GRAND RIVER DAM AUTHORITY

SH 28 BRIDGES OVER PENSACOLA DAM AND AUXILIARY SPILLWAYS

GRDA CONTRACT 41806

Mayes County, Oklahoma

NBI No. 27569, 29642 and 29645

Supplemental Report to the Preliminary Design Report

BENHAM a Haskell Company

Original Report Issued December 2017

July 18, 2018

SUPPLEMENTAL REPORT

to the

December 22, 2017

PRELIMINARY DESIGN REPORT

SH 28 Bridges over Pensacola Dam and Auxiliary Spillways

GRDA Project Number 41806

Benham Project Number 1400204

Prepared for the

GRAND RIVER DAM AUTHORITY

Grand River Dam Authority

JULY 18, 2018

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SH 28 Bridges over Pensacola Dam and Auxiliary Spillways

Supplemental Report to the Preliminary Design Report

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EXECUTIVE SUMMARY

This report supplements the December 2017 Preliminary Design Report, detailing the decisions made by GRDA in coordination with ODOT, the impact of those decisions, and the direction of the project towards completion.

The Preliminary Design Report was issued in December 2017, after review and discussion of the draft report with ODOT Personnel. The Preliminary Design Report evaluated the existing condition of the three bridges located on SH 28 over Pensacola Dam and Spillways, and summarized measures that could be taken by GRDA to rehabilitate the structures. The report additionally investigated the possibility of adding approximately 4 feet of clear roadway width to the existing 19'-8" wide driving surface to provide two full 12-foot lanes between curbs. Three scenarios of providing additional width were investigated for feasibility: widening to the downstream side of the bridges, widening to the upstream side of the bridges, and widening to both sides of the bridges. These alternatives were reviewed for constructability, historic preservation and cultural resources aspects, preliminary stability and strength analysis for impacts of widening to the supporting dam, and construction sequence and traffic control. A plan for funding the widening was also incorporated into the report. After consideration of these analyses and recommendations, GRDA selected Widening Alternate 1 (hereafter denoted "widening"), widening the bridges to the downstream side. This is the most cost-effective means to widen the existing bridges, avoiding impacts to the operations of the dam and spillway gates, and preserving the features observable from the lake. See Appendix A for updated widening exhibits.

GRDA's widening and rehabilitation project pairs well with a deck rehabilitation project that ODOT is undertaking on the same three bridges. Upon further discussion, GRDA and ODOT agreed to proceed with the two projects remaining as separate plans, but bid jointly under ODOT's letting system as mandatory tied projects. Tying the projects together minimizes impacts to the highway users and communities as well as minimizing costs. The two agencies hosted a Stakeholder meeting held in October 2017, to present the initial plan for rehabilitation and widening, and to better understand the needs and concerns of the adjoining communities.

A coordination meeting was held in January 2018 regarding concerns about the extent of deck deterioration and how to mitigate and plan for the potential effects of advanced deterioration on the two projects. Preliminary 30% and 60% plans for the rehabilitation and widening were prepared and reviewed jointly by GRDA and ODOT in the spring of 2018. Between these two submittals, ODOT arranged for a hydro demolition and overlay expert to visit the site and to present the recommended process to GRDA, ODOT and the consultants preparing the plans. Following this meeting, GRDA and ODOT concurred that the sequence of construction and rehabilitation should be widening first, followed by hydrodemolition of the existing deck with asphalt overlay. Further, the mile-long Pensacola Dam Bridge will be closed for 9 months during

the season between Labor Day and Memorial Day to minimize impacts to the communities and their revenue. The remainder of construction duration will be completed with a minimum of one lane open at all times. Minutes from these meetings are included in Appendix B of this supplemental report. Comments from these meetings were incorporated into a set of 60% Rehabilitation and Widening Plans, issued June 29, 2018.

Generally, portions of the December 2017 report that are still current are not included in this supplemental report; however, the “Project Description” and “Description of the Main Sections of the Bridges and Dam” with minor updates are included for convenience.

PROJECT DESCRIPTION

The purpose of this project is to extend the life of three bridges located on SH 28 over the Grand Neosho River in Mayes County, Oklahoma. The bridge structures cross the Pensacola Dam and the West and East Spillways, which were constructed in 1940. Significant rehabilitation and strengthening is needed for the bridges to continue serving the needs of the Grand River Dam Authority (GRDA), the Oklahoma Department of Transportation (ODOT), and the adjoining communities. GRDA and ODOT are committed to restoring the integrity of the aging structures and are coordinating efforts to minimize the impacts of the rehabilitation to the stakeholders.

Figure 1 shows the site and location of the three bridges, the Pensacola Dam Bridge and the West and East Spillway Bridges. The Pensacola Dam Bridge is shown in red, and is divided into three distinct sections: the Arch Section, the Main Spillway Section, and the Non-Overflow Section. The overall length of the Pensacola Dam Bridge is 5669 feet. The West and East Spillway bridges are shown below in orange, and extend 451 feet and 410 feet in length, respectively. The West and East Spillway Bridges are similar in nature to the Main Spillway Section of the Pensacola Dam Bridge, but are not as tall.

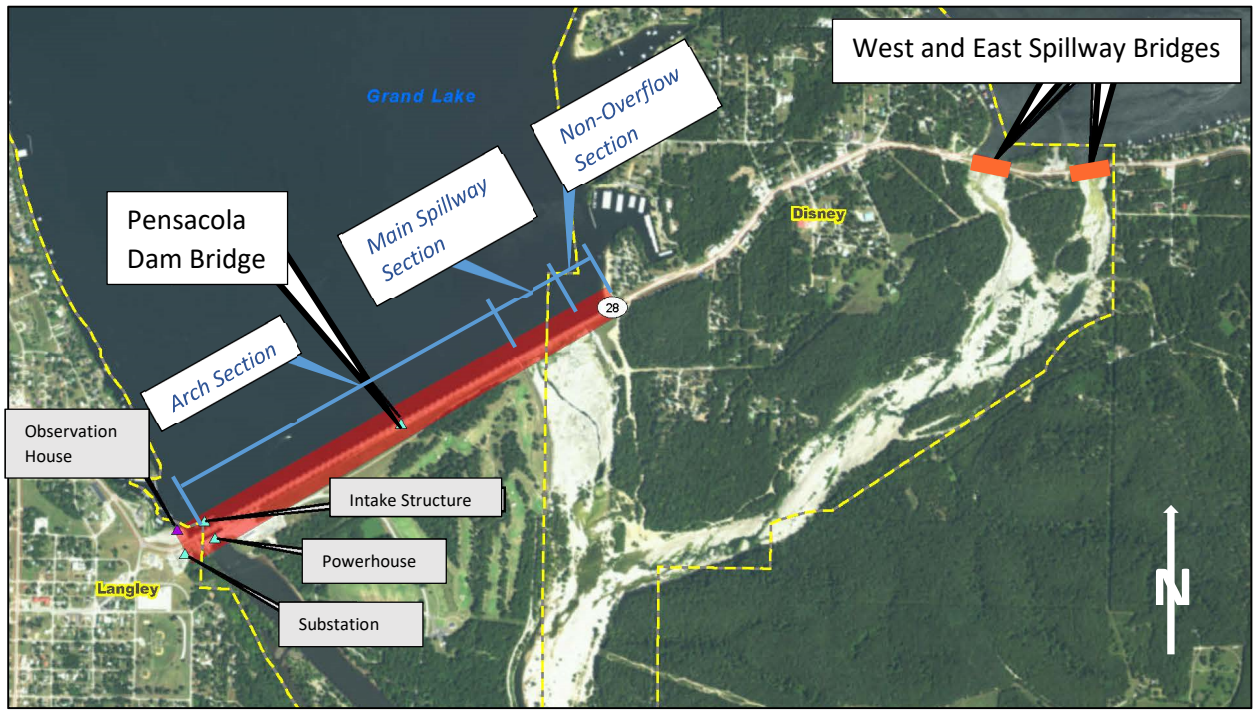


Figure 1. Aerial View of Pensacola Dam and Spillways

GRDA and ODOT share responsibility for the maintenance of the three bridges. ODOT maintains the driving surface of the bridges between the curbs. GRDA owns and maintains the remainder of the bridges, dam, and spillways; and is responsible for operating the hydroelectric powerhouse.

GRDA and ODOT have designated funds for the rehabilitation of the three bridges, with construction scheduled for late 2019. GRDA has allocated $10 million for the bridge rehabilitation project, and ODOT has programmed $5 million for deck rehabilitation. A BUILD Grant request is being made for $14.3 million for widening of the three structures, and a portion of rehabilitation costs that are not currently funded by GRDA.

As shown in Figure 2, the existing lanes are 9'-10" wide, for a roadway width of 19'-8". The agencies desire to widen the roadway surface of the three bridges to 24' wide if suitable grant(s) or other funding mechanisms can be acquired to finance the widening. Updated Detailed Construction Cost Estimates for Widening and Rehabilitation and for Rehabilitation only are provided in Appendix C.

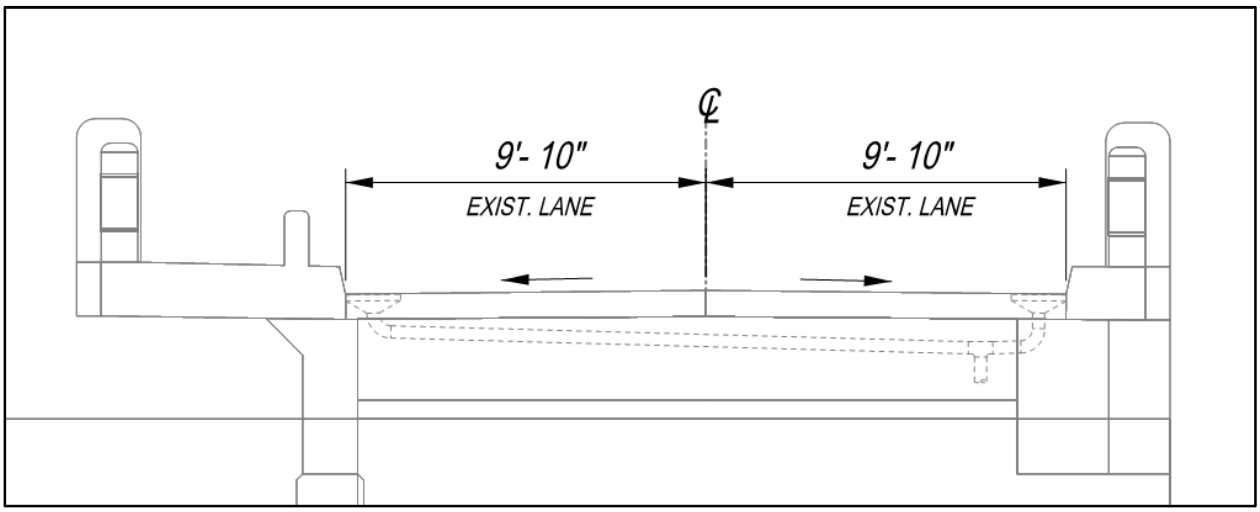


Figure 2. Existing Roadway Configuration

MAIN SECTIONS OF THE BRIDGES AND DAM

The Pensacola Dam Bridge and the West and East Spillway Bridges cross the Pensacola Dam and Auxiliary Spillways. The Dam includes a hydroelectric powerhouse at the west end, which supplies electricity to Northeastern Oklahoma. The intake structure for the powerhouse takes water from the lake through the arch structures and into the powerhouse. The spillway sections are used to control the lake level for both recreational use of the lake and flood control on the Grand Neosho River system.

