Dice was a skillfully pragmatic man with a mathematical eye and a calculating brain. His method of calculating a bridge's dimensions was noticeably different from other builders of his day and consisted of using a ball of twine to get his mathematical equations precise. As Peggy Smith Hake noted, "We are told Mr. Dice could tell by the 'feel' of the wire if the tension was right."[29] He built a regional reputation as a builder of suspension bridges, as Robert Hayden acclaimed, an "almost legendary reputation".[30] Dice and Eddy left a legacy of bridges in the central Missouri region; sometimes they worked together and other times they worked alone. There are not any distinctive differences between the Dice and Eddy bridges, as Dice learned the bridge building trade from Eddy and most likely stuck with the designs he was taught.

These men built a total of eleven swinging bridges in Benton County during a significant period of 1895 to 1928.[31] Today, eight of the nine Benton County swinging bridges no longer remain standing, either having been replaced or torn down. The Warsaw Upper Bridge, built in 1927, is the last surviving swinging bridge in Benton County built by Dice and located over the Osage River on MO 7 in Warsaw, Missouri. **(Figure 13)** While it no longer carries vehicular traffic, the swinging bridge is opened to pedestrian traffic. The Warsaw Upper Bridge was placed on the National Registry of Historic Places in 1999. According to Robert Hayden, fifteen suspension bridges once spanned the Osage River before Lake of the Ozarks was excavated.[32] Nine of those swinging bridges over the Osage River were once housed in Benton County.

Not only was Joseph A. Dice an enterprising engineer of bridges, but at various times throughout his life, he served Benton County, Missouri as County Highway Engineer and County Surveyor.[33] Yet, building his bridges seemed to have been Dice's favorite career endeavor. Joseph A. Dice was a man of unique talent when it came to building bridges, but as contracting became more formalized, he most likely knew he could not compete for state contracts. As noted earlier, Joseph A. Dice was a builder who basically carried the blueprints in his head, having no official drafts, engineering plans or written instruction. During the era of Dice's bridge building career, bridge projects were a contribution to connecting people to other places for both social and commerce reasons. Formalized engineering standards did not exist at

[27] Ginny Duffield, "Third Bridge in a Lifetime" - The Miller County Autogram-Sentinel – Thursday, May 7, 2009.
[28] Bridgehunter.com: Historic and Notable Bridges of the U.S., Tuscumbia Swinging Bridge. https://www.bridgehunter.com/mo/miller/tuscumbia-swinging/
[29] Peggy Smith Hake, "Joseph Dice, Bridge Builder (1866-1947)"
[30] Robert Hayden, "Joseph A. Dice, Bridge Builder. A historical study of a self-made bridge engineer, his work, and his region from 1890 through the present," a project conducted by Historical Surveys, Inc., Garrison N.D. for the U.S. Army Corps of Engineers, pp. I and 27
[31] Ibin, p. 27.
[32] Robert Hayden, "An historical study of suspension bridges built over the Osage River and its tributaries from 1895 to 1937." A project conducted by Historical Surveys, Inc., Garrison, N.D., for the U.S. Army Corps of Engineers, Kansas City District, Harry S. Truman Dam and Reservoir Project, Missouri, 1979, p. 1.
[33] Roster of State, District and County Officers of the State of Missouri [in] 1919, Compiled by John L. Sullivan, Secretary of State, p. 34.

that time. Trademarks of builder, Joseph A. Dice's unique construction included planked flooring for the roadbed and ends that are not attached to the abutments, but merely rest on them (thus the term "swinger"). All of Dice's bridges were characteristically one-lane, floor beams cut to 14 feet, as found "in every one of his bridges without exception." [34]

With the impounding of the Osage River it increased the demand for the heavy-duty truss bridge. Without a doubt, Dice realized this was the beginning of the wire-cable suspension bridge's demise, and most likely was instrumental in Dice's final decision for retiring from bridge building. Local historian Peggy Smith-Hake noted, "When the highway department required blueprints for construction, Mr. Dice retired as a bridge builder!".[35]

Construction of the Grand Auglaize Bridge:

Joseph A. Dice designed the Grand Auglaize Bridge. The common consensus of the local inhabitants regarding the Grand Auglaize Bridge's construction date is ca. 1930-1931. According to the locals, when Bagnell Dam was built to impound the Osage River, it also confined the Grand Auglaize Creek which had previously flowed into the river, causing the waterway to backup and flood the vicinity.[36] The need for a bridge became a priority when the residents were no longer able to safely cross the creek by automobile, on what was once the old Linn Creek-Brumley Road.

