



McClellan-Kerr Arkansas River Navigation System (MKARNS) Mooring Modernization Project

*Better Utilizing Investments to Leverage Development
Transportation Discretionary Grant Application*

Applicant: Oklahoma Department of Transportation (ODOT)

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Supporting information can be found at:

https://www.ok.gov/odot/Progress_and_Performance/Federal_Grant_Awards/BUILD_Grants/2020/MKARNS_Mooring_Modernization_Project.html

BUILD Request Amount: \$21,016,000 (80%)
Local Match: \$5,254,000 (20%)

ODOT Contact:

Matthew Swift, Division Engineer
Strategic Asset & Performance Management
(405) 521-2704
e-mail: mswift@odot.org

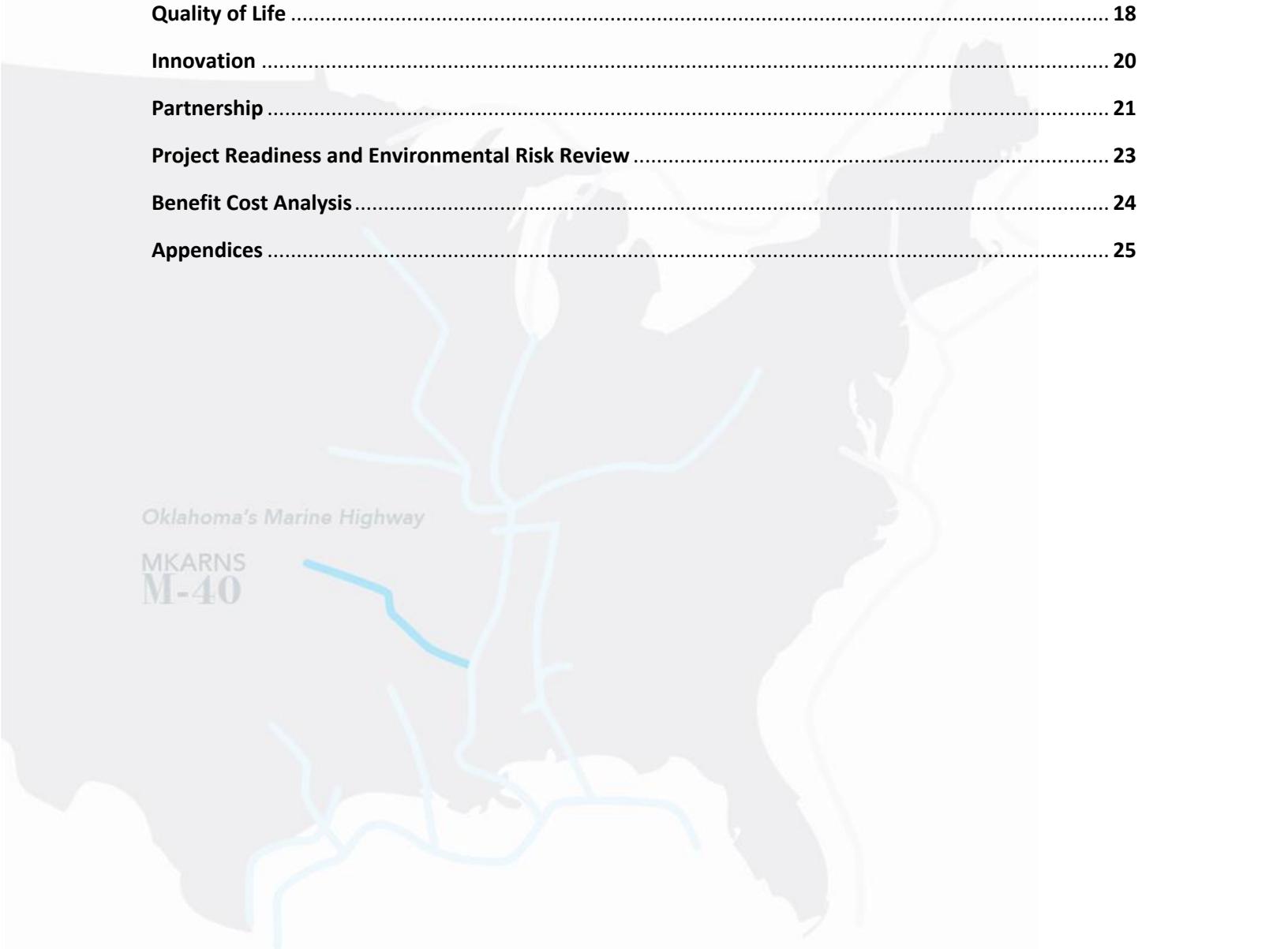


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Oklahoma's Marine Highway

MKARNS
M-40



1 PROJECT DESCRIPTION

The McClellan-Kerr Arkansas River Navigation System (MKARNS) plays a vital role to the regional, state and national economy. It serves as the primary navigable waterway in the State of Oklahoma. The MKARNS waterway originates in northeastern Oklahoma and flows southeast to the Mississippi River. The **MKARNS Mooring Modernization Project** (the Project) will construct monopile moorings in the waterway to **replace obsolete anchors** with a modernized mooring system that will enable safe harbor for mariners, reliability in the event of a flood, and reduce ongoing maintenance costs at the ports.

The Project will replace existing structures which were not designed for the type of major flood events the region has experienced in recent years and enhance harbor safety by eliminating risk of loose barges and damage to infrastructure. The Project will **expand much needed capacity** for vessels within the waterway and prepare ports for forecasted increases in freight demand through the MKARNS.

New mooring infrastructure will be an investment in long-term strength and security for Oklahoma to continue to be a major player in the U.S. and global markets. The MKARNS waterway links Oklahoma to a 12-state service area with various domestic ports of the U.S. inland waterways system and foreign ports by way of New Orleans and the Gulf of Intracoastal waterway.

Oklahoma produces and supplies a variety of products including, but not limited to, agriculture, chemical fertilizers, petroleum, and iron and steel throughout the U.S. and internationally. In 2018,

Oklahoma's waterborne commerce on the MKARNS totaled 5.5 million tons with a value of \$2.1 billion and more than 10.9 million tons traversed the entire MKARNS waterway with a value of more than \$3.5 billion.¹

The primary goal of the Project is to ensure safe and efficient freight movement, protect Oklahoma's road and bridges, and provide long-term vitality of the waterway.

Oklahoma's Marine Highway
MKARNS M-40

The Project will invest in monopile moorings at the Port of Muskogee, Tulsa Port of Catoosa and on the Grand River which will serve Oakley's Port 33. These three ports total 3,100 acres of industrial park, employ nearly 9,000 workers, and process nearly 5.5-6.2 million tons of cargo annually.²

These ports are an important economic engine for the State of Oklahoma, making them a key component of the regional and national freight transportation system. The Project will invest in necessary mooring technologies to preserve the waterway's economic vitality and prepare for future freight traffic demand within the larger U.S. economy. Since the official opening of the MKARNS

in 1971, the Port Authorities and State of Oklahoma have made strategic infrastructure investments to

¹ [Waterway Fact Sheet \(2019\)](#)

² [MAKRNS Update \(2018\)](#)

maintain ports and channel infrastructure in a state of good repair, promote the development of jobs, and improve transportation land access to ports. In order to ensure the MKARNS continues to provide safe, reliable, and productive operation, construction of a new mooring system is required to expand capacity and address freight flow growth, reduce safety risks during flood events, and ensure efficient cargo operations.

The modernized mooring system will create a more permanent, safe and efficient industry standard to secure vessels and will be designed to accommodate normal navigation conditions as well as extreme flooding conditions that have been encountered over the last several years.³ Strategic investment in moorings is vital to shipping of freight and is required to accommodate the forecasted growth.