Working from west to east, the Pensacola Dam Bridge is identified by three primary sections based on the dam features:

- Arch Section. Arches and buttresses form the dam, with the arch barrels extending into the lake. The tops of the arches are visible on the right side of Figure 3, shown on the next page. The intake structure is located on the far-left side of Figure 3. The downstream sides of the arches and buttresses are shown in Figure 4. The bridge's distinctive spandrel arch which supports the downstream side of the bridge is also visible.
- Main Spillway Section. The upstream and downstream views of the main spillway are shown in Figures 5 and 6, respectively. The bridge is supported by piers extending upwards through the main spillway. The Hoist Bridge is shown on the upstream side of Figure 5. The Hoist Bridge provides access to open and close the spillway gates and to lower stoplogs into slots to allow spillway and gate maintenance.
- Non-Overflow Section. A gravity dam forms the east end of the dam. The bridge is supported by the gravity dam on the upstream side, and by piers extending up from the gravity dam on the downstream side. See Figures 7 and 8, respectively.

The West and East Spillway Bridges have the same configuration as the Main Spillway Section of the Pensacola Dam Bridge.

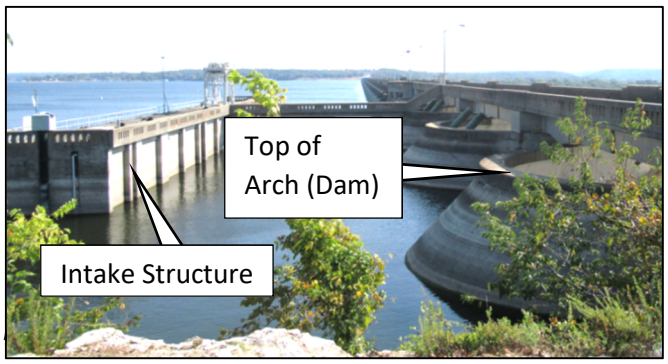


Figure 3. Upstream View Arch Section

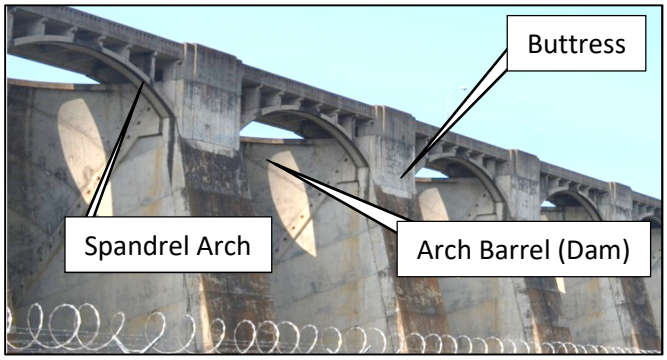


Figure 4. Downstream View Arch Section

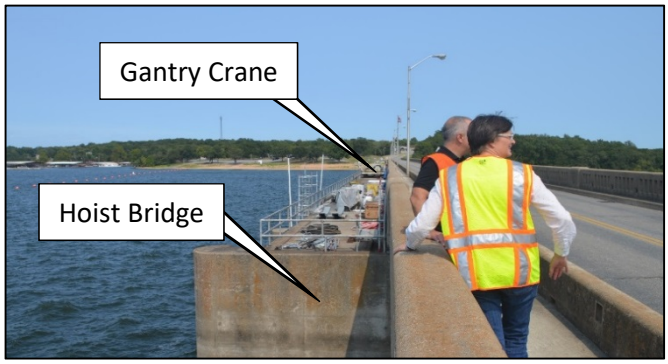


Figure 5. Upstream View Spillway Section

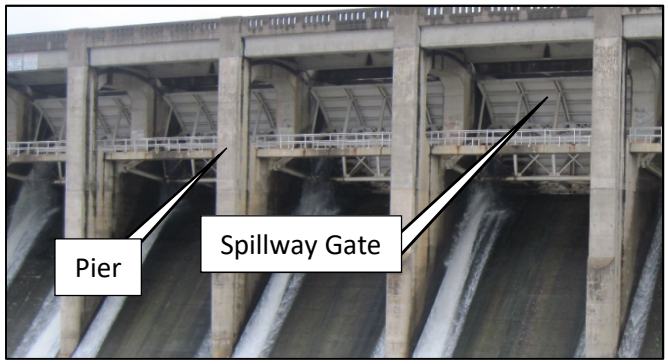


Figure 6. Downstream View Spillway Section

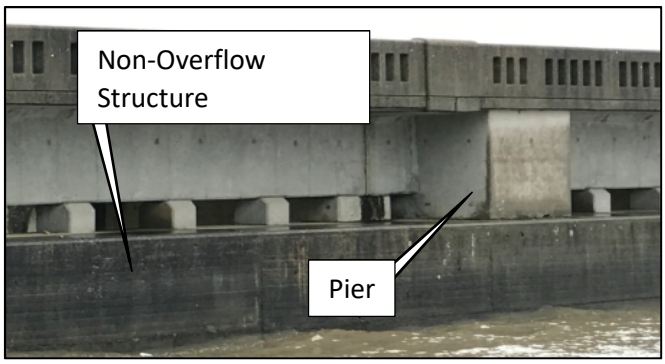


Figure 7. Upstream View Non-Overflow Section

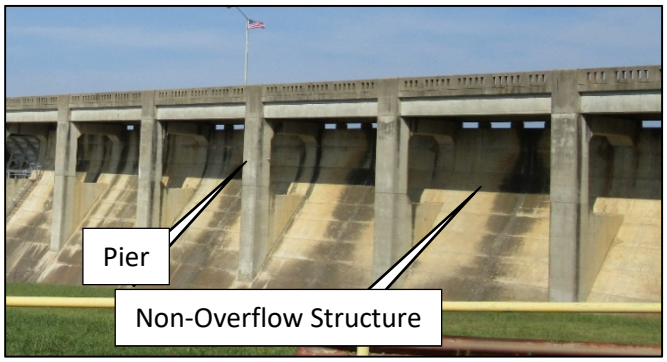


Figure 8. Downstream View Non-Overflow Section

LOAD RATINGS AND REHABILITATION MEASURES

The bridges were originally designed for an H15 or an H20 truck, which is a two-axle truck weighing a total of 15 or 20 tons, respectively. The bridges are load posted for 16-tons for a single two- axle truck, 29-tons for a single trailer (three axle truck), and 45-tons for double trailer units. The existing load ratings addressed the design of the arch section of the bridge, showing the decks to control the load rating of the bridges at 16.4 tons. The required operating rating to remove the load posting is 23 tons.

Additional load ratings have been prepared since the completion of the Preliminary Design Report. Differences in the span length and spacing of floor beams, and differing sizes and reinforcement of longitudinal girders in the spillway and non-overflow portions of the bridge have been determined to produce lower operating ratings than the arch section. Specifically, the load rating for moment for the floor beams in the spillway and non-overflow sections is 13.3 tons.

Additional truck combinations were also applied to the structure at the request of ODOT's Bridge Division, the EV-4 and Type 3-3 truck, resulting in a rating of 12.4 tons for the floor beams for moment, 13.7 tons for the deck in positive moment and 15.3 tons in negative moment. ODOT is currently coordinating with FHWA on load postings for an EV-3 truck, which has a heavy tandem load of 31k per axle, spaced 4 feet apart. In the interim, the HS-20 truck load ratings will be referenced for the remainder of this supplemental report.

In contrast to the load rating values, the majority of the bridge members do not exhibit significant distress, other than the deterioration of the hinges in the upstream longitudinal girder of the arch section. A short summary of the total number of structural members and the degree of deterioration is shown in Table 1, below.

Table 1: Existing Condition

Snapshot of Condition	Total Count	Estimated Moderate Deterioration	Significant Deterioration
Total Number of Floor Beams, 3 Br.	729	212 29%	5 1%
Total Number of Longitudinal Girders, 3 Br.	161	4 2%	10 6%
Total Number of Hinges, 3 Br.	102	10 10%	15 15%
Total Number of Arches, 3 Br.	51	5 10%	0 0%

The concrete members typically exhibit small evenly-spaced flexural cracks, as is anticipated with reinforced concrete design. Part of the explanation of this may be that the load distribution among members are allowing the bridge to behave in a more complex manner than the simplifying assumptions made in the calculations. Additionally, the strength of the materials may be higher than recommended for use by the Manual for Bridge Evaluation tables for a bridge of this age. Thirdly, although heavy trucks regularly cross this bridge, their speed is often reduced, and may result in lower impact forces on the bridge than are used in the calculations.

These lower load ratings have been reviewed with ODOT's Bridge Division, and due to the good condition of the structural elements in question, the complex nature of the bridge and simplifications made in load rating calculations and the relatively short duration until the rehabilitation project begins, the bridge posting limits will remain as is.

ODOT is obtaining material samples of the concrete and reinforcing steel, to perform materials testing and perhaps allow raising the material strength. Additionally, GRDA and ODOT are exploring the feasibility of load testing the bridges with strain gages and a truck of known weight, as this has often allowed the load rating to be increased. This method of load rating is acceptable under the FHWA bridge load rating requirements. If the load ratings are found to be able to be raised, the strengthening measures will be revisited.

In the interim, this report and the 60% Rehabilitation and Widening Plans issued June 29, 2018 propose two primary measures to improve the strength of the bridge: the addition of "sister" floor beams and Carbon Fiber Reinforce Polymer (CFRP) strengthening.

Sister floor beams are planned to be placed between existing floor beams, reducing the span length of the deck passing over the floor beams longitudinally. This halving of the span length raises the deck rating to approximately 34 tons and 60 tons for positive moment and negative moment, respectively.