Hence, Joseph Dice was contracted by Union Electric Light & Power (St. Louis, Missouri) under the authority of Louis H. Egan, president of the utility company, to erect a bridge over the Grand Auglaize waterway.[37] According to H. Dwight Weaver, the bridge was budgeted for $17,200, but Mr. Dice was able to construct the Grand Auglaize Bridge for $11,500.[38]

The HAER Inventory of Missouri Historic Bridges, completed in 1990, listed ten suspension bridges (built by Dice) remaining in central Missouri. There are only four that are known to survive today: three in Miller County and one in Benton County. It is important to note, the Grand Auglaize Bridge is the last constructed bridge of its original design, left standing in Miller County; the other two bridges (Kemna and Mill Creek) were rehabilitated in 1978. Kemna and Mill Creek Bridges were modified from their original design, such as replacing timber towers with steel towers, while still retaining the original character and charm of a vernacular bridge.

Bridge Comparisons:

At one time there were numerous suspension bridges designed by Dice scattered throughout Missouri with most wire-cable suspensions being housed in Miller and Benton Counties. Unfortunately, most of these historic bridges have been

[34] Robert Hayden, "Joseph A. Dice, Bridge Builder," p. 30.

[35] Peggy Smith Hake, "Joseph Dice, Bridge Builder (1866-1947)".

[36] Mark Beabout in a personal interview with Kelly Warman-Stallings, October 17, 2019. Mark Beabout is the President of the grassroots campaign, "Save the Historical Brumley Swinging Bridge". Beabout is also an amateur county historian.

[37] Thomas Wright in a personal interview with Kelly Warman-Stallings, January 6, 2020.

[38] H. Dwight Weaver. History & Geography of Lake of the Ozarks, Vol. 1, (Mount Pleasant, South Carolina: Arcadia Publishing, 2000), p. 77

lost to either neglect, flooding, and/or replacement by concrete and steel. Mr. Dice was also credited with building wooden suspension bridges; he used local supplies of wood and concrete and only purchased the strands of wire for the cables. "For the steel suspension bridges," Tom Chesser noted, "he ordered kits from a bridge company in Pennsylvania and just strung the cable and hung the steel "I" beams. The suspension bridge kits were less expensive than those for the steel truss bridge type since less steel was used in the suspension type bridge." [39]

Dice built six suspension bridges in Miller County in addition to the Grand Auglaize Bridge:

1. **Tuscumbia Toll Bridge** – built 1905; replaced 1932
   Located at Tuscumbia, the original Tuscumbia Toll Bridge was a 618.0 feet swinging suspension bridge that once spanned the Osage River. Some of the notably characteristic features of this bridge was its wooden towers and wooden rails. It was torn down and replaced with a historic truss bridge in 1932. **(Figure 14)**

2. **Kemna Bridge** - built 1924; modified 1978
   Located near St. Elizabeth, Kemna Bridge does not retain its original integrity. The bridge was modified from its original design with the majority of its original materials being replaced (ie: steel towers replaced the original wooden towers, the original concrete pedestals were replaced with modern concrete pedestals, the steel cables reinforced with new cables and the historic timber flooring was replaced with modern steel).[40] **(Figure 15)**

3. **Buetcher Bridge** - built ca. 1925; replaced 2011
   Located southwest of St. Anthony, the original Buetcher Bridge was a 141.0 feet swinging bridge that once spanned Tavern Creek. The character-defining feature of this Dice bridge was it only housed one small steel tower, where the cables attached to thick dual timber posts at the opposite end. A modern concrete bridge replaced it in 2011. **(Figure 16)**

4. **Kliethermes Bridge**-built c/1925; demolished 2008
   Once located northwest of St. Anthony, the original Kliethermes Bridge, a 215.9 feet swinging bridge, no longer exists. What set this bridge apart from other Dice bridges in Miller County was it housed a small steel tower at one end and two stone pillars at the other end of the bridge. It was torn down on March 12, 2008. **(Figure 17)**

5. **Mill Creek Bridge** - built c/1925; modified 1978
   Located southwest of Brumley, Mill Creek Bridge does not retain its original integrity. The bridge was modified from its original design with the majority of its original materials being replaced (ie: the original wooden towers and original concrete pedestals were replaced with historic steel and modern concrete, the steel cables reinforced with new cables, original suspender cables and original floor beams have been replaced with modern in-kind materials, the original anchorages appear to have been

[39] Tom Chesser, "Nomination Report on Boeckman Bridge, National Register of Historic Places," Lake of the Ozarks Council of Local Governments, Camdenton, Missouri, 1978, Section 8 - p. 1; and, Hayden, p. 27.
[40] Thomas Wright in a personal interview with Kelly Warman-Stallings, April 24, 2020

replaced and the original timber flooring replaced with modern steel).[41] **(Figure 18)**

6. **Boeckman Bridge** – built 1926; modified 1976; replaced 2002
Located southeast of St. Elizabeth, the original 185.0 feet Boeckman Bridge, which crossed over Big Tavern Creek, no longer remains standing. A notable feature of this swinging bridge was the steel tower, encased in concrete piers, sat directly on top of a rock bluff on the east end of the bridge. A modern concrete bridge replaced the swinging bridge. **(Figure 19)**