1.1 CHALLENGES & OPPORTUNITIES

ODOT and Port Partners all agree that this project is top priority for the MKARNS. The Project will:

- **Expand limited capacity at existing ports and prepare the inland waterway for forecasted freight demands;**
- **Reduce safety risks by replacing obsolete anchorage systems;**
- **Protect Oklahoma's infrastructure and economy during flooding events; and**
- **Better maintain a state of good repair in the waterway by minimizing operations and maintenance costs.**

Limited capacity at existing ports

The Project will replace obsolete anchors and simultaneously expand capacity for large and heavy vessels. Existing anchorage structures at port terminals are limited and cannot support the incoming growth of barges and vessels that move freight. Because capacity is limited, some vessels today are deadman anchored along the banks of the waterway which leads to congestion in the waterway. The Project will prepare the MKARNS to better address forecasted freight demand and movement by waterway. **Freight movement by waterway in Oklahoma is forecasted to grow by 35 percent through 2045 and reach 8.5 million of tons in 2045.**

³ [MKARNS Update \(2018\)](#)

Safety risks during flooding events

Historic flooding in 2019 was devastating for ports and industries along the MKARNS of Oklahoma and Arkansas. Prior to 2019, all events were compared to the 1986 flood on the MKARNS which yielded water flows of 375,000 cubic feet per second (cfs), a standard measurement of the volumetric flow rate of water. However, the 2019 flood flows **nearly doubled the 1986 flood reaching flows more than 675,000 cfs**, which led to infrastructure damage.⁴ The current anchorage system has not changed since the inception of the ports and the existing structures were not designed for major flood events.

During the barrage of floodwater flow in 2019, two barges broke loose and floated downstream striking a dam structure before they sank. While the dam structure properly maintained its integrity, obsolete anchoring structures pose a risk to infrastructure in the waterway including dams and bridges. For 2.5 months the MKARNS system was closed because of high water flooding, unsafe water flows and dredging needs. Once the water flow normalized, the system remained closed for an additional 1.5 months while the excavation and salvage of the barges occurred.⁵ The flood event resulted in an immense time delay for the system and highlighted the need for new infrastructure able to withstand future flood events. Complete disruption of operations on the MKARNS costs its beneficiaries **\$2 million per day and a maximum daily loss of \$20.7 million in Gross Domestic Product within the State of Oklahoma.**⁶

In 2002, a barge struck an I-40 bridge pier and the bridge collapsed resulting in **14 deaths, 11 injuries, and \$27 million in bridge reconstruction**. While this situation did not arise from failed anchoring, loose barges during flooding events could result in catastrophic events. Investments in mooring construction will provide a safe and reliable tie down method that is designed to accommodate extreme conditions during significant flooding events. Proper tie down infrastructure will allow the MKARNS in Oklahoma to be prepared to handle potential future flooding events and to support continuous growth on the “marine highway”.

State of good repair

While the MKARNS currently offers strong performance and high reliability, it faces a significant maintenance backlog. **Critical maintenance needs are now approaching \$117 million dollars** on the Oklahoma segment of the MKARNS. Modernized mooring structures will reduce and **nearly eliminate the ongoing operating and maintenance costs** of existing structures.

⁴ [National Waterways Conference \(2019\)](#)

⁵ Cleaning process that takes place to remove debris, mud, weeds or other materials from the riverbed.

⁶ [Regional Economic Impact Study](#).

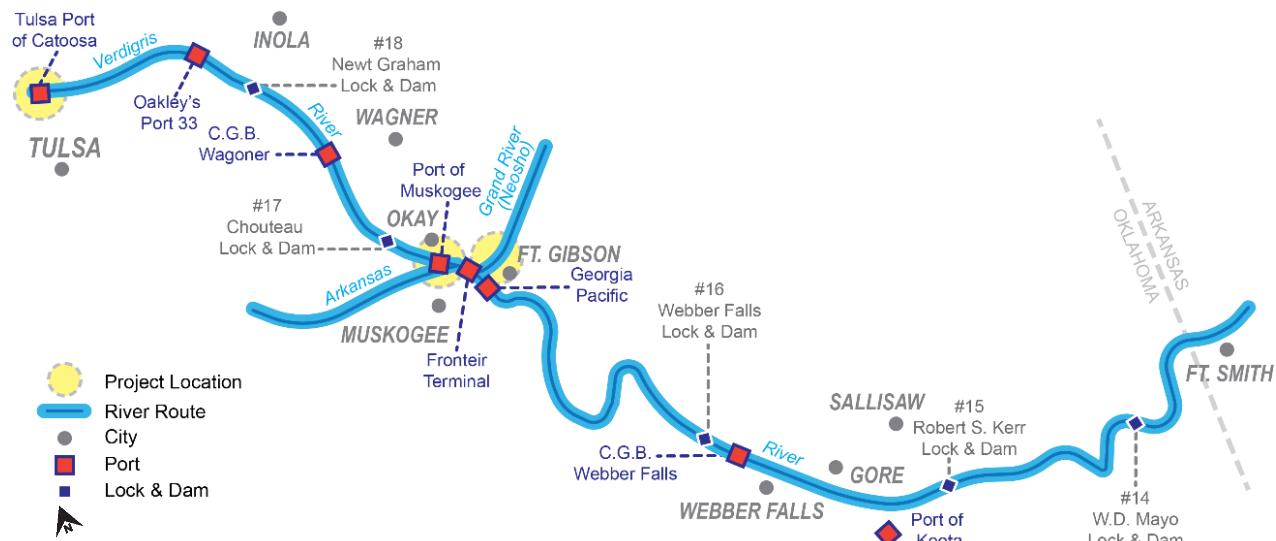
1.2 PROJECT OVERVIEW

The Project and requested BUILD funding will be used to construct monopile mooring structures at three locations: the Tulsa Port of Catoosa, the Port of Muskogee, and in the Grand River to support Oakley's Port 33. The three locations have varied existing structures including deadman anchors and dolphin moorings. Deadman anchors (located at the Grand River location) consist of lines connected to buried timbers or bridge beams which are installed on dry land and buried to make use of earth pressure to resist pull forces. Dolphin moorings in the waterway today (located at the Tulsa Port of Catoosa and Port of Muskogee) consist of a combination of vertical and horizontal "batter" wood piles.

The Project includes the following improvements:

- Tulsa Port of Catoosa – The Project will remove replace 6 dolphin structures with new monopile mooring structures.
- Port of Muskogee – The Project will replace 20 dolphin structures with new monopile moorings.
- Oakley's 33 Grand River Location – The Project will replace 6 deadman anchors with new monopile mooring structures.

FIGURE 1: OKLAHOMA PORTS



The selected design solution for the modernized mooring system will include monopile structures (a steel casing approximately 8 to 10 ft in diameter and approximately 80 to 85 ft in length with a precast concrete superstructure). These will be designed to support moorage of three abreast barge tows at each monopile and are designed for elevations representative of the 2019 flood event. The design solution will also include flow monitoring sensors, corrosion prevention measures, and implementation of a barge tracking system.

1.3 FUNDING REQUEST

The BUILD grant funding request for the Project is \$21,016,000, which includes 6 structures at the Tulsa Port of Catoosa, 20 structures at the Port of Muskogee, and 6 structures in the Grand River used by Oakley's Port 33.

The MKARNS is a unique and vital commercial transportation corridor in Oklahoma. Strategic investment in the Project and waterway network is a priority for Oklahoma. The Oklahoma Department of Transportation (ODOT) is committed to leverage federal dollars with local investment. ODOT will leverage \$5,254,000 million in funding (a 20% percent local match).