Locating the sister floor beams midway between the existing beams does not, however, improve the load rating of the floor beams. The floor beams in the arch section of the bridge have a short span length, and load ratings of 26.8 tons for shear and 23 tons for moment, and therefore do not require additional measures to provide sufficient strength to remove the load posting signage.

At the spillway and non-overflow sections, the floor beams are significantly longer, resulting in lower load ratings, 17.8 tons for shear and 13.3 tons for moment. In these two sections, the choices are to also add sister floor beams adjacent to the existing floor beams. This allows the new sister beam to share the load with the existing floor beams, and raises the shear and moment

load ratings to approximately 35 and 26 tons. A review of the possibility of eliminating the mid-span sister beams in lieu of these traditional side-by-side sister beams revealed that the deck ratings do not quite reach the desired 23 tons. The ratings are 18.6 tons and 32.7 tons for positive moment and negative moment, respectively. Thus, at the spillway and non-overflow sections, sister beams located midway between existing floor beams and located as true sister beams are necessary to provide sufficient strength.

See Table 2 below, where the Proposed Load Ratings based on Operating Ratings reflect mid-span sister floor beams in the arch section, and both mid-span and true sister beams in the spillway and non-overflow sections.

Table 2: Existing and Proposed Load Ratings (Operating Ratings)

			Current			Proposed		
			HS-20 Truck	**EV-3 Truck**	**Type 3-3 Truck**	**HS-20 Truck**	**EV-3 Truck**	**Type 3-3 Truck**
Arch Section	Floor Beam	V	26.8 tons	20.4 tons	*	26.8 tons	20.4 tons	*
		M	23 tons	20.4 tons	*	23 tons	20.4 tons	*
	Longitudinal Beams	V	43.7 tons	28.3 tons	56 tons	43 tons	28 tons	56 tons
		M	46.3 tons	41.3 tons	118 tons	46 tons	41 tons	118 tons
	Deck	+M	16.4 tons	14.4 tons	*	34 tons	>23	*
		-M	25.8 tons	17.4 tons	*	60 tons	>23	*
	Arch		over 27.2 tons		>23	over 27.2 tons	>23	>23
Spillway/Non-Overflow Section	Floor Beam	V	17.8 tons	16.2 tons	*	35.7 tons	>23	>23
		M	13.3 tons	12.4 tons	*	26.6 tons	>23	>23
	Longitudinal Beams	V	25.2 tons	22.1 tons	33.6 tons	21 tons	>23	>23
		M	38.8 tons	25.7 tons	62 tons	33 tons	>23	>23
	Deck	+M	16.0 tons	13.7 tons	*	34.5 tons	>23	>23
		-M	27.7 tons	15.3 tons	*	62 tons	>23	>23

* Does not control, by inspection

A review of the longitudinal girders with the additional weight of sister floor beams reveals that the load ratings decrease to approximately 20 tons, assuming concrete girders are used. As the spillway and non-overflow sections of the bridge and dam are not as visually impactful as the arch section, the weight may be reduced by using steel rolled shape sections in lieu of concrete, in turn raising the load rating. Additionally, the longitudinal girders may be strengthened with CFRP.

Design loads for these scenarios have been provided to CFRP engineers for three different CFRP vendors to investigate the costs to increase the capacity of the bridges sufficiently to remove the load postings. Loads have also been provided to the CFRP engineers to carry the current

American Association of State Highway Officials (AASHTO) HL-93 Design Loading. The CFRP engineers are developing designs and cost estimates to provide solutions for strengthening where possible with CFRP. When their designs and cost estimates are complete, the CFRP strengthening and sister beam strengthening approach will be evaluated to determine an economical solution for strengthening.

The combined benefits of the sister beams and CFRP can be used to strengthen the structures sufficiently to remove the load posting for these bridges.

The hinges located in the upstream longitudinal girders in the arch section were used in the calculation of the load ratings for Table 2. The upstream longitudinal girders load ratings are more than adequate at 46.3 tons and 43.7 tons for moment and shear, respectively. However, the girders exhibit shear cracks at the hinges, indicating they are not performing well under current loads. Some of these hinges have been repaired in the past rehabilitation projects. Contributing factors to the deterioration include the following:

- The girders are located on the north and upstream side of the bridge. The proximity to the lake combined with the moisture typical on the north side of a structure increase deterioration.
- The hinges are located beneath the deck joints. While ODOT and GRDA have a long-standing policy not to salt these bridges, the moisture seeping through the joints accumulates at the hinges. The tightness of the hinge components traps moisture and prevents drying from the wind and sun.
- Some vehicles currently using the bridges exceed the posted load limits. Enforcement of load limit signage is limited at best.
- The differential load mechanism and stiffness of the upstream hinged continuous longitudinal girder compared to the spandrel arch beams may be a contributing factor.

The proposed rehabilitation for the hinges centers on sounding the hinges and examining the cracks during rehabilitation. Plans call for cracks to be examined to determine whether they continue through the hinge or are more superficial. Unsound concrete will be removed with hand tools and lightweight hand-held tools, and for further inspection of the cracks. If the hinge areas are generally sound, corrosion inhibitor will be applied, cracks will be injected with epoxy resin, and pneumatically applied mortar used. Following these repairs, a two-way application of CFRP will be used on the two halves of the hinge. Should the deterioration be found deep in the hinge, the longitudinal girders will be supported, and the longitudinal girders cut back to sound material, salvaging the existing reinforcing, and augmenting with new reinforcing where needed. The section will be rebuilt, and the two-way application of CFRP will complete the work. Care

will be taken in the application of CRFP design, to ensure that moisture is allowed to escape from the section, rather than being trapped within the concrete due to a "bathtub effect".

The spandrel arch beams are rated at 27 tons. The addition of sister beams in the arch section are envisioned to be supported by the buttress via a longitudinal girder located on the interior of the arch. This prevents additional load from bearing on the existing arches. The sister floor beams may be cantilevered beyond the supporting beam, or may be extended to the new arch section with a low profile if necessary.

The updated cost estimates in Appendix C include the costs of epoxy injection, pneumatic mortar repair, and CFRP, in addition to the cost of sister beams. Application of these measures will strengthen the bridges sufficiently to remove load posting for the HS-20 truck.

HISTORIC PRESERVATION AND CULTURAL RESOURCES

GRDA is committed to preserving the historic significance of the Pensacola Dam Historic District, while being equally interested in the safety and utility of the bridges and the SH 28 roadway corridor. GRDA has updated the Oklahoma State Historic Preservation Office (SHPO) with the progress of design and plan development with methods of rehabilitation that will not adversely affect the historic property. However, without federal funding or permitting, the SHPO does not have a nexus for formal Section 106 of the National Historic Preservation Act, as amended (36 CFR 800) consultation, and informal consultation would continue. Should the proposed project become categorized as a federal undertaking due to federal funding and/or permitting requirements, formal consultation with the SHPO would be conducted. See Appendix D for updates to the historical preservation and alternatives analysis of the project.

NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE

As described above, the proposed project would become categorized as a federal undertaking if there is federal funding and/or permitting requirements. Therefore, the proposed project would also be subject to compliance with the National Environmental Policy Act (NEPA) (42 U.S. Code [U.S.C] Sections 4321-4375), the implementing regulations promulgated by the Council on Environmental Quality (CEQ, 40 CFR 1500), and associated environmental regulations. NEPA documentation and associated specialists' studies, including wildlife habitat and vegetation assessment, water resources assessment, cultural resources surveys, community impact assessments, and hazardous materials initial site assessments are ongoing in anticipation of the proposed project becoming a federal undertaking. Background research and data collection are being conducted within a one-quarter mile buffer centered on the roadway centerline, shown as Figure 1. Project Location in Appendix E. Specialists' studies are being focused on the area within

the bridge footprint of the proposed project plus a 100-foot buffer around the bridge footprint, as shown on the Specialists' Studies Area map in Appendix E. NEPA documentation and specialists' studies are anticipated to be complete by early 2019.

CONSTRUCTABILITY

The height of the main Pensacola Dam Bridge 150' above the downstream side through the arch and spillway sections of the bridge presents a challenge, but crane access is available on the downstream side of the bridges. Work platforms can be supported from the buttresses and piers, supported from the ground using scaffolding, or hung from the underside of the bridge. Accelerated Bridge Construction Techniques such as Precast Concrete Elements and Systems (PCES) will be used wherever possible. This minimizes the amount of formwork and cast-in-place concrete necessary for construction. The two smaller spillway bridges can be accessed much more easily from the downstream side of the bridge, with a reduced height of approximately 45 feet from the spillway to bridge surface.

CONSTRUCTION SEQUENCE AND TRAFFIC CONTROL

Modifying the recommendation for Scenario 1 from the Constructability section of the original report, the widening of the Pensacola Dam Bridge will occur in conjunction with ODOT's deck rehabilitation. Any remaining rehabilitation work below the Pensacola Dam Bridge deck can be completed as necessary after the deck rehabilitation and widening. The construction duration for the Pensacola Dam Bridge rehabilitation and widening is estimated to be 12 months. The 12 months begins with 9 months of closure to SH 28 traffic across the Pensacola Dam Bridge while the deck is rehabilitated and widened. Closure of the SH 28 eastbound lane across the bridge for 1.5 months is estimated during the rehabilitation work below the SH 28 eastbound lane of the bridge. The year long duration for Pensacola Dam Bridge rehabilitation and widening concludes with 1.5 months of closure to the SH 28 westbound lane while rehabilitation work below this lane of the bridge occurs.

As noted above, the Pensacola Dam Bridge will be closed during the widening and deck rehabilitation. During this closure, SH 28 traffic will be detoured along the route shown in the original report and in the 60% Plans. For the rehabilitation work below the Pensacola Dam Bridge deck, SH 28 will be partially open across the Pensacola Dam Bridge. During the below deck rehabilitation work under the SH 28 eastbound lane, traffic will be in the SH 28 westbound lane, with the eastbound lane of SH 28 closed on the dam. Innovative techniques will be incorporated into the construction sequence and traffic control plan to mitigate delays during periods when

the bridges are open for two-way traffic located in one lane, and to enforce the speed limits for work zone safety in the confined space.

Two-way traffic in the SH 28 westbound lane will be controlled by a temporary traffic signal at each end of the bridge. As noted before, the work zones will be shortened to reduce impacts to traffic. The speed limit across the dam during construction will be reduced to 20 mph. Portable longitudinal barrier should be used along the work zone to separate the traffic from the work area as shown in Figure 9. A serpentine movement may be introduced if necessary to control vehicular speed in the construction zone. The temporary traffic signals can use sensors rather than timers, if desired, to mitigate driver frustration during low volume traffic periods. This allows the users to proceed when the way is clear, rather than waiting a prescribed period of time before being allowed to proceed.