The longest vernacular bridge still in use in the state of Missouri is known as the Warsaw Upper Bridge, located in Warsaw, Benton County, Missouri. This bridge was also constructed by Mr. Dice and built in 1927 after a 1924 tornado had destroyed the original suspension bridge [with wooden towers] built in 1904.[42] The 1927 bridge is 599.7 feet long with a 14 feet width and retains original steel towers. It also retains the original cables, although some modern suspenders have been added alongside the original cables.[43] The Warsaw Upper Bridge closed to vehicular traffic in 1979 and reopened for pedestrian passage over the Osage River in 2007.[44] **(Figure 20)**

According to the website based on the book by Leland and Crystal Payton, *Damming the Osage*, an article was published entitled, "Flooding on the Osage, July 2015", which stated, "Frightened cattle or overloaded trucks broke the deck of some and tornadoes wrecked others, but no Dice bridge ever structurally failed."[45]

In comparison to other swinging bridges constructed in the early part of the 20th century, the Grand Auglaize has stood the test of time and is the last remaining full intact suspension bridge in Miller County.

Conclusion:

The Grand Auglaize Bridge is an important example of vernacular bridge construction of the early 1900s and was built in response to community needs. According to Robert Hayden, the suspension bridges are "similar in construction to other suspension "swingers" in the United States." Their importance, he notes, stems from their simplicity of design and manner of construction.[46] Grand Auglaize Bridge carries many trademarks of builder, Joseph A. Dice's unique construction, i.e., planked flooring for the roadbed and ends that are not attached to the abutments, but merely rest on them (thus the term "swinger"). All of Dice's bridges were characteristically one-lane, floor beams cut to 14 feet, as found "in every one of his bridges without exception." [47]

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[41] Thomas Wright in a personal interview with Kelly Warman-Stallings, April 24, 2020

[42] Bridgemiester.com: 1927 Upper (Swinging) https://www.bridgemeister.com/list.php?type=state&state=Missouri

[43] HistoricBridges.com: Warsaw Upper Bridge https://historicbridges.org/bridges/browser/?bridgebrowser=missouri/warsawupperbridge/

[44] Bridgehunter.com: Warsaw Upper Bridge, https://bridgehunter.com/mo/benton/warsaw-upper/

[45] Damming the Osage: The Conflicted Story of Lake of the Ozarks and Truman Reservoir, by Leland and Crystal Payton, p. 74. https://www.dammingtheosage.com/flooding-on-the-osage-july-2015/

[46] Robert Hayden, "An historical study of suspension bridges built over the Osage River and its tributaries from 1895 to 1937," p. 1.

[47] Robert Hayden, "Joseph A. Dice, Bridge Builder," p. 30.

The significance of the Dice bridges is noted in the 1990 HAER Inventory of Missouri Historic Bridges:

"As a group, these spans comprise the state's most important examples of vernacular bridge construction, designed and built without the benefit of detailed structural analysis or computation. Dice built his lightweight suspension bridges empirically using easily obtainable materials, and, as a result they cost substantially less than comparable steel truss spans. They were breathtakingly light, however, and have fared poorly in subsequent years. The Glaize Bridge, which is the oldest and longest of the Dice bridges still carrying traffic, is distinguished as one of the best-preserved among his remaining spans. It is a superlative example of an esoteric structural type among Missouri's most important early vehicular spans." [48]

In 1993, the Missouri Historic Bridge Inventory, conducted by Fraser Design and inventoried by Clayton Fraser and Michelle Crow-Dolby, made a reference to the "outstanding, technologically significant example of an esoteric bridge type, built using vernacular tradition". [49]

According to HistoricBridges.org, the following was written about the Grand Auglaize Bridge:

"A true tribute to Dice's skills, his bridges have in many cases, including the Grand Auglaize Suspension Bridge, lasted longer than newer bridges built by corporate consulting engineers with their fancy AASHTO regulations and high-tech engineering computer programs. One of the largest of the remaining Dice bridges, and also with the highest level of historic integrity, the Grand Auglaize Swinging Bridge is truly a testament to the results of a man who was skilled and hard working. The bridge is a tribute not to engineers, but to a craftsman. The Grand Auglaize Bridge is the second longest surviving Dice suspension bridge in the state. It also retains the highest degree of historic integrity. Original towers, cables, railings, and floor beams are present on the bridge." [50]

It is interesting to note the 1893 U. S. Geological Survey (USGS)topographic map for this location refers to the waterway under the bridge as the Grand Auglaize Creek, but at some point during the early 1900s the cartographers who created the USGS maps renamed the stream Grandglaize.[51] Not to be confused with the Grand Glaize Bridge that crosses the Grand Glaize Arm of Lake of the Ozarks, this particular waterway forms about seven miles upstream from the bridge where the Dry Auglaize Creek and Wet Glaize Creek merge to form the Grand Auglaize Creek [aka: Grandglaize Creek].