TABLE 1: PROJECT FUNDING

Funding Source	\$ Amount (%)
ODOT	\$5,254,000 (20%)
U.S. DOT BUILD	\$21,016,000 (80%)
Total Project Cost	\$26,270,000 (100%)

1.4 PROJECT PARTNERS

The Project boasts numerous supporters including State and Federal Congressional delegation, industry representatives, local business owners, tribal leaders, and other stakeholders. These partners understand the importance of leveraging the “marine highway” as a solution to the congested National Highway Freight Network (NHFN) corridors. Project supporters understand the importance of the Project to the long-term vitality of the MKARNS.

A snapshot of Project partners is shown below and a complete list of project supporters is provided in the Partnership section of the application.

FIGURE 2: PRIMARY PROJECT PARTNERS



Oklahoma Department of
Transportation



Tulsa Port of
Catoosa



Port of Muskogee



Oakley's Port 33

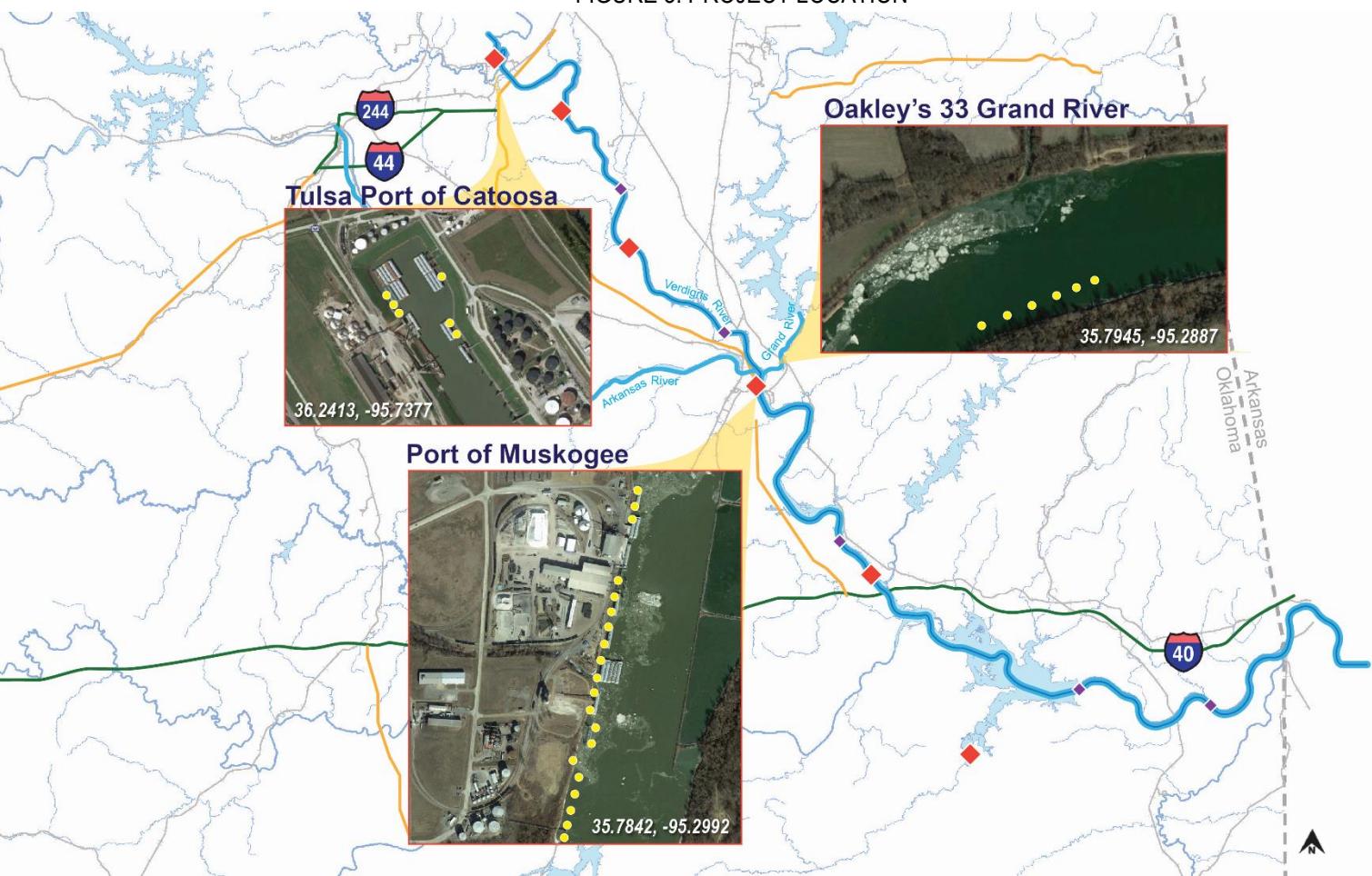


2 PROJECT LOCATION

The MKARNS is 445-mile long marine highway which consists of the Verdigris, Arkansas, and White Rivers. The MKARNS serves a 12-state region and is the most westerly inland ice free waterway system in the Country. As such, the waterway provides access to port terminals to transfer freight from barge to either rail or truck. The MKARNS is synonymous with the Arkansas River in Oklahoma from the Port of Muskogee downstream to the State of Arkansas border. Upstream from the Port of Muskogee, MKARNS leaves the Arkansas River to join the Verdigris River and terminates at Tulsa Port of Catoosa.

The Project will consist of constructing 32 monopile moorings at the Tulsa Port of Catoosa, Port of Muskogee and the Grand River which will serve Oakley's Port 33, all of which are located in Northeast Oklahoma. These three ports include the two largest public ports (Tulsa Port of Catoosa and Port of Muskogee) and the largest private port (Oakley's Port 33) along the MKARNS waterway in Oklahoma. The specific geospatial coordinates of proposed mooring structures are shown in Figure 3.

FIGURE 3: PROJECT LOCATION



The MKARNS Oklahoma segment is adjacent to several “opportunity zones” certified by the U.S. Treasury as economically distressed communities. One Project location, the Port of Muskogee, is located within an opportunity zone (GEOID10: 4010100600). All three Project locations are located in rural areas, outside of urbanized boundaries.

3 GRANT FUNDS, SOURCES, AND USES

The cost to of the project is \$26.2 million. ODOT is committed to leverage federal dollars with local investment. Table 2 shows a complete cost breakdown for each mooring structure and Table 3 shows the total project budget including mobilization and de-mobilization. All obligated BUILD funds would be used for project construction and construction contingency. The table provides a breakdown of sources and uses of funds for each project component. In total, ODOT requests \$21,016,000 million in BUILD funding, 80% of total project costs. ODOT's 20% local match will come from dedicated annual state appropriations.

TABLE 2: MOORING STRUCTURE COST

Item	Quantity	Unit Cost	Total
10 ft Drilled Shaft	80 FT	\$4,375	\$350,000
Pile Tremie Concrete Cubic Yards	296 CY	\$300	\$90,000
Precast Cap Concrete	120 CY	\$500	\$60,000
Grout and Misc. Outfitting	Lump Sum	\$50,000	\$50,000
Rock Anchors / Rock Socket	Lump Sum	\$35,000	\$35,000
Sub Total			\$585,000
30% Construction Contingency			\$175,000
Total Cost Per Structure			\$760,000

TABLE 3: PROJECT COST

Item	Quantity	Unit Cost	Total
Mooring Structures	32 structures	\$760,000	\$24,320,000
Mobilization and De-Mobilization	Lump Sum	\$1,950,000	\$1,950,000
Total Structure Cost			\$26,270,000

TABLE 4: PROJECT FUNDING

Funding Source	\$ Amount (%)
ODOT	\$5,254,000 (20%)
U.S. DOT BUILD	\$21,016,000 (80%)
Total Project Cost	\$26,270,000 (100%)

4 SAFETY

4.1 IMPROVED SAFETY CONDITIONS

The MKARNS opened as an official navigable waterway nearly 50 years ago. Ports constructed near the same time implemented mooring technology, but the anchorage system has remained unchanged since the inception of the ports.