Following rehabilitation work under the SH 28 eastbound lane of the bridge, for any remaining rehabilitation work under the SH 28 westbound lane of the bridge, the two-way traffic will be moved to the SH 28 eastbound lane. Traffic control devices and portable longitudinal barrier will be adjusted to accommodate two-way traffic in the SH 28 eastbound lane.

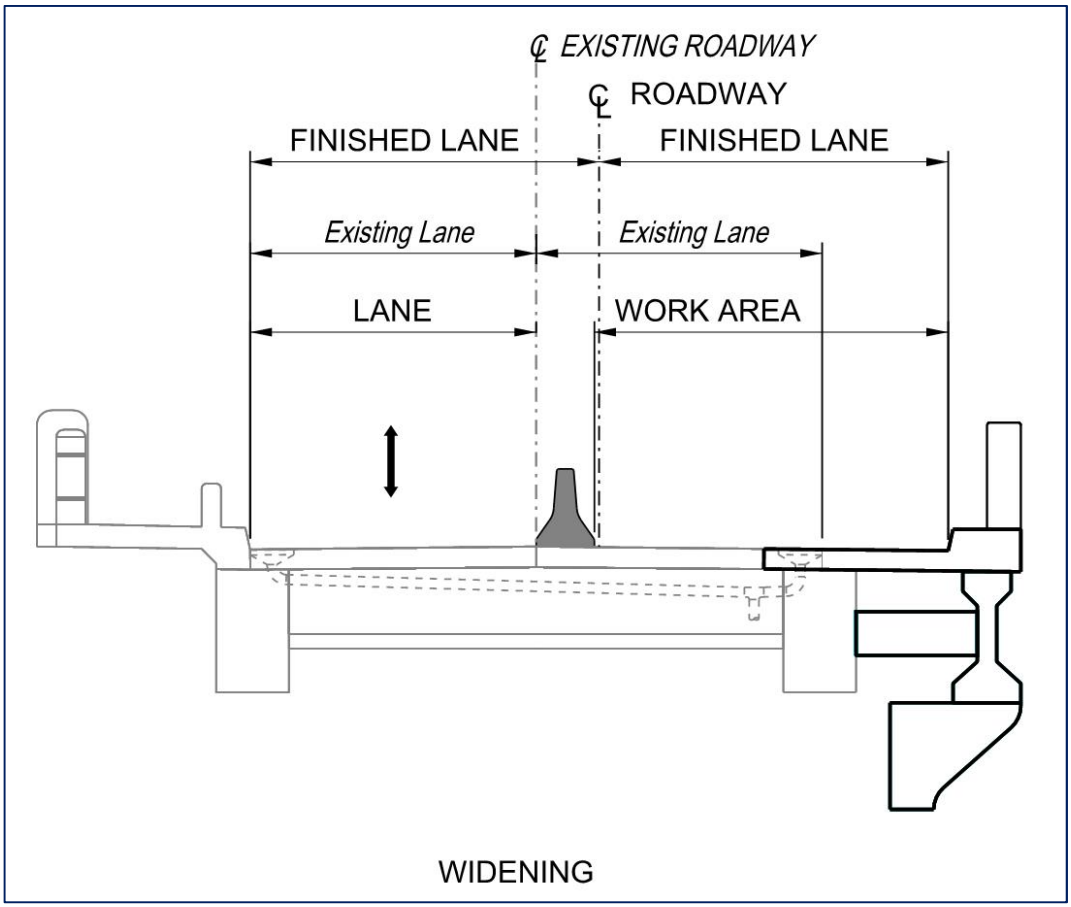


Figure 9. Work Zone Protection

After the Pensacola Dam Bridge rehabilitation and widening is complete, widening on the West and East Spillway Bridges can begin. The widening of the West and East Spillway Bridges is estimated to be 4.5 months. During the widening of the spillway bridges, SH 28 traffic across these two bridges will be moved to the SH 28 westbound lane while the widening occurs on the downstream side of the bridges. Unlike the Pensacola Dam Bridge, the contractor can work from below the downstream portion of the spillway bridges thus allowing SH 28 traffic to utilize the westbound lane during the widening. Two-way traffic in the SH 28 westbound lane will be controlled by a temporary traffic signal at each end of the spillway bridges. Traffic control devices and portable longitudinal barrier will be placed to accommodate two-way traffic in the SH 28 westbound lane.

Deck rehabilitation on the West Spillway Bridge commences after the West and East Spillway Bridge widening is finished. The deck rehabilitation of the West Spillway Bridge is estimated to last 1 month. The West Spillway bridge will be closed to SH 28 traffic during the deck rehabilitation. During this closure, SH 28 traffic will be detoured along the same route as utilized for the Pensacola Dam Bridge closure.

The final phase of the rehabilitation and widening project is deck rehabilitation on the East Spillway Bridge. The East Spillway Bridge deck rehabilitation starts after the West Spillway Bridge deck rehabilitation is finished. The estimated duration for the East Spillway Bridge deck rehabilitation is also 1 month. The East Spillway bridge will be closed to SH 28 traffic during the deck rehabilitation. SH 28 traffic will be detoured along the same route previously used for bridge closure.

SUPPLEMENTAL FUNDING EVALUATION

The final determination was made to focus initial efforts on an application for a BUILD Grant as a key avenue for funding of the SH 28 project. The team will continue to move forward to be well positioned for submitting the application in July 2018. Notice of BUILD Grant award is December 2018.

SCHEDULE

On-going activities and the upcoming schedule include the following:

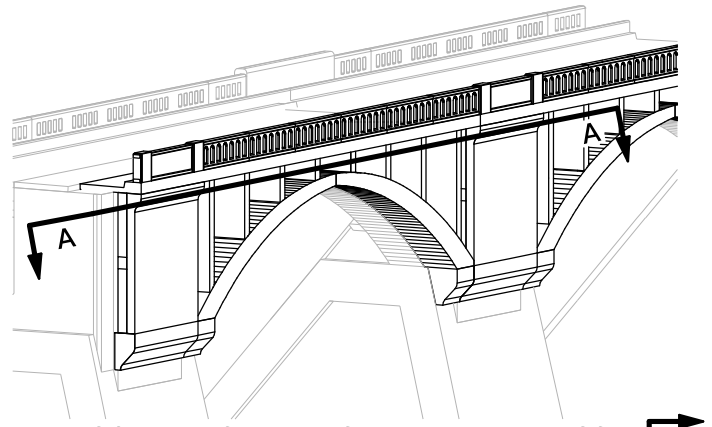
- BUILD Grant Application | July 19, 2018
- Revisit NEPA and Specialist Studies footprint | July 2018
- Specialist Studies | August 2018
- Materials testing of the concrete and reinforcing in the bridges | August 2018
- CFRP design and cost estimates | August 2018
- Investigation into the possibility of load testing the bridges to improve the load ratings | August 2018
- Development of paving design for the widening in coordination with ODOT | August 2018
- Development of temporary construction easement as necessary for the widening at the east end of the East Spillway Bridge | August 2018
- Refinement of the rehabilitation and strengthening design | September 2018
- Constructability reviews | September 2018
- Notice of BUILD Grant Award | December 19, 2018 (if selected)
- NEPA Documentation Completed | December 2018
- Coordination with SHPO | January 2019
- Public Meeting | January or February 2019
- Submission of 90% Plans | March 2019
- 90% Review Meeting | April 2019
- Submittal of PS&E Plans | May 2019
- Construction Letting | July 2019
- Project Award | August 2019
- Construction Start Date Pensacola Dam Bridge | September 2019
- Pensacola Dam Bridge Re-opens to Traffic | May 2020
- Construction proceeds on Spillway Bridges | May 2020
- Construction Complete on all bridges | April 2021