With the Grand Auglaize Bridge being a tourist attraction for Lake of the Ozarks, the "swinging bridge" has aesthetic and nostalgic value as well. Many visitors go out of their way to see this unusual historic bridge, which is situated near a primitive campground, located in the Lake of the Ozarks State Park. Moreover, the bridge continues to provide a means of crossing the Grand

[48] U.S. Department of the Interior, "Historic American Building Survey-Missouri Historic Bridge Survey," Vol. 1. (Washington, D.C., 1990).
[49] Missouri Department of Transportation, Historic Bridge Inventory, 1993, p. 15.
[50] - HistoricBridges.org: Grand Auglaize Bridge, Miller County, Missouri. https://historicbridges.org/bridges/browser/?bridgebrowser=missouri/grandauglaize/
[51] H. Dwight Weaver. History & Geography of Lake of the Ozarks, Vol. 1, (Mount Pleasant, South Carolina: Arcadia Publishing, 2000), p. 76

Auglaize Creek for local citizens, not to mention when former residents return to the county for a visit, cherishing a drive across the "old swinging bridge".

The Grand Auglaize Bridge is a part of the legacy of suspension bridges in the Osage Valley that continues to function as a part of a transportation corridor for local citizens and Lake of the Ozarks tourists alike.

The Grand Auglaize Bridge is a historic bridge which retains its vernacular character, and is the only remaining intact "swinging" bridge in Miller County.

Bibliography:

"A Context For Common Historic Bridge Types" NCHRP Project 25-25, Task 15, Prepared for The National Cooperative Highway Research Program, Transportation Research Council, National Research Council, Prepared By Parsons Brinckerhoff and Engineering and Industrial Heritage, October 2005, p. 3-132 http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(15)_FR.pdf

"Bridge Engineering Assistance Program, BEAP Project Number: 20TTAP-11, Miller County Bridge No. 2740017, Swinging Bridges Road over Grand Auglaize, S36, T39N, R15W, Prepared For: Miller County Commission, Miller County, Missouri, October 24, 2019, Prepared by McClure Engineering.", p. 8

Ancestry.com. 1940 United States Census, Benton County, Missouri, Joseph A. Dice https://search.ancestry.com

Bridgehunter.com: Historic and Notable Bridges of the U.S., Midland Bridge Company. https://bridgehunter.com/category/builder/midland-bridge-co/

Bridgehunter.com: Historic and Notable Bridges of the U.S., Tuscumbia Swinging Bridge https://www.bridgehunter.com/mo/miller/tuscumbia-swinging/

Bridgehunter.com: Historic and Notable Bridges of the U.S., Warsaw Upper Bridge https://bridgehunter.com/mo/benton/warsaw-upper/

Bridgemiester.com: Suspension Bridges of Missouri, 1927 Upper (Swinging) https://www.bridgemeister.com/list.php?type=state&state=Missouri

Chesser, Tom. "Nomination Report on Boeckman Bridge, National Register of Historic Places," Lake of the Ozarks Council of Local Governments, Camdenton, Missouri, 1978, Section 8 - p. 1

Dabbs, Janet. "Fate Of Lake Of The Ozarks Historic Swinging Bridge Hangs In The Balance"- Lake Expo - June 14, 2019 https://www.lakeexpo.com/news/lake_news/fate-of-lake-of-the-ozarks-historic-swinging-bridge-hangs/article_3419936c-8e25-11e9-958c-87b026e73774.html

Duffield, Ginny. "Third Bridge in a Lifetime" - The Miller County Autogram-Sentinel - May 7, 2009

Gies, Joseph. Bridges and Men (Garden City, New York: Doubleday & Co., 1963), pp. 179-180

HAER Inventory: Missouri Historic Bridge Inventory, p. 1 https://historicbridges.org/missouri/grandauglaize/inventory.pdf

Hayden, Robert. "An historical study of suspension bridges built over the Osage River and its tributaries from 1895 to 1937," p. 1.

Hayden, Robert. "Joseph A. Dice, Bridge Builder." A historical study of a self-made bridge engineer, his work, and his region from 1890 through the present," a project conducted by Historical Surveys, Inc., Garrison N.D. for the U.S. Army Corps of Engineers, pp. I and 27

HistoricBridges.org: Grand Auglaize Bridge, Miller County, Missouri

https://historicbridges.org/bridges/browser/?bridgebrowser=missouri/grandauglaize/

HistoricBridges.org: Warsaw Upper Bridge, Benton County, Missouri https://historicbridges.org/bridges/browser/?bridgebrowser=missouri/warsawupperbridge/

Jackson, Donald C. Great American Bridges and Dams (New York: Wiley, 1988), p. 35.