The Project will replace existing obsolete anchorage structures and enhance harbor safety by eliminating risk during extreme weather conditions. Existing infrastructure was unable to safely anchor barges during the recent flood event in Oklahoma in 2019.

Historic flooding in 2019 was devastating for ports and industries along the MKARNS of Oklahoma and Arkansas. The waterway reached river stages, elevations, and flows never previously experienced. The waterway reached more than 675,000 cubic feet per second (cfs). Typically, at Muskogee, flows are about 8,000 cfs under normal conditions.⁷

The existing anchorage system, unchanged since its inception in the early 1970s, is not designed to support recently experienced flows or water elevations.

During the barrage of floodwater flow in 2019, two barges broke loose from the Port of Muskogee and floated downstream. After catching the barges and re-securing the vessels to trees along the soggy riverbank, they broke free again and struck a dam structure at the Webbers Falls Lock and Dam before they sank. The dam structure properly maintained its integrity, but obsolete anchoring structures pose a risk to infrastructure in the waterway.

In total, the damages to the dam structure cost more than \$310,000 in repairs, however, the damage could have been much worse. The Oklahoma community experienced the potential risk to infrastructure when in 2002, a barge struck an I-40 bridge pier. While this situation did not arise from failed anchoring, it illustrates the potential devastating effects that may result from failed mooring structures. The event resulted in 14 deaths, 11 injuries, \$24 million in bridge reconstruction, a 64-day closure of the waterway, and a major impact on freight commerce and travel.⁸



May 2019 flooding near Muskogee

Source: Tulsa World



MKARNS dam near Webbers Falls

Source: The Waterways Journal

⁷ [National Waterways Conference \(2019\)](#)

⁸ [Tulsa World](#)

Hundreds of barges along the MKARNS system were at risk during the 2019 flooding because of deadman anchors and other fixed mooring structures that were up to ten feet below the water's surface.

The existing structures were not designed to withstand flood flows yielded by the 2019 flood event. Existing conditions create potential safety risks if no alternative tie down solution is constructed. There is a risk for future infrastructure collisions, flood damage to port infrastructure, local homes, and potential loss of product to market. Because much of the bulk commodity transported along the MKARNS system includes chemical fertilizer, this poses an environmental hazard to the waterway system for water supply and fish and wildlife that use these rivers as their home.



Port of Muskogee in normal conditions



Port of Muskogee in 2019 flood event

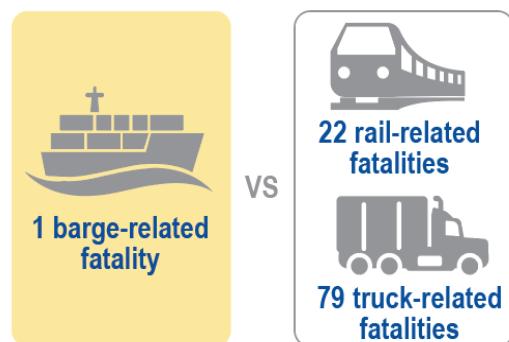
Investments in mooring construction will provide a safe, reliable tie down method that is designed to accommodate forecasted extreme flooding conditions. The design solution also considers detail by the Army Corps of Engineers (USACE) for proper tie down infrastructure on navigable rivers and includes detail to properly secure both loaded and unloaded barges. Modern tie down infrastructure will allow the MKARNS in Oklahoma to be prepared to handle potential future extreme flooding events and to support continuous growth on the “marine highway”.

4.2 CONTINUE TO SUPPORT SAFE MOVEMENT OF FREIGHT

The MKARNS is an integral part of the regional and national movement of freight and goods. By safely moving America’s cargo at the lowest cost, barge transportation plays a vital role to not only the nation’s economy, but in preserving the environment, limiting truck traffic congestion, and reducing safety risks on our nation’s roads.⁹

Inland waterway transportation has a low fatality and injury record compared to rail or truck freight movement. Compared to each barge related fatality, there are 21.9 fatalities related to rail and 79 truck-related fatalities.¹⁰ For each injury involving barge transportation, there are 80 injuries related to rail and 824 truck-related injuries.¹¹ Inland waterways are one of the safest ways to move freight in our nation.

Ratio of **fatalities** in freight transportation



Source: National Waterway Foundation

⁹ [Waterways System](#)

¹⁰ [Sustainability of Barge Transportation](#)

¹¹ [Sustainability of Barge Transportation](#)

4.3 IMPROVED WORKER SAFETY

Monopile moorings will improve worker safety and minimize risk during mooring procedures. Monopile (and dolphin) mooring procedures require less skill and physical force by Captains and deckhands. A monopile mooring will allow Captains to maneuver a barge alongside the mooring structure as the deckhand throws a line around the pipe to secure the barge. This is an easier and safer process than what is required to secure to a deadman anchor which requires the Captain to maneuver the barge towards to the river bank as the deckhand uses a long (approximately 20 ft) pike pole to retrieve a floating cell connected to the deadman anchor cable. The deckhand then must physically pull the cable to the deck to secure the barge. The process to secure a barge using a deadman anchor is physically strenuous for both the Captain and deckhand. During this process the deckhands are the eyes in front of the barge which can also be strained during the night, high wind conditions, or pouring rain.

4.4 EXISTING VANDALISM AND SAFETY CONCERNs

The general public has access to the MKARNS waterway and riverbanks as it is a recreational asset for the community. While many use the waterway for recreation, boating, and fishing, the ports do encounter vandalism, particularly to the deadman anchors which are set on the dry shore. Oakley's 33 has encountered reoccurring vandalism that ruins anchors by burning tires, cutting cables or shooting floating cells. Acts of vandalism cost the ports money and pose a risk to the integrity of the moorings. The monopile moorings will greatly improve the safety and minimize the existing risk posed by deadman anchors on the shore.



5 STATE OF GOOD REPAIR

Each port has its own individual needs, but there is an overwhelming agreement that the single most important priority is to preserve the safe, reliable, and productive operation of the MKARNS itself. While the MKARNS currently offers strong performance and high reliability, it faces significant maintenance backlog. Critical maintenance needs are now approaching \$230 million dollars. Critical maintenance is described by the U.S. Army Corps of Engineers as having a 50 percent chance of failure during the next five years.¹²

Oklahoma freight traffic along the system has fluctuated between 3.8 and 6.2 million tons annually.¹³ In current conditions, barges are moored to either monopile or dolphin moorings with ropes that are secured to keels or bitts on the barge. Deadman anchors are also used to tie down barges with a wire cable. The existing structures do not accommodate current capacity needs, are obsolete during extreme flooding events, and require substantial maintenance and repair in their current condition.

The Tulsa Port of Catoosa completed a replacement study in 2019 which found that **all the evaluated dolphin structures showed signs of deterioration, with some in need of immediate repair or decommissioning.**¹⁴

The existing structures do not meet the standards defined to measure the state of good repair for capital assets as defined in 49 CFR § 625.41. Existing structures are no longer able to perform their designed function and no longer support water flows, elevations, and freight capacities experienced in the waterway today. The use of the existing structures poses an identified safety risk to the waterway and its infrastructure. During flood events, hundreds of barges will be at risk due to failing mooring structures. In addition to extreme events, the existing conditions also cost the ports significant annual maintenance costs.