APPENDIX A

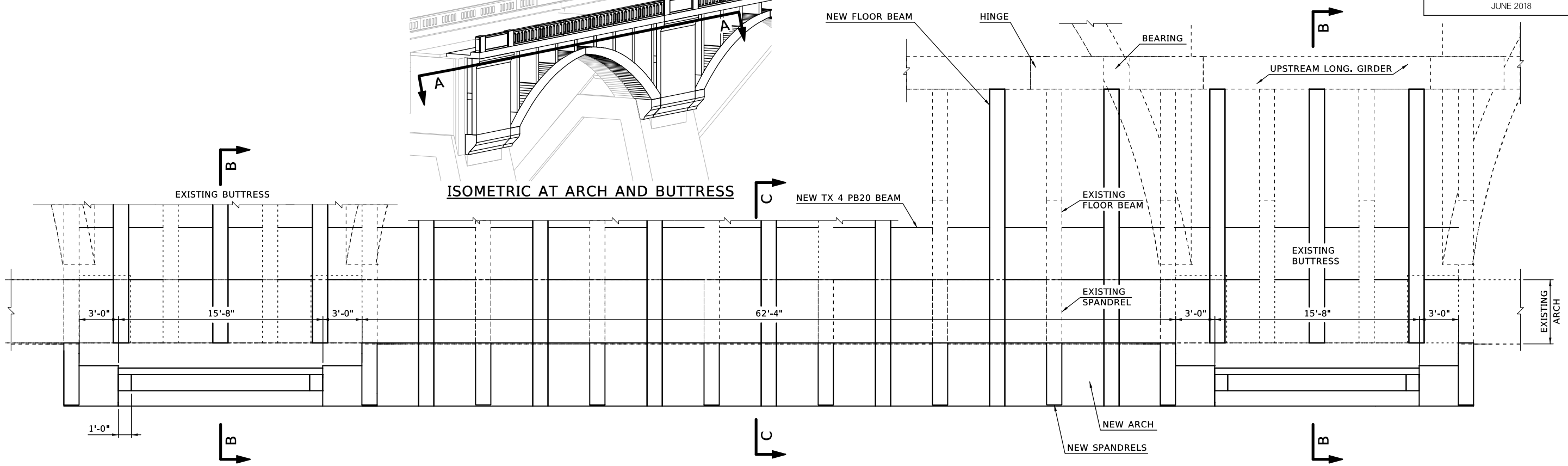
UPDATED
WIDENING EXHIBITS

GRAND RIVER DAM AUTHORITY

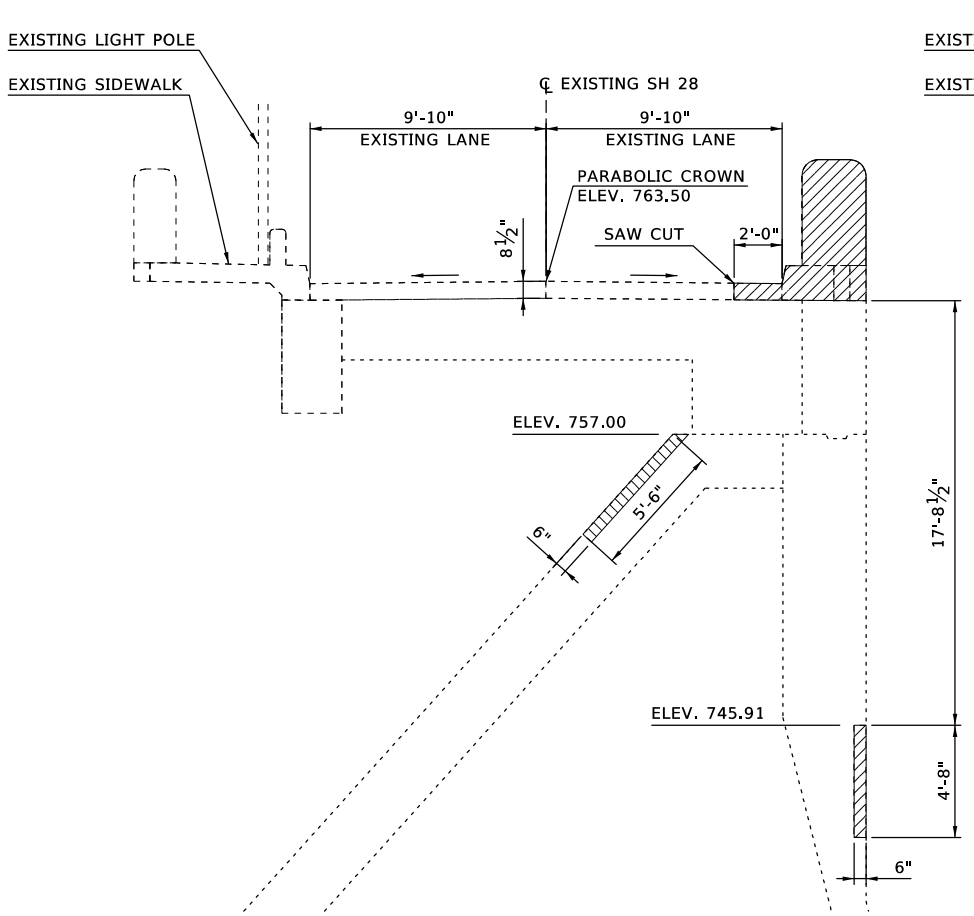
60%
PLANS
W/ COMMENTS INCORPORATED
JUNE 2018



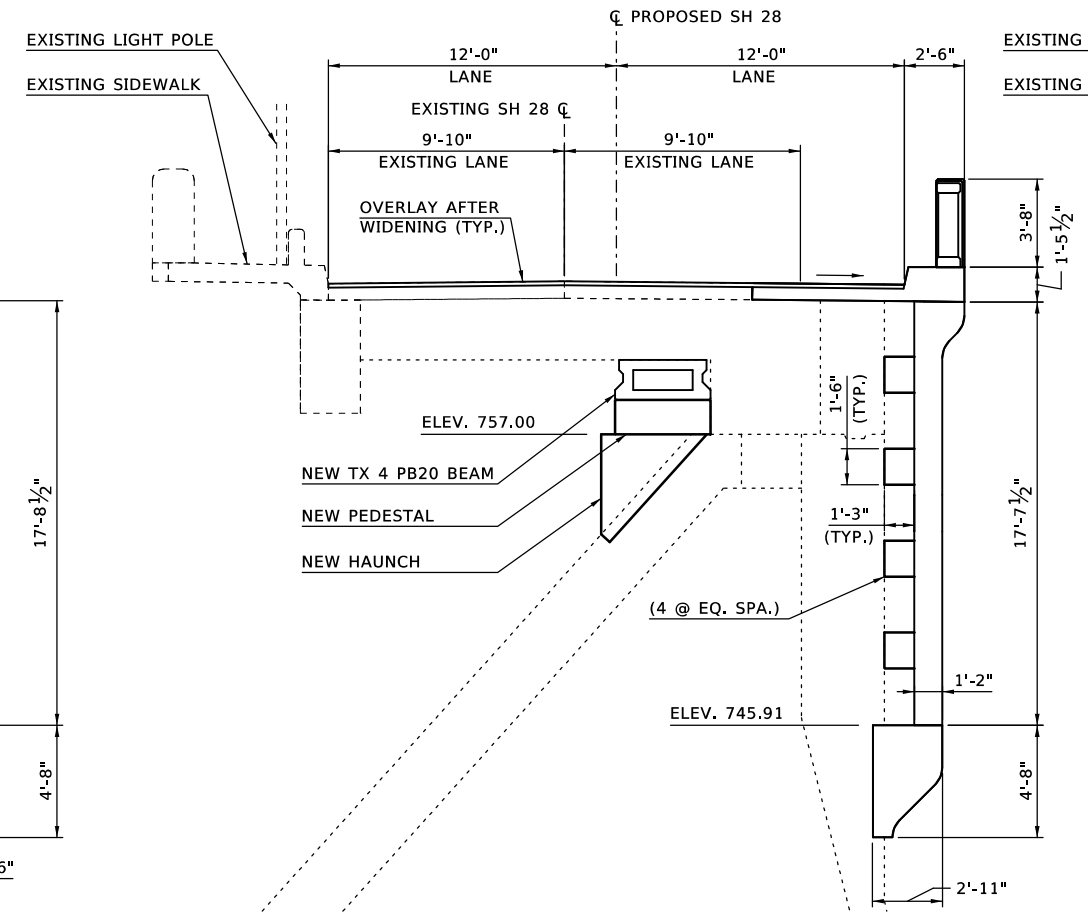
ISOMETRIC AT ARCH AND BUTTRESS



SECTION A-A



TYPICAL SECTION OF REMOVAL



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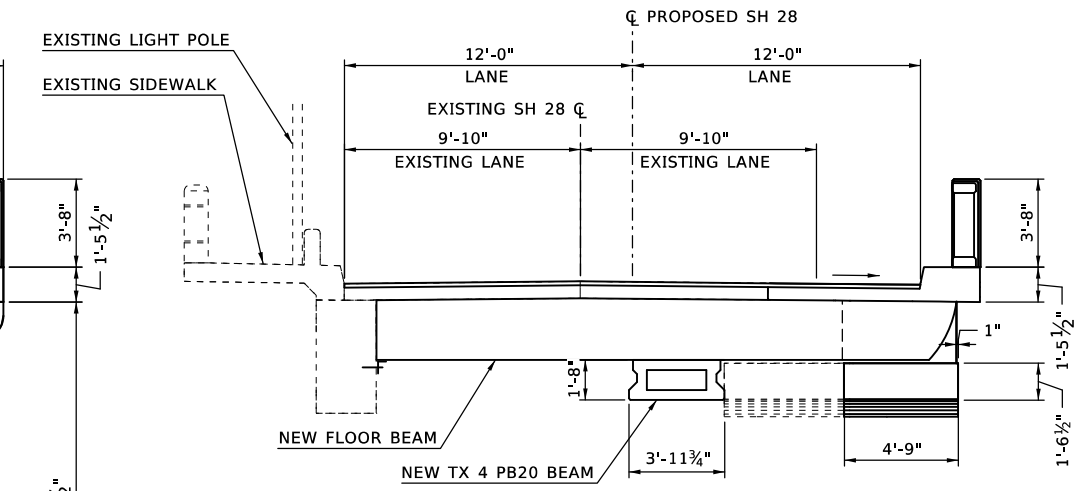

SECTION C-C

ALTERNATE 1

BENHAM
a Haskell Company

BRIDGE A

DESIGN			GRAND RIVER DAM AUTHORITY
DRAWN			MAIN DAM ARCH TYPICAL SECTION
CHECKED			
APPROVED	SOT	2/18	
SQUAD	BENHAM		

COUNTY MAYES HIGHWAY SH-28 STATE JOB NO. 41806 SHEET NO. 0007

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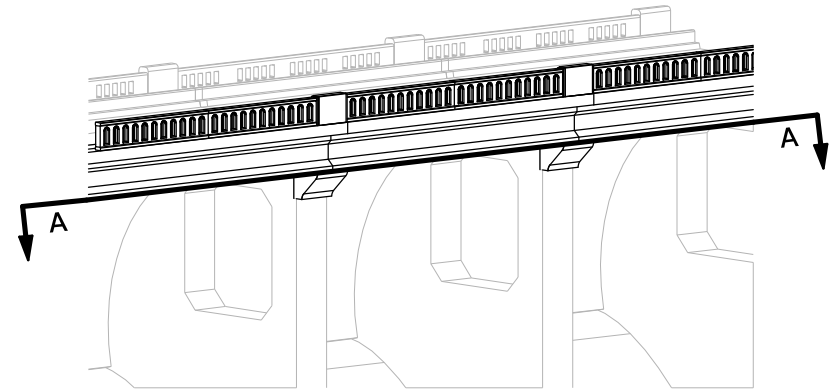
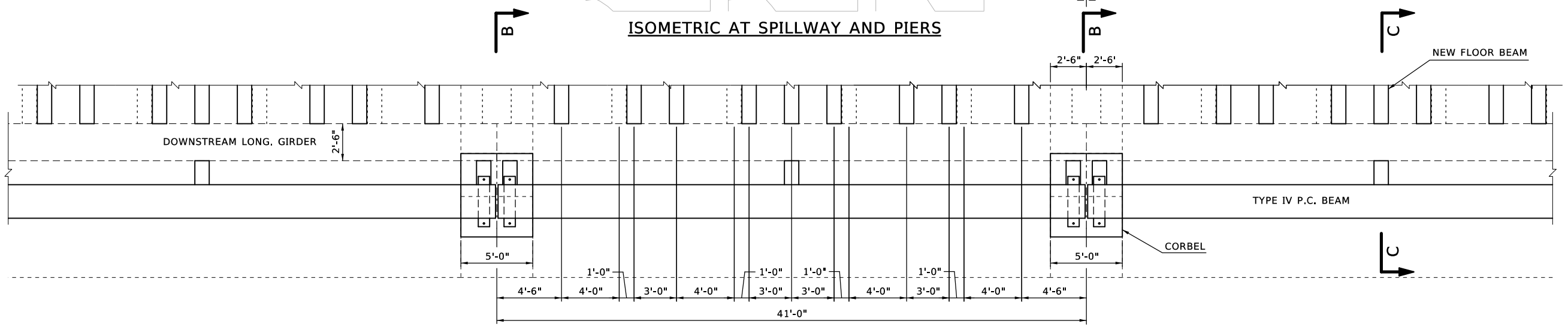
GRAND RIVER DAM AUTHORITY