Missouri Department of Transportation, Historic Bridge Inventory, 1993, p. 15 http://epg.modot.mo.gov/documents/Historic_Bridge_Inventory/dist5/miller.pdf

Newspapers.com: Daniel M. Eddy, St. Louis Post-Dispatch, St. Louis, Missouri, 10 Dec 1893 https://www.newspapers.com/clip/6075837/daniel_m_eddy/

Payton, Leland and Crystal. Damming the Osage: The Conflicted Story of Lake of the Ozarks and Truman Reservoir, p. 74, (Lens & Pen, November 1, 2012)

PSBA Fracture Critical Inspection Report, p. 2 https://docs.wixstatic.com/ugd/cbf041_a3503abf5c79483dabadabf9bbf4a6fc.pdf

Roster of State, District and County Officers of the State of Missouri, 1919, Compiled by John L. Sullivan, Secretary of State, p. 34

Sayenga, Donald. Encyclopedia Brittannica: John Augustus Roebling, American Engineer, July 19, 2019 https://www.britannica.com/biography/John-Augustus-Roebling

Smith Hake, Peggy. "Joseph Dice, Bridge Builder (1866-1947)" An article in "Bridges of Miller County", Miller County Historical Society Research Library online www.millercountymuseum.org/bridges.html

U.S. Department of the Interior, National Park Service "Historic American Building Survey-Missouri Historic Bridge Survey," Vol. 1.

Weaver, H. Dwight. History & Geography of Lake of the Ozarks, Vol. 1, (Mount Pleasant, South Carolina: Arcadia Publishing, 2000), p. 76-77

Wikipedia.com: John A. Roebling (last edited on January 1, 2020), accessed January 4, 2020 https://en.wikipedia.org/wiki/John_A._Roebling

Wikipedia.com: Kansas City Bridge Company (last edited on February 13, 2020), accessed March 1, 2020 https://en.wikipedia.org/wiki/Kansas_City_Bridge_Company

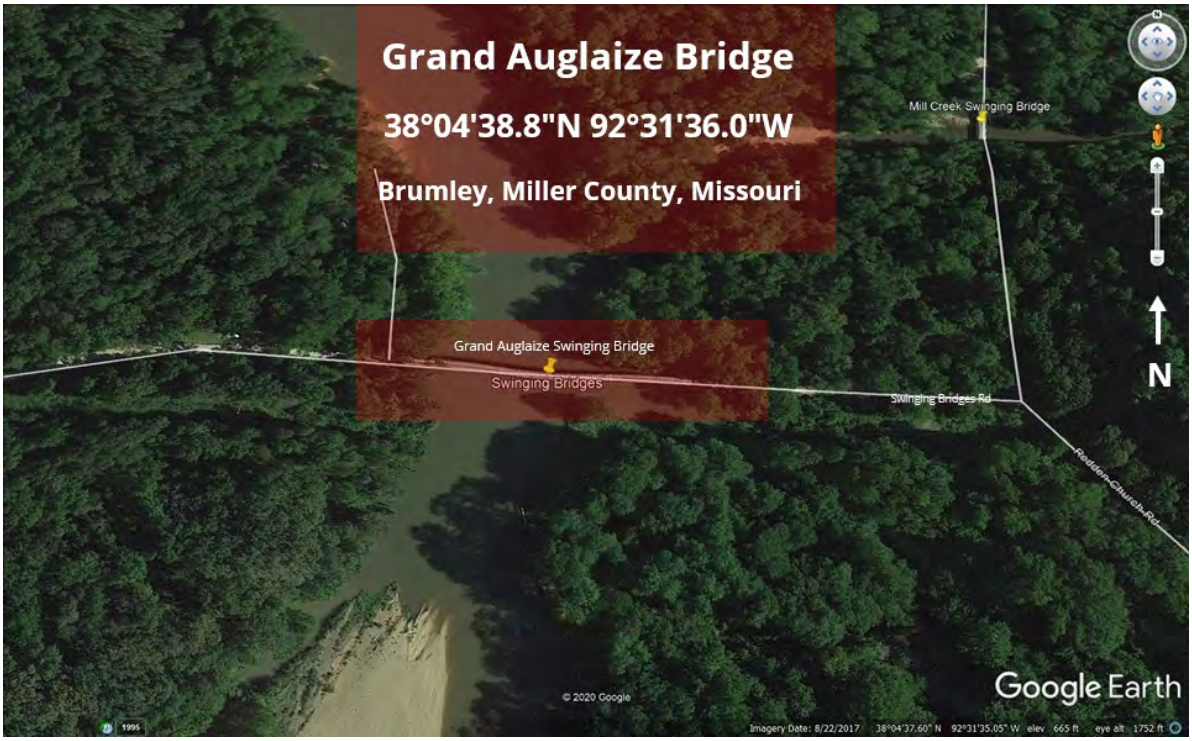
Verbal Boundary Description:

38°04'38.8"N 92°31'36.1"W, Section 36, Township 39 N., Range 15 W.

Source: Missouri Bureau of Geology and Mines, E.R. Buckley, Ph D., Director and State Geologist, Geological Map of Miller County, Missouri by Sydney H. Ball and A. F. Smith (1903); and, Bridgehunter.com, Historic and Notable Bridges of the U.S., Grand Auglaize Bridge https://bridgehunter.com/mo/miller/grand/

Boundary Justification:

The boundary encompasses the entire wire-cable suspension bridge along with its abutments; this area contains all the property that is historically associated with the Grand Auglaize Bridge.