On an average year without extreme flooding and weather events, ports incur approximately \$9,750 in the annual maintenance of the current mooring systems. Placing newly designed mooring structures at each designated project location will greatly reduce and nearly eliminate ongoing operations and maintenance costs associated with existing infrastructure repairs yielding a reduction of \$6,550 in annual savings. The new mooring structures will have a lifespan of 75 years, thus investing in a long-term solution.



Tower dolphin structure in disrepair at Tulsa Port of Catoosa

¹² [MKARNS Non-Routine Maintenance Items](#)

¹³ [MKARNS Update \(2018\)](#)

¹⁴ [Mooring Dolphin Report \(2019\)](#)

6 ECONOMIC COMPETITIVENESS

The primary goal of the Project is to ensure safe and efficient freight movement, as well as to provide long-term vitality of the waterway. Modernized mooring structures will replace obsolete anchors and ensure the Oklahoma segment of the waterway is prepared for flooding events, today's freight demand, and future projected increases in demand for large and heavy vessels.

6.1 REGIONAL SIGNIFICANCE

There are three Foreign Trade Zones on the MKARNS at the ports of Little Rock, Muskogee, and Catoosa and at least 42 countries have commercial transactions via the MKARNS. In 2015, the waterway changed from a "moderate" to a "high-use" designated waterway which upgraded the "Marine Highway M40" from a "Connector" to a "Corridor" due to its five-year average of more than 3.3 billion-ton miles traveled. As of 2018, the MKARNS waterborne commerce totaled 5.5 million tons.

Oklahoma supplies agricultural products throughout the U.S. and internationally. In total, Oklahoma shipped \$5.4 billion worth of goods around the globe in 2017.¹⁵

The MKARNS and Oklahoma ports provide an efficient flow of goods from production to the U.S. and foreign markets. In addition to Oklahoma-produced goods, surrounding great plain states bring products to the MKARNS for shipment because it is an economical and efficient way to bring goods to market. In 2017, approximately half of the tonnage traversing Oklahoma ports was directly related to Kansas shipments (approximately 2.9 million tons).¹⁶ Top commodities traded on the MKARNS include, but are not limited to, iron, steel, chemical fertilizer, and soybeans.¹⁷

Current maintenance has not kept up with the growing freight demand. Investments in the Project is key for Oklahoma's future waterway growth and economic vitality in the global and national trade market.



Eastern U.S. Marine Highways



MKARNS

¹⁵ [World's Top Exports, Oklahoma's Top 10 Exports](#)

¹⁶ [MKARNS Presentation](#)

¹⁷ [Waterway Fact Sheet \(2019\)](#)

6.2 FLOOD IMPACTS ON ECONOMY

The flood event of 2019 brought record water levels along the MKARNS in Oklahoma. Floodwater flows reached nearly 675,000 cfs (normally 8,000 cfs) and water levels near the Port of Muskogee measured approximately 24 feet above normal (70 feet in total).¹⁸ ¹⁹ During this event, infrastructure designed to secure barges and vessels were up to 10 feet below the water surface causing failure of several mooring structures and leading to two barges breaking free. The barges collided into the Webbers Falls Lock and Dam 16 and sank. Due to heavy flows and high-water levels, it was deemed that the barges would have to remain in place until conditions were safe to retrieve them. The collision with the Dam occurred on May 23rd and salvage crews were not able complete salvage operations and re-open the waterway until September 30th. This four-month closure from May to the September was devastating for the regional and statewide economy. The event cost Oklahoma businesses and industry \$2 million dollars a day and a total of \$20 million in state gross domestic product (GDP).²⁰ Infrastructure investments for this Project are important to prevent future prolonged closures of the MKARNS.

6.3 EFFICIENCIES IN DOING BUSINESS

Waterways provide great cargo capacity and move freight more safely and efficiently than truck or rail. This generates valuable cost savings for businesses and shippers.²¹ If Oklahoma's 5.5 million tons of waterborne commerce were transported by alternative methods, it would require 220,000 trucks or 55,000 railcars respectively.²²

Waterway transportation in Oklahoma helps to save money for farmers, manufacturers and consumers which encourages future growth and trade.²³ The Project will implement new tie down structures to improve efficiency and reduce wait times. With less wait time, shipments will move more efficiently and continue to save time and money for businesses that trade along the MKARNS system. Mooring improvements will sustain a lowered risk factor during extreme weather conditions and allow vessels to remain secured.

Overall, investments in inland river navigation are investments in the long-term strength and security for Oklahoma's economy and preparation for the U.S. to remain competitive in the global goods movement market.²⁴

¹⁸ [Webbers Falls \(2019\)](#)

¹⁹ [National Waterways Conference \(2019\)](#)

²⁰ [Webbers Falls \(2019\)](#)

²¹ [Regional Economic Impact Study \(2015\)](#)

²² [Waterway Fact Sheet \(2019\)](#)

²³ [Waterway Fact Sheet \(2019\)](#)

²⁴ [Waterway Fact Sheet \(2019\)](#)

6.4 LOCAL ECONOMY

Local industries along the MKARNS manufacture bulk commodities that provide direct access to global markets. Oklahoma is a major energy and agriculture producer, as well as a producer of manufactured goods. Northeast Oklahoma is home to the largest Maintenance, Repair, and Operation (MRO) facility in the world used to maintain American Airline airplanes. The facility alone employs more than 6,000 employees while the aerospace and defense industries in Oklahoma employ more than 120,000 employees statewide.²⁵ The aerospace industry is growing in Oklahoma and the manufactured goods needed to maintain this industry is commonly shipped on the MKARNS. The U.S. Chamber of Commerce identifies several essential commodities that are shipped to and from Oklahoma through the MKARNS including electronic products and equipment, agricultural and food products, and basic chemicals.



6.5 FORECASTED GROWTH

The Project's design of mooring infrastructure will allow for storage of empty or full barges at any elevation, including the extreme conditions and elevations experienced in the 2019 flood event. A total of 32 newly constructed moorings will accommodate future growth by increasing the capacity that each mooring structure can hold (number of barges), as well as adding to total mooring structures in the waterway. This Project will prepare the MKARNS for freight demand and movement by waterway, which is forecasted to grow by 35 percent and reach 8.5 million of tons in 2045.

²⁵ Aerospace and Industrial



7 ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability is a priority and a key aspect of goods movement by waterway. Maintaining air quality standards, investing in infrastructure to reduce the risk of loss of goods and improving congestion related emissions at each port will further improve the quality of life for regional economies. The Project provides improvements to ensure the long-term vitality of the waterway, ports, and mooring system, which will maintain efficient flow of freight, protect hydropower investment, and reduce risk to flood protection infrastructure.

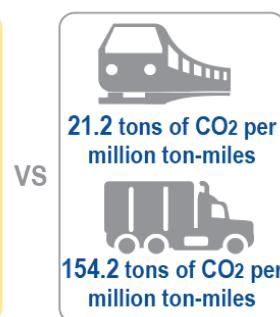
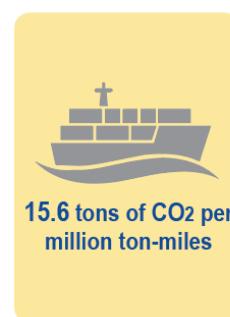
7.1 EFFICIENT GOODS MOVEMENT WITH REDUCED EMISSIONS

Use of waterway freight movement is the most energy efficient and least damaging mode of transportation for the environment.