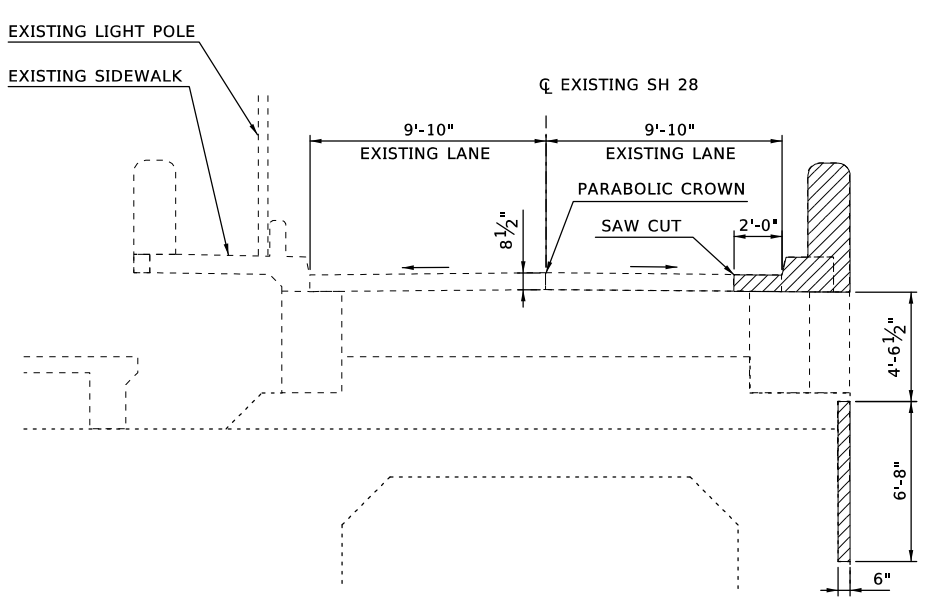
60%
PLANS
W/ COMMENTS INCORPORATED
JUNE 2018



ISOMETRIC AT SPILLWAY AND PIERS



SECTION A-A



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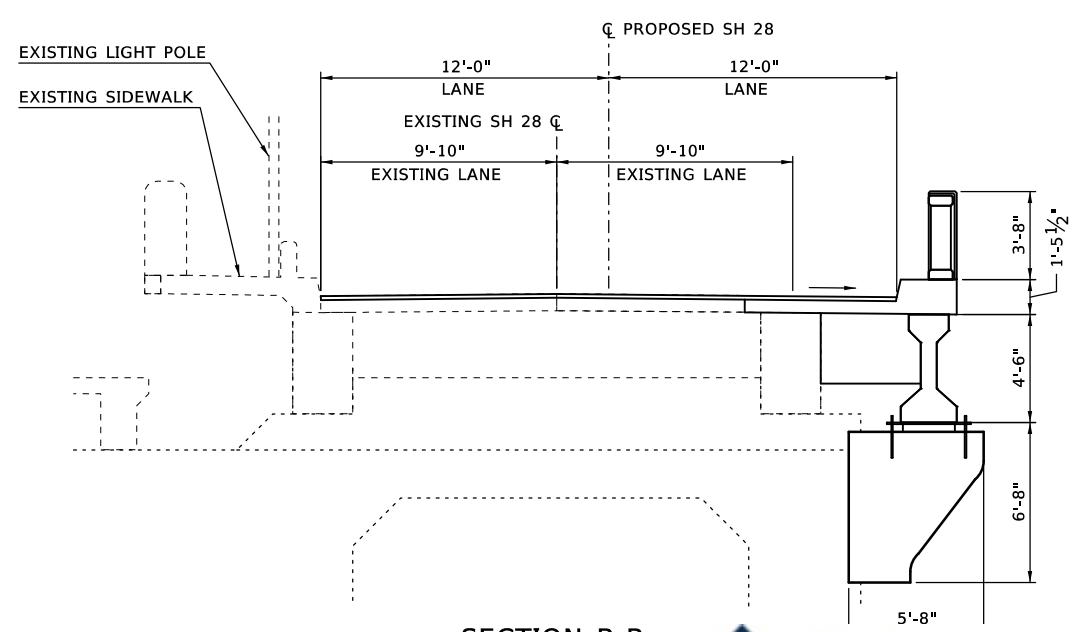

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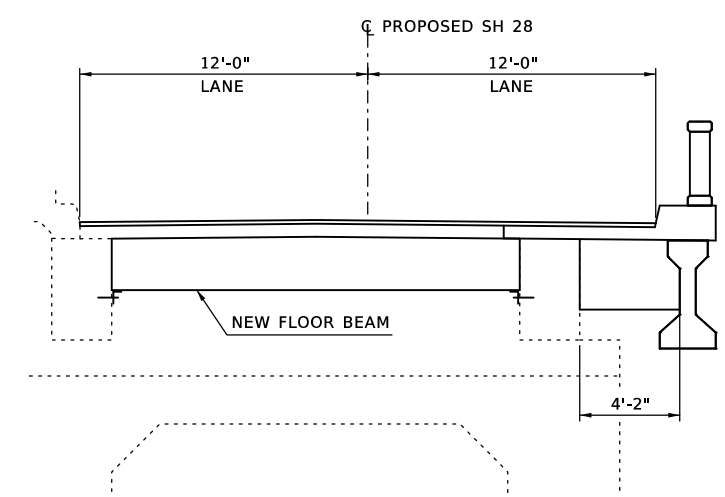

SECTION C-C

ALTERNATE 1

BENHAM
a Haskell Company

BRIDGE A

DESIGN			GRAND RIVER DAM AUTHORITY
DRAWN			MAIN DAM SPILLWAY TYPICAL SECTION
CHECKED			
APPROVED	SOT	2/18	
SQUAD	BENHAM		

COUNTY MAYES HIGHWAY SH-28 STATE JOB NO. 41806 SHEET NO. 0008

6/29/2018

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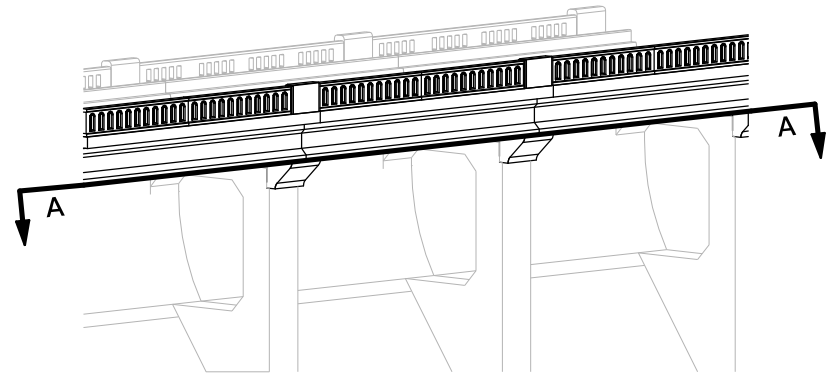
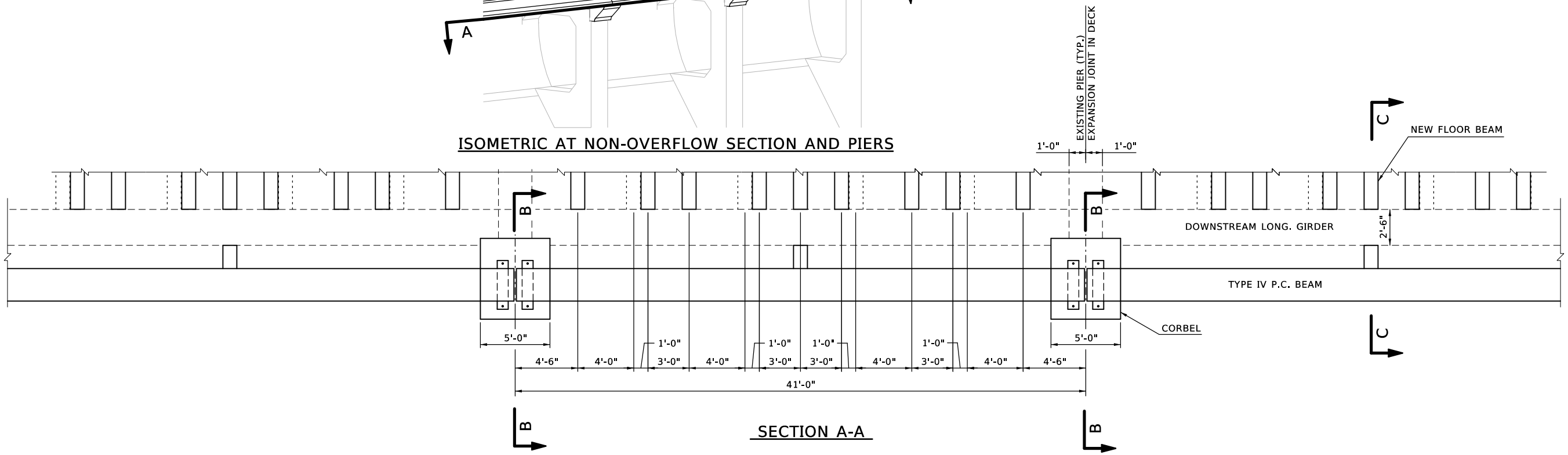
GRAND RIVER DAM AUTHORITY

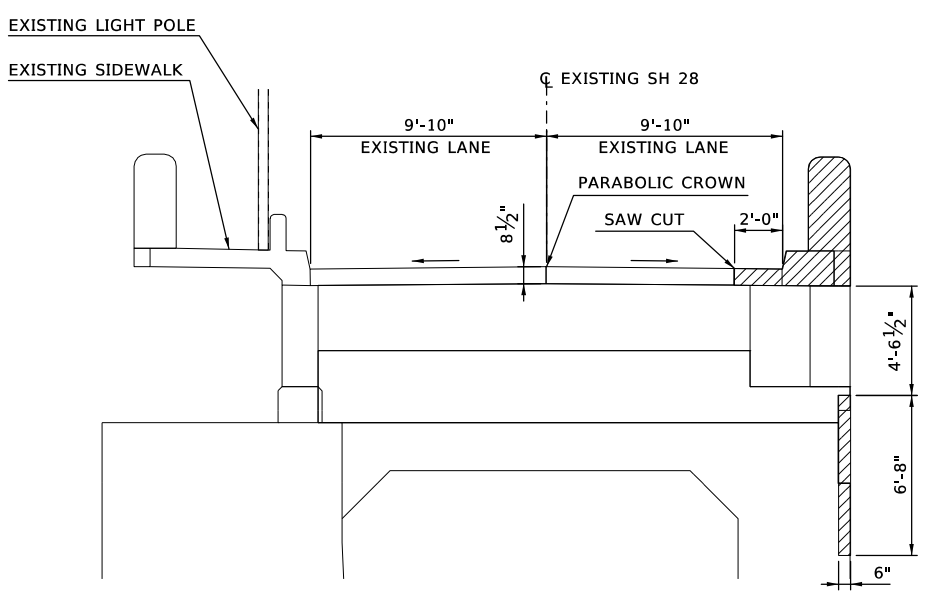
60%
PLANS
W/ COMMENTS INCORPORATED
JUNE 2018