Source: Google Earth. Accessed March 10, 2020.

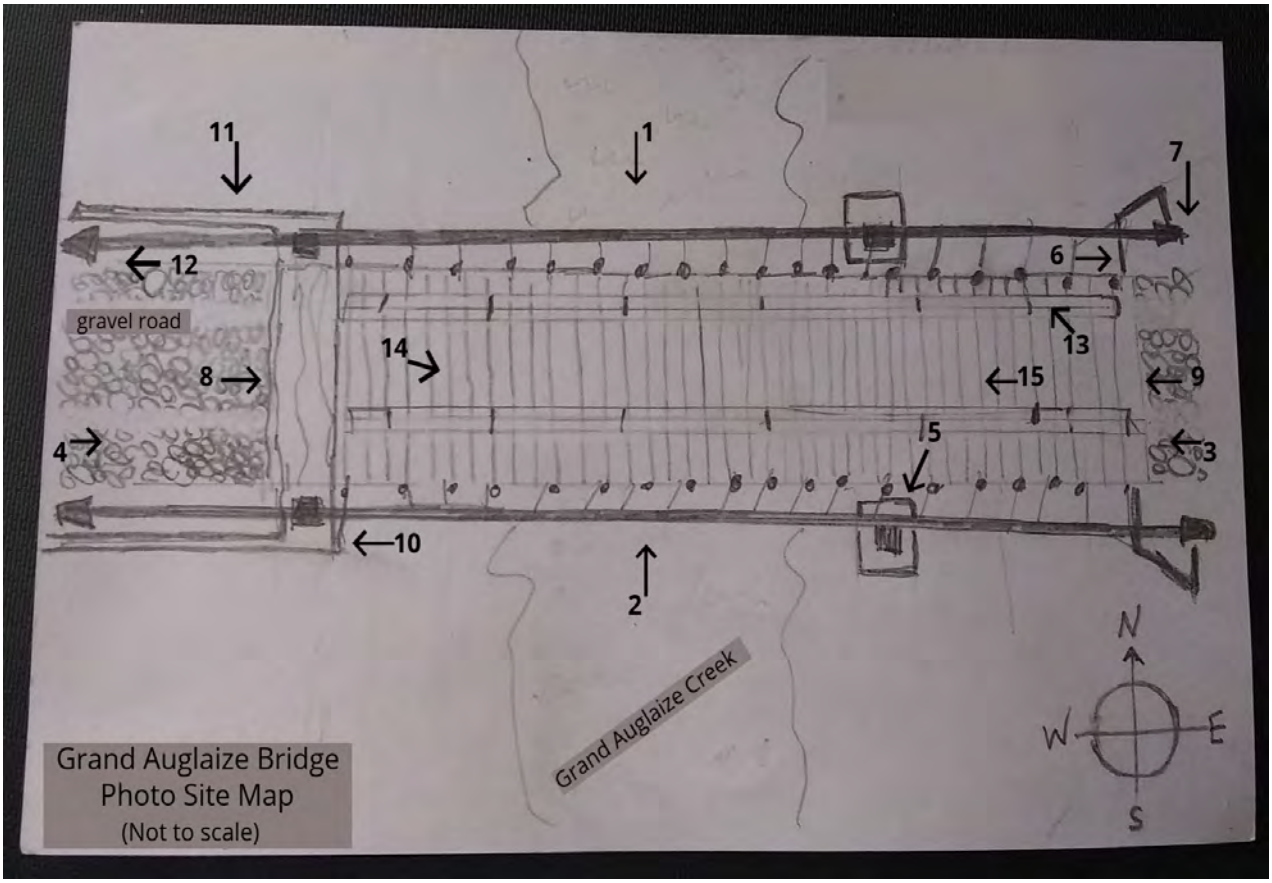


Figure 1 – Photo Site Map
Source: Site Map drawn by Kirk Warman. Modified by author May 7, 2020

Figure 2 - Main Suspension Cables, highlighted with red arrows
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