- **More energy efficiency per gallon of fuel.** Transporting freight by water is the most energy efficient choice. Barges can move one ton of cargo 647 miles per gallon of fuel. A rail car would move the same ton of cargo 477 miles and a semi-truck only 145 miles.²⁶
- **Small carbon footprint.** Barges have the smallest carbon footprint among other modes including rail and truck. To move an identical amount of cargo by rail generates 30 percent more carbon dioxide, and 10 times more emissions by trucks.²⁷
- **Fewer vessels or vehicles required.** To fill one barge full of dry commodities it would require an equivalent of 15 jumbo rail cars or 60 large semi-trucks.²⁸
- **Reduced emissions and air pollution.** Towboats emit 35 to 60 percent fewer emissions than locomotives or trucks which aids in decreased pollution.²⁹

The Project will replace and expand mooring capacity, thus reducing vessel idling time and mooring efficiency. This will further improve the efficiency of the waterway. Investing in the Project will further encourage use of barges for the transport of goods and contribute to sustainable outcomes including reduced fuel consumption, reduced carbon emissions and pollutants, and improved air quality.

Barges have the **smallest carbon footprint** among other transportation modes



Source: National Waterway Foundation

²⁶ [Sustainability of Barge Transportation](#)

²⁷ [Sustainability of Barge Transportation](#)

²⁸ [Waterway Fact Sheet \(2019\)](#)

²⁹ [Waterway Fact Sheet \(2019\)](#)

7.2 FLOOD PROTECTION

The MKARNS is a multi-beneficiary system that includes water supply, navigation, fish and wildlife, recreation, hydropower generation, and flood control. The MKARNS is part of the Arkansas River Basin which includes upstream reservoirs that control when and how water flows. It is estimated that flood damages prevented by the Arkansas River Basin (under control of the U.S. Army Corporation of Engineers Tulsa District) totaled roughly \$525 million in 2016. Cumulative damages prevented through 2016 equate to an estimated \$14.9 billion.³⁰ Ensuring safe mooring for vessels in the waterway will minimize risk to flooding control infrastructure along the waterway.

Monitoring systems will also be considered with this Project to provide information on river elevation, flow rates, and remote camera surveillance of the area.

7.3 RIVERBED PROTECTION

Deadman anchor construction (and repair) requires digging holes along the riverbank to place buried steel beams and timbers. Cables are attached to the foundations which are used as ties for barges and vessels. The monopile moorings implemented for this Project will be constructed in the river and eliminate further disturbance to the riverbank at the Grand River location of the Project. The Project will eliminate the need to disturb the shore line and riverbank during routine maintenance, repair, or replacement.

7.4 RIVERBANK STABILITY

The Project will improve the riverbank stability by removing the deadman anchors as the existing Grand River location. Deadman anchors can lead to riverbank erosion as cables dig into the shore soil and as tension shifts or vibrates the anchor over time. Deadman anchors also require more maintenance and have a shorter design life compared to the proposed monopiles. Continual repair, maintenance, and replacement of deadman anchors produce greater erosion overtime as compared to the proposed design solution.

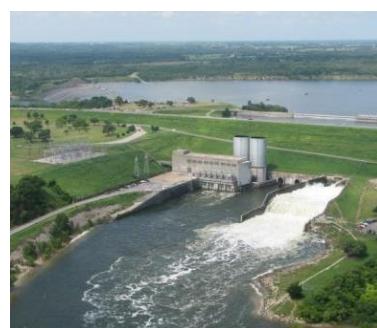
³⁰ [Waterway Fact Sheet \(2019\)](#)

7.5 CLEAN ENERGY

The Oklahoma segment of the MKARNS includes two hydropower plants with a total of 7 power generating units. In 2018, these units provided clean energy and power to approximately 636,500 end users.³¹ If the MKARNS were to become inoperable, the hydropower plants would have to be replaced with alternative natural gas plant(s). A study completed in 2015 describes the impacts that would occur if the hydropower facilities ceased operations:

- Sales would decrease by \$474 million;
- Nearly 3,000 full time and part time jobs would be lost;
- Business tax incomes would decrease by \$21 million and;
- National Gross Domestic Product (GDP) would decrease by nearly \$250 million

This highlights the importance of investments to ensure the MKARNS remains in a state of good repair.³² Minimizing risk to infrastructure in the waterway, including hydropower facilities, is a key benefit of modernized mooring infrastructure investment.



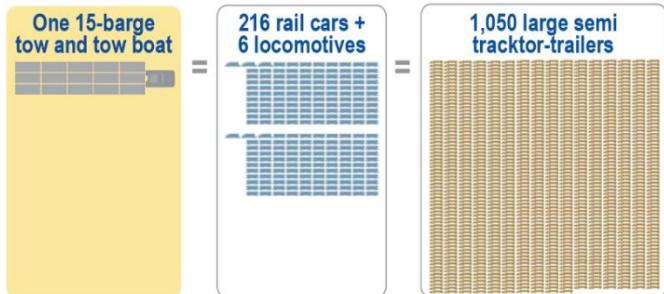
³¹ [MKARNS Update \(2018\)](#)

³² [MBTC Final Research Report](#)

8 QUALITY OF LIFE

8.1 IMPROVED TRANSPORTATION FOR INDIVIDUALS

Waterway is an efficient way to move large amounts of freight. It would take the equivalent of 15 jumbo rail cars or 60 large semi-trucks to carry a comparable amount dry commodities of one barge.³³ Efficiencies in waterway travel on the MKARNS allow lower shipment prices (approximately 15 percent), and thus identifies waterway freight movement as the preferred method over rail or truck.



Source: National Waterway Foundation

If Oklahoma's 5.5 million tons of waterborne commerce were transported by an alternative method, it would require 220,000 trucks or 55,000 railcars respectively.³⁴ This would be not only require more energy and generate more emissions, but it would also vastly change the local roadway transportation network for residents in the surrounding rural areas and Tulsa metropolitan area. Additional trucks alone would increase traffic and congestion on the network and potentially increase injuries and fatalities from crashes.

Investments in the Project will enhance mooring structure capabilities in the waterway to ensure that tie off structures can continue to support this competitive system in Oklahoma and continue to lessen truck traffic on the roadway.

8.2 ACCESS TO ENERGY AND WATER SUPPLY

The MKARNS in Oklahoma benefits approximately 636,500 end users by supplying them with clean hydropower energy. There are two hydropower plants in Oklahoma that include a total of seven power generating units.³⁵ Hydroelectricity qualifies as clean energy because its uses running water to produce electricity. Hydroelectricity is a key contributor to residents and businesses located in the Project area because it provides efficient, low-cost electricity to users. Hydroelectric plants have created numerous lakes that serve as storage vessels for 50 Oklahoma municipal water systems and rural water districts.³⁶

On a national scale, Oklahoma generated more than one-third (36%) of its electricity from renewable sources in 2019. Most of this power is generated via wind energy, but the other renewable contributors included hydroelectric and solar energy.³⁷ Operability of the MKARNS system is vital for Oklahoma's hydroelectric plants to be able to continue to provide for local users that rely on electricity supplied from these plants for their work, homes, and other needs. This Project will ensure that the vessels that use this waterway daily can be safely secured and harbored in the event of a severe flood or storm to reduce risk of damage to hydroelectric facilities.