ISOMETRIC AT NON-OVERFLOW SECTION AND PIERS



SECTION A-A



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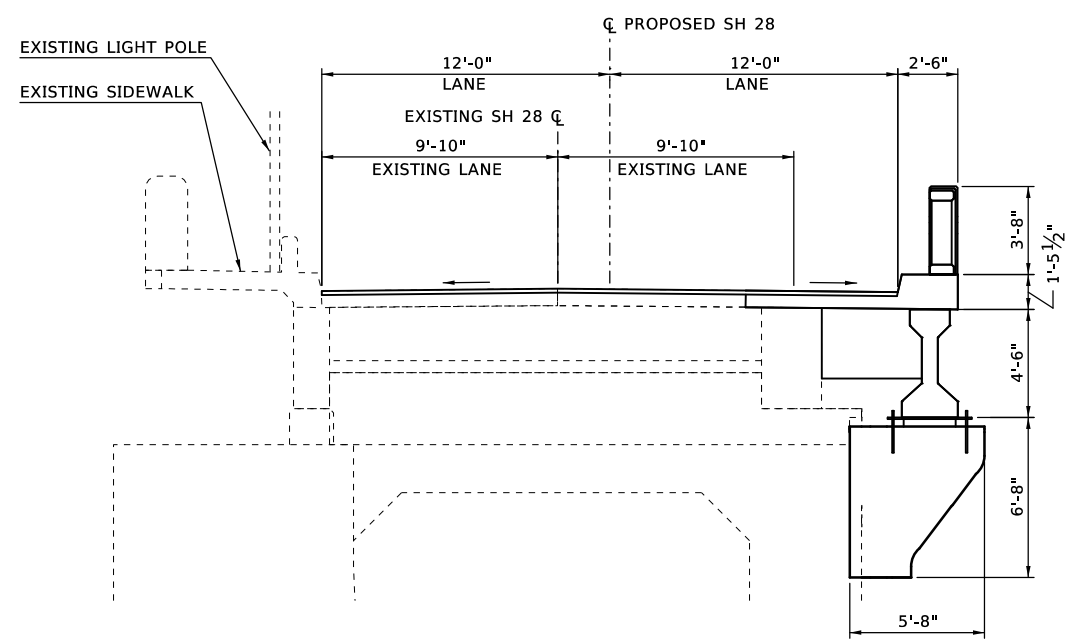

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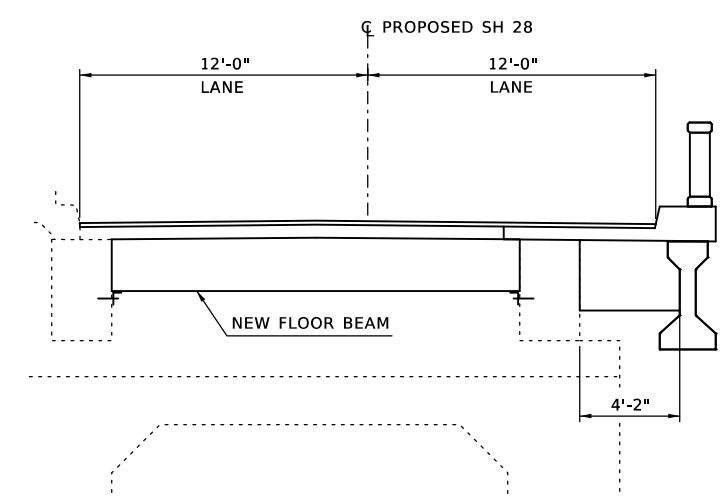

SECTION C-C

BRIDGE A

ALTERNATE 1

BENHAM
a Haskell Company

DESIGN			GRAND RIVER DAM AUTHORITY
DRAWN			MAIN DAM NON-OVERFLOW TYPICAL SECTION
CHECKED			
APPROVED	SOT	2/18	
SQUAD	BENHAM		

COUNTY MAYES HIGHWAY SH-28 STATE JOB NO. 41806 SHEET NO. 0009

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6/29/2018

APPENDIX B

ADDITIONAL MEETING MINUTES

SH-28 Pensacola Dam – GRDA Hydroblast Questions
Project Name GRDA SH-28 Widening over Pensacola Dam
Project Number GRDA: 41806 | ODOT JP 31884(004)
Benham # 1400204
Location Division 8 Auditorium, Tulsa, OK
Date January 17, 2018

Attendees:

Oklahoma Department of Transportation

Joe Brutsché	Project Management Division	Project Manager
Randle White	Division 8	Division Engineer
Jennifer Bullard	Division 8	East Div. Engr. - Construction
Jessica Prince	Division 8	West Div. Engr. - Construction
Matt Casillas	Division 8	Division Local Government Manager
Steve Jacobi	Bridge Division	Engineering Manager (via phone)
Walt Peters	Bridge Division	Tulsa Construction Residency, EIT Program
Mohamed Elyazgi	Bridge Division	Engineering Manager (via phone)

Benham Design, LLC

Sue Tryon	Project Manager
Karen Jones	Bridge Engineer
Scott Foster	Bridge Engineer

We believe the following record to be an accurate summary of decisions and related discussions. We will appreciate notification of exceptions to this record within 10 (ten) days of its receipt. Failing such notification, we will consider this a statement of fact in which you concur.

Discussion

- How to strengthen the deck.
  - The deck controls the load rating, at HS 16.4 at midspan, and HS 25.76 over supports.
  - Kenny Seward prepared a report in 2012, which tested a concrete core of the deck, finding the compressive strength to be 4700 psi.
  - The existing deck is 8.5” thick. The overlay envisions removing 2” of asphalt overlay and concrete, and replacing 2” with latex modified overlay. The asphalt is estimated as 1/2”, and the deck removal as 1 1/2”.
  - The modulus of elasticity of latex modified overlay is lower, and is considered non-structural. Have not re-run the load rating to determine what the rating would be with losing 1 ½” of the deck as a part of the structural element.
  - Latex Modified Overlays are only recommended when the overlays are equal to or less than 2.5” thick. Generally they have a higher bonding capacity than regular concrete. **Bridge Division** will look into other types of overlays.
    - Fiber-reinforced concrete is not necessarily good for a thin deck.
    - The Corps used a Silicone overlay at Keystone Dam Bridge, and it was also used in Division 7.
    - Silica fume is another possibility.

- Simpson envisioned sawcutting 1/3" wide x 3/5" deep grooves 1' apart by 6' long from curb to curb over the tops of the transverse beams. Then insert strands and resin into the grooves to provide negative moment strength to the deck. This was to restore the original strength, assuming 10% corrosion. Then CFRP on the underside between transverse beams, also a foot apart for positive moment.
- We were anticipating most of the deck would be removed with hydroblast and new top mat could be placed with the overlay.
  - Eliminates the need to cut grooves into the new overlay
- Some areas may be strong enough that only 1.5" of deck is removed. This doesn't result in the top mat being replaced or upgraded. We would then require grooves into the new overlay with the strands to bring the strength up, if we believe the reinforcing has experienced 10% loss. That may not be a valid assumption if the deck has good strength in that area.
  - **Benham** will evaluate the structural capacity of the deck if 2.5" is removed and 2.5" of non-structural overlay is replaced. Because of the type of deck drains, it is not desirable to raise the deck surface. Benham will evaluate the strain in the reinforcing, assuming it remains bonded. The Load Ratings will be recalculated assuming less structural depth.
- **Walt Peters** will contact some hydrodemolition companies for more information.
- If necessary, the load rating can be determined by putting instrumentation on the reinforcing in maximum stress areas and using dump trucks with known axle loads. We will re-visit this possibility later.

- How to best anticipate deck blow-out on both sets of plans
  - How to support the overhangs if blowout? How to support the deck formwork?
    - **Aguirre & Fields** should include plan notes should instruct the contractor to prepare a plan for supporting the deck/formwork in case of a blow-out, or near blow-out of the deck. The plans should be prepared by an Oklahoma PE, and be submitted for approval by Bridge Division.
    - **Aguirre & Fields and Benham** should both show options for shallow depth and deep/full deck repairs on both sets of plans.
    - **Aguirre & Fields** will include notes and **ODOT** will develop special provisions regarding Hydroblast test areas. The contractor will conduct a pre-demolition test, finding two locations on the bridge that have sound concrete, two that are bad, and two that are average to calibrate their pressure and head speed, and to determine how the bridge is responding to hydrodemolition.
  - Cost Estimates – **Aguirre & Fields** should adjust the cost estimates to accommodate thicker overlay on portions of the bridge. One pay item should be for removal of deck, and one for placement of overlay, based on volume rather than square yardage.

- How to manage transverse beam deterioration at joints
  - Could foresee some transverse beams at joints don't survive hydroblast
  - Fiber wrap is required to restore their strength.
  - Could foresee some don't pass pull-off test to fiber-wrap.
  - Either results in replacement of some of the transverse beams, and better to do so before overlay.
  - **Aguirre & Fields** plans should show replacement details for the transverse beams, in case there is a blow-out, with non-participating items for GRDA to cover cost of transverse beam repairs.
  - **Aguirre & Fields and Benham** should have notes requiring the Contractor to have an approved plan for how to support the longitudinal girders, etc, if the transverse beams should blow out. Possible methods could be mentioned in a note, along with an indication that other methods will be considered. Possible methods listed could include ideas such as:
    - A lightweight truss-like structure resting on good portions of the deck, and extending through holes in the deck with rods.

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        - A lightweight truss-like structure or a beam hung between longitudinal beams.
        - Supports to the spandrel arch, buttress, or top ring of the arch barrel.
    - **Benham** plans will show replacement details for the transverse beams, in case they survive the hydroblast but do not pass the pull-off test for fiber-wrap. This may require removal of a portion of the deck for access.

- We don't have an estimate yet to bring the bridge up to carry current truck loading. What if the cost is so high that GRDA can't afford this level of rehabilitation?
    - If bringing the strength up to current traffic loads is too expensive, GRDA may revert to two or three small rehabilitation plans over time, rather than one large rehabilitation effort.
    - In that case, it may be better to do the ODOT Deck project first, and then GRDA will bid out a smaller rehabilitation project later.