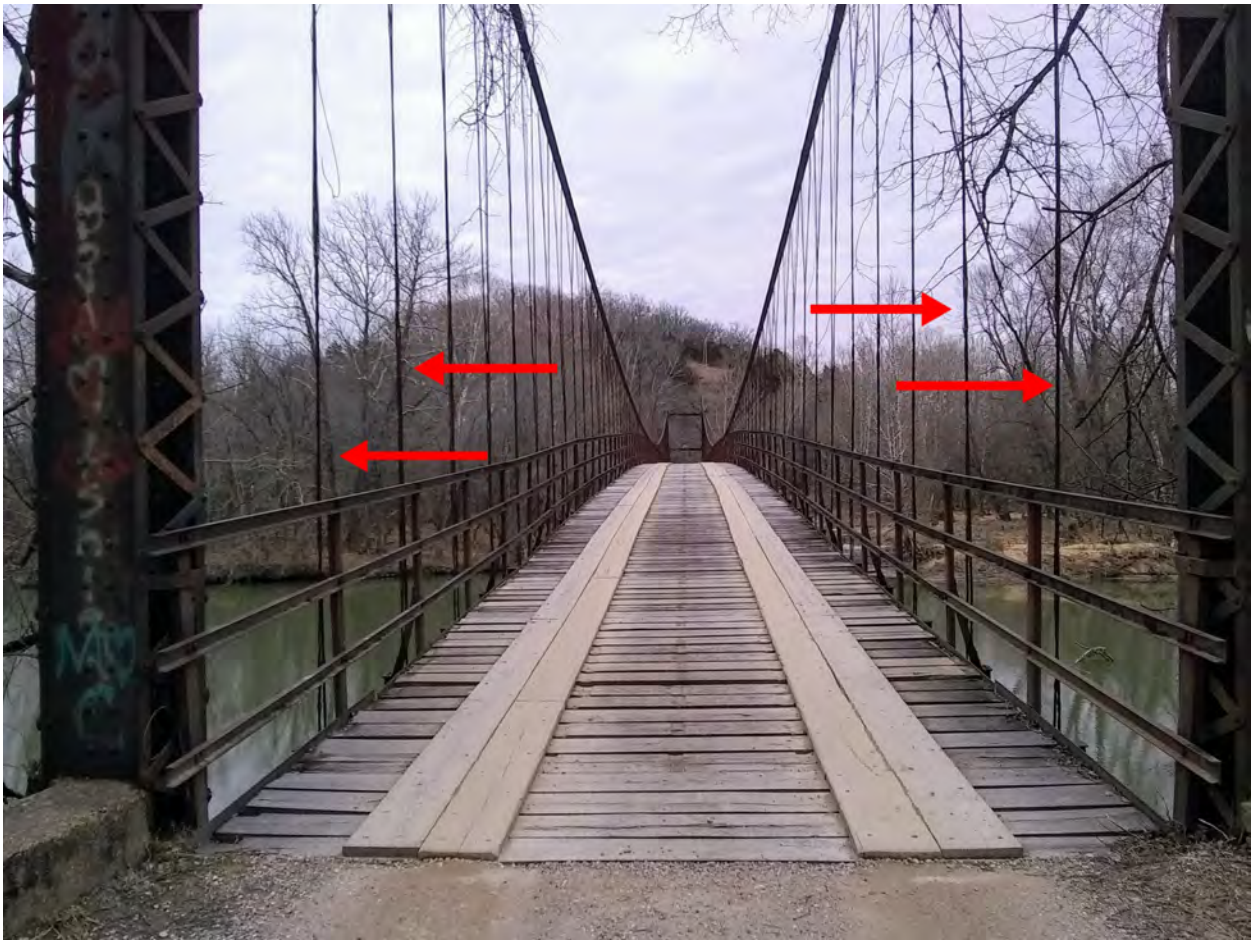


Figure 3 - Hanger Cables, highlighted with red arrows
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

Figure 4 - Floor Beams, with highlighted red arrows
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

Figure 5 – East Tower, with highlighted red arrow
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

Figure 6 - Stringers, with highlighted red arrows
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

Figure 7 - East end of Grand Auglaize Bridge before clean-up (left), East end of Grand Auglaize Bridge after clean-up (right).
Source: Photo taken by Mark Beabout, November 3, 2019