³³ [Waterway Fact Sheet \(2019\)](#)

³⁴ [Waterway Fact Sheet \(2019\)](#)

³⁵ [MKARNS Update \(2018\)](#)

³⁶ [Grand River Dam Authority \(2019\)](#)

³⁷ [Oklahoma Energy Estimates](#)

8.3 JOBS AND LOCAL RURAL VITALITY

In addition to keeping costs low for goods at market, the waterway is also an important contributor to jobs in the surrounding rural areas. Tulsa's Port of Catoosa has more than 3,000 employees in an industrial park with 70 facilities that primarily include manufacturing, distribution and goods processing companies.³⁸ The Port of Muskogee employs approximately 2,500 people and provides extensive rail service to its users. In addition, Oakley's Port 33 is a privately-owned port located in Catoosa. Oakley's Port 33 handles over 2.7 million tons of dry bulk annually.³⁹ The efficiency and ability to safely access these ports for freight movement is vital for the neighboring communities and economic development of the state.

In total, the Oklahoma MKARNS segment and ports support more than 11,800 jobs and directly contribute \$1.6 billion to Oklahoma's economy.⁴⁰ Of that estimated \$1.6 billion, approximately \$812 million is from direct business revenue, \$656 million is through personal income, and \$144 million is through local purchases.⁴¹

Total Revenue Impact:	=	Direct Business Revenue:	+	Personal Income:	+	Local Purchases:
\$1.6 Billion		\$812 Million		\$656 Million		\$144 Million

The Project will aid in the ability for the ports to continue to provide jobs in this industry as well as encourage outside markets to use Oklahoma Ports for trade. Support of jobs, and investing in freight movement that is low cost, transports more, and continuously maintained will continue to contribute to overall quality of life in the region.

8.4 EFFICIENT MOVEMENT OF GOODS WITH REDUCED COSTS

Goods movement is essential for creating a high quality of life. Communities cannot thrive without effective movement of goods. An efficient transportation system and freight network is vital to Oklahoma and supports the region's economic development.

Waterways provide significant cargo capacity and move freight more safely and efficiently than truck or rail. This generates valuable cost savings for businesses and shippers.⁴² Waterway transportation in Oklahoma helps to save money for farmers and manufactures, which in turn saves money for consumers.⁴³ The Project will implement new tie down structures to improve efficiency and further support investment in the waterway which will help keep costs low for energy, manufactured goods, and food for everyday U.S. consumers. The Project will aid in continuation of the state's economic growth and ability to compete with the country wide market.

³⁸ [Tulsa Port of Catoosa](#)

³⁹ [Oklahoma LRTP \(2015-2040\), Section 6.6](#)

⁴⁰ [MKARNS Update \(2018\)](#)

⁴¹ [Waterways Work](#)

⁴² [Regional Economic Impact Study \(2015\)](#)

⁴³ [Waterway Fact Sheet \(2019\)](#)

9 INNOVATION

Maintenance needs along the waterway system in Oklahoma have continued to grow in value as infrastructure becomes obsolete or nears the end of its design life. The Project will include innovations in corrosion protection systems and precast concrete structures which together will reduce capital and maintenance costs and increase safety. The use of these innovations methods and how they will each be incorporated into delivery of the Project is highlighted below.

9.1 CORROSION PROTECTION SYSTEMS

The Verdigris River and The Arkansas River cross one another southeast of the Port of Muskogee. The Arkansas River flows are stronger than that of the Verdigris River and can speed up the deterioration process of infrastructure. To achieve a 50-year design life, corrosion protection systems will be considered during preliminary design for mooring structures to counteract damage that could be caused by each river's chemistry. Corrosion protection coatings that will be considered include polypropylene cladding along with active and passive anode protection.

9.2 PRECAST CONCRETE

Precast concrete is a method of casting concrete structures using a reusable form and cured in a controlled environment. The structures are then transported and placed at the construction site.⁴⁴ Use of precast concrete streamlines the construction process and often reduces costs. Concrete is the ideal material for this Project because it provides long-term performance in each river environment.

9.3 RIVER MONITORING & TECHNOLOGY

Powered monopiles can support remote operated cameras including infrared monitors. The project will deploy a combination of waterway flow monitoring devices and technologies including lights, river gauge monitors, signage and other instrumentation. Lights and signage will increase waterway safety and waterway monitoring will improve information communications and awareness for port operators. Infrared remote cameras will increase safety and awareness of anchored vessels during extreme weather conditions and at night, particularly at the Grand River location.

9.4 VESSEL TRACKING TECHNOLOGY

The Project will implement GPS tracking technology, building on previous pilots in the waterway. GPS tracking of vessels will use GIS software for real time display of vessel locations. This technology can also enable automated alarms when vessels enter or leave specified geographic regions. This technology will further ensure navigational safety and security, especially in poor weather conditions.

⁴⁴ [American Concrete Institute](#)

10 PARTNERSHIP

ODOT and the Port Partners involved in this project including the Tulsa Port of Catoosa, Port of Muskogee, and Oakey's Port 33 are committed to improving infrastructure conditions along the MKARNS to provide increased safety, reduced maintenance costs, and ensure operability of the waterway. ODOT has and will continue coordinating with the U.S. Army Corp of Engineers as their involvement and input will be key in successful delivery of this Project. The Tulsa District of USACE has provided a letter in support of the Project which identifies that the Project directly aligns with their mission to support and improve commercial navigation on the MKARNS, and that the Project enhances their ability to succeed in their mission.

ODOT and the Port Partners work closely with regional organizations and local municipalities, businesses and freight stakeholders. More than a dozen entities have shown their support for the project by providing letters of support. This includes the regional planning agency, Oklahoma Chamber of Commerce, USACE, local municipalities, and various industry stakeholders. The Project is also strongly supported by the nearby Indian Nations. The Port of Muskogee is located within the historic tribal boundaries of the Cherokee and Muscogee (Creek) Nations. The Cherokees, in fact, own the bed and banks of the Waterway and in 1985, the Port entered into a riverbed use agreement which authorized use of the riverbed property. Letters of Support can be found in the Letters of Support section on the [Project website](#).

TABLE 5: PROJECT PARTNERS

Project Partners					
 OKLAHOMA DEPARTMENT OF TRANSPORTATION	 TULSA PORT OF CATOOSA	 PORT OF MUSKOGEE	 OAKLEY PORTS	Oakley's Port 33	
Oklahoma Department of Transportation	Tulsa Port of Catoosa	Port of Muskogee			
Congressional Delegation					
					
U.S. Senator Jim Inhofe	U.S. Senator James Lankford	U.S. Representative Frank Lucas	U.S. Representative Tom Cole	U.S. Representative Kevin Hern	U.S. Representative Markwayne Mullin
Indian Nations					
Creek Nation • Cherokee Nation • Chickasaw Nation					

To take best advantage of economies of scale, ODOT will coordinate and let the project for all three port locations. ODOT will enter into contractual agreements with each of the Port Partners. Upon completion of construction, each respective Port Partner will take over operations and maintenance of the new mooring structures in perpetuity.

10.1 ODOT'S COMMITMENT TO WATERWAYS

The importance of the MKARNS to Oklahoma's economy is undeniable. ODOT and the Arkansas Waterways Commission jointly worked on a Regional Economic Impact Study that was conducted by the University of Arkansas Little Rock, Oklahoma State University and the University of Arkansas Mack-Blackwell Rural Transportation Center in Fayetteville. The study illustrates the estimated economic impact of the MKARNS to not only Oklahoma's and Arkansas' economies, but also the nation.