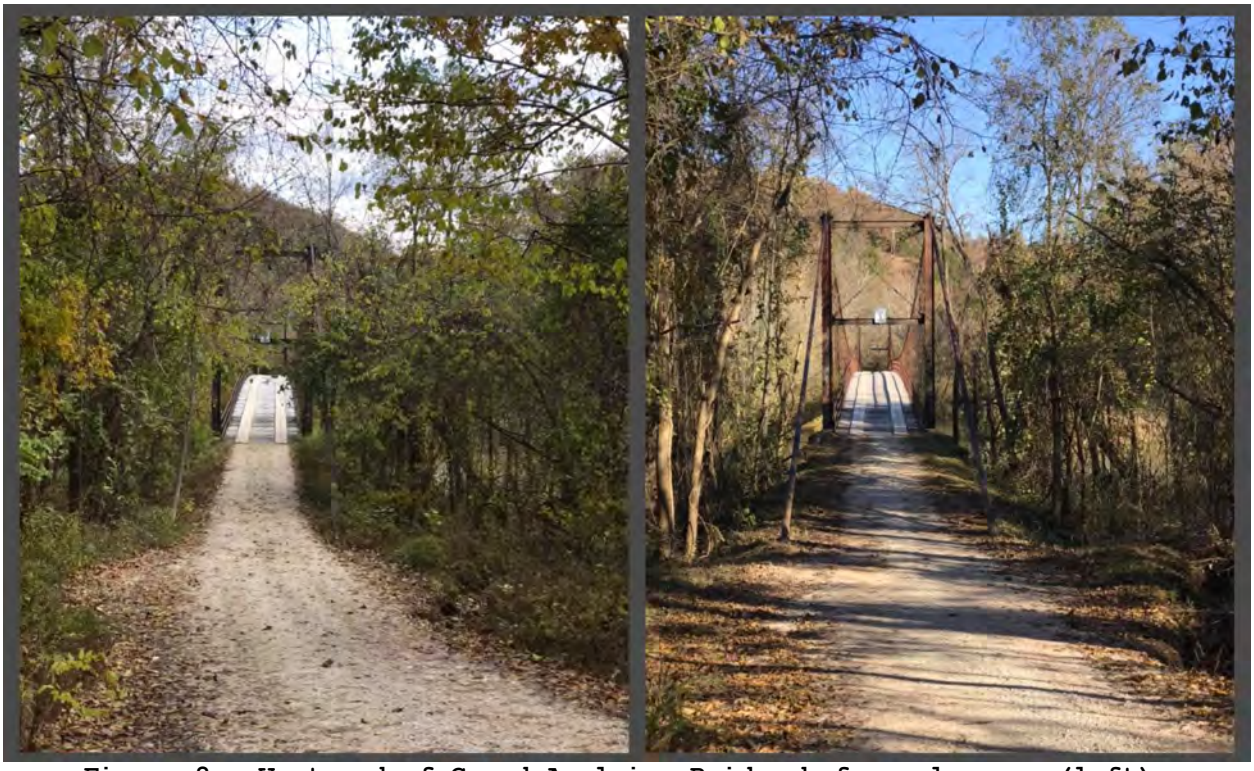


Figure 8 - West end of Grand Auglaize Bridge before clean-up (left), West end of Grand Auglaize Bridge after clean-up (right).
Source: Photo taken by Mark Beabout, November 3, 2019

Figure 9 - Miller County, Missouri; incorporated Brumley, highlighted in red
Source: ArkyBot [User]. "Miller County Missouri Incorporated and Unincorporated areas." Wikimedia Commons. Last modified October 24, 2007. Accessed January 2, 2020. Modified by author April 27, 2020. https://commons.wikimedia.org/wiki/File:Miller_County_Missouri_Incorporated_and_Unincorporated_areas_Brumley_Highlighted.svg

Figure 10 - Lake of the Ozarks State Park boundary, with red star highlighting bridge's location.

Source: Trail Meister. Accessed January 2, 2020. Modified by author January 4, 2020. https://www.trailmeister.com/trails/lake-of-the-ozarks-state-park/

Figure 11 - Mill Creek Bridge (Miller County, Missouri)
Source: Photo taken by Kelly Warman-Stallings, February 15, 2020

Figure 12 - Lake of the Ozarks,
with highlighted red arrow pointing to the Grand Glaize Arm location
Source: Index of /images/geulogy/. Modified by author January 4, 2020.
www.everythingselectric.com/images/geulogy/lake-of-the-ozarks-arkansas-satellite.jpg

Figure 13 – Warsaw Upper Bridge, Benton County, Missouri
Source: Bridgehunter.com. Warsaw Upper Bridge. Historic postcard photo
https://bridgehunter.com/mo/benton/warsaw-upper/

Figure 14 – Tuscumbia Swinging Bridge, Miller County, Missouri
Source: Bridgehunter.com. Tuscumbia Swinging Bridge, July 10, 1929. Missouri State Archives photo. https://bridgehunter.com/mo/miller/tuscumbia-swinging/

Figure 15 – Kemna Bridge, Miller County, Missouri
Source: Bridgehunter.com. Kemna Bridge. Photo taken by James Braughn.
https://bridgehunter.com/mo/miller/kemna/

Figure 16 – Buechter Bridge, Miller County, Missouri
Source: Bridgehunter.com. Buechter Bridge. Photo taken by Joe Virruso.
https://bridgehunter.com/mo/miller/buechter/

Figure 17 – Kliethermes Bridge, Miller County, Missouri
Source: Bridgehunter.com. Kliethermes Bridge. Photo taken by James Braughn.
https://bridgehunter.com/mo/miller/kliethermes/

Figure 18 – Mill Creek Bridge, Miller County, Missouri
Source: Miller County Museum and Historical Society website.
"Bridges of Miller County" article. Photo credit unknown.
www.millercountymuseum.org/bridges.html

Figure 19 – Boeckman Bridge, Miller County, Missouri
Source: Miller County Museum and Historical Society website.
"Bridges of Miller County" article. Photo credit unknown.
www.millercountymuseum.org/bridges.html

Figure 20 – Warsaw Upper Bridge (Benton County, Missouri)
Source: Bridgehunter.com. Warsaw Upper Bridge. Photo taken by Ruth Reynolds. https://bridgehunter.com/mo/benton/warsaw-upper/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