Due to the commitment of the Department to support the ports and the freight and shipping opportunities that are provided for the state, numerous transportation system improvement projects have been completed and are scheduled in their vicinities. Since 2000, the Department has awarded 186 contracts, including right-of-way and utility relocation efforts, totaling in excess of \$621.4 million within a 10-mile radius of the Port of Catoosa and Oakley's Port 33. Further, within that same area an additional 40 projects totaling nearly \$266 million are scheduled for award in FFY 2019 through 2026, of which \$240.3 million are included in the 8 Year Construction Work Plan. Similarly, since 2000, the Department has awarded 53 contracts, including right-of -way and utility relocation efforts, totaling almost \$100.7 million within a 10-mile radius of the Port of Muskogee. An additional 22 projects totaling over \$147.3 million are scheduled for award in FFY 2019 through 2026, of which \$125.1million are included in the 8 Year Construction Work Plan for that same area.

Port of Catoosa & Oakley's Port 33



Awarded Projects (since 2000)

\$621,448,497

Port of Catoosa & Oakley's Port 33



Active Projects (between 2019 and 2026)

\$266,020,573

Port of Muskogee



Awarded Projects (since 2000)

\$100,693,820

Port of Muskogee



Active Projects (between 2019 and 2026)

\$147,383,800

11 PROJECT READINESS AND ENVIRONMENTAL RISK REVIEW

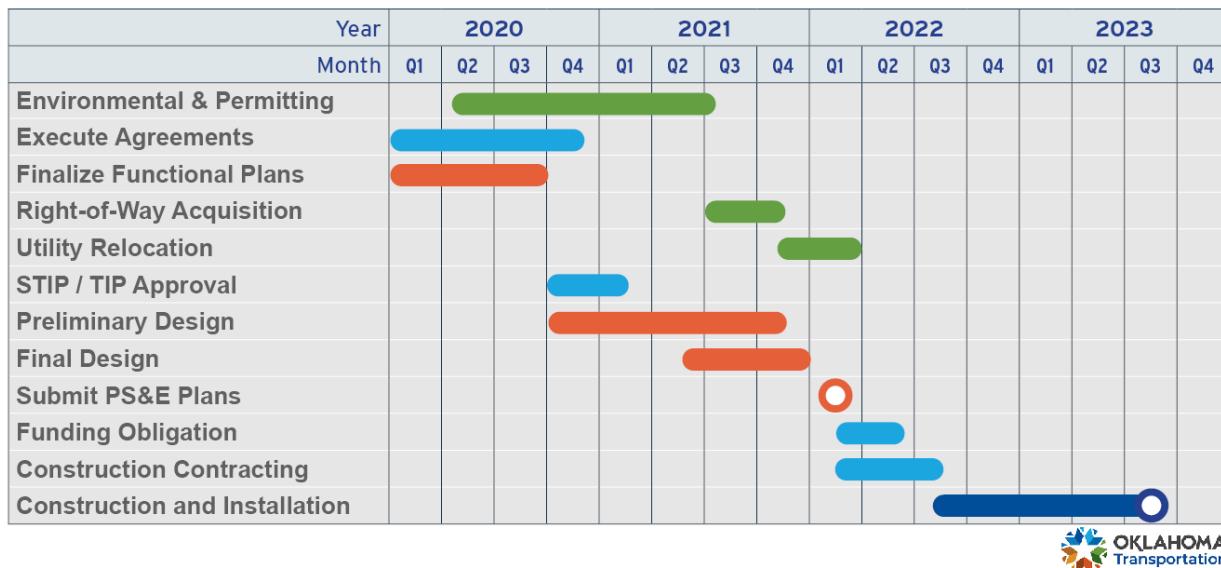
11.1 TECHNICAL FEASIBILITY

ODOT and its partners have extensive experience in the MKARNS waterway. The technical feasibility of the monopile design is evidenced by decades of use on navigable rivers in the United States for mooring barges near bridges, locks, and dams. Monopiles have performed under high flow conditions and flood conditions at sites across the nation. Design of the monopiles will be in conformance to USACE engineering standards for navigation and flood risk reduction structures. The standards for design from the USACE include provisions and standards for safe design of the line hooks and check posts, corrosion protection, and the uncertainty of hydraulic loads. USACE has guidance in the form of Engineering Manuals (EM's) that will be used for foundation design and reinforced concrete design of the monopiles. The engineering standards for design will include USACE publication EM 1110-2-2906 Design of Pile Foundations, EM 1110-2-2104 Design of Hydraulic Concrete Structures, and EM 1110-2-1604 Hydraulic Design of Navigation Locks.

11.2 PROJECT SCHEDULE

A detailed project schedule that includes all major project milestones has been prepared anticipating BUILD funding. The high-level project implementation schedule for the Phase 1 Mooring Modernization Project is shown in Figure 4.

FIGURE 4: PROJECT SCHEDULE



The schedule includes sufficient time to complete all reviews and approvals for BUILD funds to be obligated by the statutory deadline (September 30, 2022). Additionally, the schedule allows for construction to begin quickly upon obligation of funding with funds expended well in advance of the September 30, 2027 deadline. The project schedule will sufficiently accommodate all environmental reviews and permitting, state and local planning approvals, final design, and construction.

12 BENEFIT COST ANALYSIS

The Project boasts a strong benefit-cost ratio (**BCR**) of **3.17** and an **internal rate of return of 10.79 percent**. At this rate, the proposed **total capital project cost of \$26.27 million** (2018\$) will produce a **positive net user benefit of about \$52.85 million (NPV)** over 20 years.

The Benefit Cost Analysis (BCA) shows that the Project will significantly improve safety, reduce operations and maintenance (O&M) costs overtime, and provide economic benefits to the region. Over the life of the Project, investment will produce the following benefits:

- **Operations & Maintenance \$70,300 net present value (NPV)**
- **Increased Safety \$24.4 million (NPV)**
- **Economic Benefits \$15,300 (NPV)**
- **Environmental Protection \$28.3 million (NPV)**

Barge travel, as noted previously, is an incredibly safe and efficient way to move goods. If the Project is not constructed, the MKARNS risks a loss of barge capacity due to degraded mooring structures. Under this assumption, diverted goods (either to rail or truck) incur additional safety costs (crashes) and spillage.

The BCA was prepared in accordance with the 2020 FHWA BCA Guidance for Discretionary Grant Programs. Additional detail on the BCA methodology and results is located on the [project website](#).

13 APPENDICES

Additional Project resources are included on the project website at:

https://www.ok.gov/odot/Progress_and_Performance/Federal_Grant_Awards/BUILD_Grants/2020/MKARNS_Mooring_Modernization_Project.html

Specific items referenced in the application and uploaded onto the project website include:

- MKARNS Inland Waterway Fact Sheet (2019)
- ODOT MAKRNS Update (2018)
- National Waterways Conference Celebrating 200 Years of History and Soul (2019)
- Waterways System an Inland Marine Highway for Freight
- Tulsa Port of Catoosa Dolphin Removal and Replacement Study (2019)
- Mack-Blackwell Rural Transportation Center (MBTC) Economic Impact Study for the MKARNS (2015)
- Sustainability of Barge Transportation
- Oklahoma's Top 10 Exports (2020)
- McClellan-Kerr Arkansas River Navigation System Presentation (2019)
- Barge Wreckage Recovered from Webbers Falls L&D 16 (2019)
- Economic Impact of the Aerospace Industry
- MBTC 4001 – Regional Economic Impact Study for the McClellan-Kerr Arkansas River Navigation System
- Grand River Dam Authority (GRDA) and the Benefits of Hydroelectricity (2019)
- Oklahoma: State Profile and Energy Estimates (2020)
- Tulsa Port of Catoosa Website
- Oklahoma Long Range Transportation Plan (LRTP) 2015-2040
- Waterways Work for Oklahoma
- American Concrete Institute (ACI) – Definition of Precast Concrete
- MKARNS Non-Routine Maintenance Items