- Deck Drains –
    - We plan to extend the deck drains in our plans. We will not change the type of deck drains. The top grate and drain remains intact.

- There are no known or anticipated issues with environmental clearance with replacing the approach slabs.

Action Items			
What	Who	When	Status
Evaluate type of overlay to be used.	ODOT Bridge	April 15, 2018	
Prepare Special Provision for Hydrodemolition Pre-Test.	ODOT Division 8	April 15, 2018	
Contact Info Hydrodemolition Contractors	Walt Peters	April 15, 2018	
Add plan notes and details, adjust cost estimate and pay items: • Contractor plan for blow-out/support of deck • Detail options for shallow depth and deep deck repairs • Hydroblast Pre-demolition Test • Cost Estimate Deeper Section • 1 Pay Item Deck Removal • 1 Pay Item Overlay by CY. • Non-Participating Item Transverse Beam Replacement if blowout (and details) • Contractor Pre-approved Plan if Transverse Beams blow-out • Recommend call to Hydrodemolition contractors	Bridge Division to discuss w/ Aguirre & Fields.	September 2018	

Evaluate structural capacity of the deck without strength from the upper portion of the deck. Include the load rating.	Benham	April 15, 2018	
Add plan notes and details, adjust cost estimate and pay items: • Detail options for shallow depth and deep deck repairs • Contractor to have pre-approved plan for transverse beam blow-out. • Plans to show replacement details for transverse beams in case they do not pass pull-off test for fiber-wrap.	Benham	April 15, 2018	

SH-28 Pensacola Dam – 30% Preliminary Plan Review Meeting

Project Name: GRDA SH-28 Widening over Pensacola Dam
Project Number GRDA: 41806
Project Number Benham: 1400204
Location: Division 8 Conference Room
Date: March 15, 2018
Attendees:

Steve Jacoby, GRDA
Randle White, ODOT
Matt Casillas, ODOT
Jennifer Bullard, ODOT
Mohamed Elyazgi (ODOT, via phone)
Joe Brutsché (ODOT, via phone)
Aaron Beets, ODOT
Karen Jones, Benham
Larry Wicks, Benham
Scott Foster, Benham
Sue Tryon, Benham

We believe the following record to be an accurate summary of decisions and related discussions. We will appreciate notification of exceptions to this record within 10 (ten) days of its receipt. Failing such notification, we will consider this a statement of fact in which you concur.

Discussion

- Discussed Options for Bridge End Treatments; graphics of guardrail lengths are attached to the meeting minutes
  - West End Pensacola Dam
    - Calculated guardrail length of need extends beyond the sidewalks on the north and south sides, and the substation entrance on the south side.
    - The retaining wall with fence on the south side of the highway is near the clear zone. Check with Heather Goodson on historic value.
  - East End Pensacola Dam
    - Move Beach Drive to the east to align with park entrance to the north, or move as far east as possible. Terrain is steep southeast of the dam.
    - Park entrance on the north side could be moved to the west to align with the relocated Beach Drive.
  - West Auxiliary Spillway Bridge Ends
    - No comments on guardrail lengths.
  - East Auxiliary Spillway Bridge Ends – particularly by parking lot at west end.
    - Proposed guardrail length on the north side at the west end is shorter than the existing guardrail length at this location. It is presumed the existing guardrail length serves to protect the Cherokee State Park Boat Ramp parking lot. This parking lot appears to be outside the SH 28 clear zone.
    - Proposed guardrail length on the south side at the west end is longer than the existing guardrail length at this location. The proposed length conflicts with a side road /drive.
    - No comments on guardrail lengths at east end.

- Emergency Detour Route
  - Do not include in 60% Plans; do include in 90% plans
  - Steve Jacoby to provide modification of north detour route to Benham

- 30% Plans; Comments
  - Title Sheet; replace ODOT with GRDA
  - Title Blocks, all sheets; replace ODOT with GRDA
  - Add Staking pay item if project remains a widening project
  - Include details to insure existing drains on north (upstream) side of the bridge are improved and extend away from superstructure

- Carbon Fiber Wrap and Rehabilitation Details
  - FYFE has presented their details for Carbon Fiber Wrap, and we will discuss further next week. They have also provided a full set of plan notes, which will be developed into a special provision to strengthen their effect on the project.
  - Special Provisions and Pay Item Notes will indicate clearly that this is not a typical fiber wrap project, but is for strength improvement, and qualified personnel will be required.
  - FYFE plans to contact local contractors to prepare a cost estimate. The cost of the fiber wrap and epoxy will be dwarfed by the cost of rigging. They will have the rigging included in their costs.
  - Simpson Strongtie will provide details and calculations within the next week or two.
  - Similar to the deck details, other repair details will include good condition scenarios and poor condition scenarios. Tables will be provided for the types of repairs per element and location, with an allowance for overruns of the various quantities for use as needed.

- Agreed Upon Schedule for 60% Plans:
  - 30% comments received today
    - Submit 60% plans 4/20/18
    - 60% Review meeting week of 5/7 to 5/11/18
    - Submit 60% Plans with Comments Incorporated 6/11/18 if all comments received at meeting

  - 60% Plans will incorporate
    - Further details for widening and rehabilitation, including fiber wrap
    - Rehabilitation of Catwalks, Abutments, Miscellaneous Repairs, and Deck Drain Extension Details
    - Construction Sequence Layouts Main Bridge, Spillway Bridges
    - Guardrail and End Treatment Improvements Main Bridge and Spillway Bridges.
    - Official Detour Route Sheets (SH-28/SH-20/SH-88).

  - Public Meeting
    - Plan continues to be to hold the public meeting after the funds for widening are anticipated to be forthcoming. Plan to hold in August 2018 or when the decision has been made.

Action Items			
What	Who	When	Status
Send pdf's of Bridge end treatments to Joe Brutsche and Steve Jacoby	Benham	3/19/2018	complete
Contact Heather Goodson with Cox McLain to determine if small retaining wall west of Pensacola Dam on the south side is a historical element	Benham	3/19/2018	complete
Provide Benham modified northern detour route	GRDA	3/30/2018	
Provide Benham feedback on Guardrail Length concerns on the north and south sides of the East Auxiliary Spillway Bridge, west end.	GRDA	3/30/2018	

SH-28 Pensacola Dam – Hydrodemolition Presentation

Project Name: GRDA SH-28 Widening over Pensacola Dam
Project Number GRDA: 41806
Project Number Benham: 1400204
Location: Division 8 Conference Room
Date: April 17, 2018
Attendees:

Steve Jacoby, GRDA
Craig Landrum, GRDA
Mike Holloway, ODOT
Paul Green, Freese & Nichols
Walt Peters, ODOT
Randle White, ODOT
Matt Casillas, ODOT
Jennifer Bullard, ODOT
Ryan Braggs, ODOT
Mohamed Elyazgi (ODOT, via phone)
Joe Brutsché (ODOT, via phone)
Trapper Parks, ODOT
Aaron Beats, ODOT
Justin Hernandez, ODOT
Ralph Nguyen, Aguirre & Fields
Staci Winlock, Aguirre & Fields
Karen Jones, Benham
Larry Wicks, Benham
Scott Foster, Benham
Sue Tryon, Benham

We believe the following record to be an accurate summary of decisions and related discussions. We will appreciate notification of exceptions to this record within 10 (ten) days of its receipt. Failing such notification, we will consider this a statement of fact in which you concur.

Discussion

The above listed parties met at ODOT Division 8 to hear a presentation by Patrick (Pat) Martens P.E., from Bridge Preservation and Inspection Services. Mr. Martens, a 30-year employee at the Missouri Department of Transportation in their bridge inspection division, started hydrodemolition rehabilitation projects in Missouri.

- Mr. Martens proceeded in explaining the hydrodemolition process.

  A programmable robot with an 8' wide path uses water jets with a force of 15-20 ksi to break up and dislodge inferior deck. In a typical removal, the robot uses about 55 gallons per minute. The source of water can be directly from the lake, but does need to be filtered. A vacuum-equipped vehicle follows the hydrodemolition robot to clean up the slurry and grit. The vacuum process should follow as close as possible to the demolition to avoid re-adherence to deck.

  There are two main options for removal: Fast Track (minimal bar exposure) and Deep Cutting (total bar exposure). Deep cutting extends about 3" deep into deck and will remove some sound concrete. Deep cutting is three to four times longer and three to four times more expensive. Fast Track is total removal of unsound concrete with minimal bar exposure; removing only unsound concrete with a single pass of calibrated pressure. Fast Track cleans up bars, clears out existing microfracturing and will not induce microfracturing. The remainder of the discussion focused on the Fast Track Process.

- Fast Track Process.

  The Fast Track process starts with mechanical milling of asphalt overlay and scarifying of concrete deck. The goal is to roughen the deck surface to allow the jets to engage the surface to start the cutting process. Leave a minimum of ½" of material for hydroblasting.

  After milling, the machine is calibrated, first by testing a sound concrete area by setting the hydroblasting depth to ½". It should only take one pass of the robot to obtain the ½". Next the hydrodemolition checks the calibration on unsound concrete with the same settings to ensure all unsound concrete is removed. The machine is calibrated to trace the delamination plane. There is some trial and error to find the correct settings. It's better to mill 1 ½" and hydro ½". The entire bridge is hydroblasted; no need to sound the deck to determine bad spots. The robot will seek out the bad areas. Selective removal ends up being a mix of sound and bad concrete.

  Add a specification in the plans to remove deck patches before the hydrodemolition because the patches tend to remain, which is not desirable. The robot is stopped short of drains and joints, and manual removal is required.

  The Contractor is required to have a water control plan and adhere to the Clean Water Act; the debris resulting from hydrodemolition may not disposed of into water features. A permit may be required. Hay bales, gravel berms, etc. may be used to collect the contaminated water. With Pensacola being so long and flat, the Contractor may need to work in stages to be able to collect the contaminated water.

  The final step in hydrodemolition is cleaning up the debris. A vacuum truck follows behind the robot. It takes several passes to obtain a clean deck.

  After the deck is cleaned, the entire deck is overlaid with latex modified concrete (LMC), which essentially waterproofs the concrete. For the LMC, a mobile batch plant is required and an auger and hopper are used to disperse LMC. It is important to have a contractor that is familiar working with LMC; it does not behave or cure like normal concrete. Moisture and wet burlap and plastic are very important to the curing process. In the LMC application, one of the main keys to a quality bond between the hydrodemolitioned deck and the LMC is to heavily saturate (flood) the surface to fill all the pores with water.

  High early strength LMC is available. Mr. Martens recommends 1 ½" minimum thickness of LMC. In extreme cases, LCM can be as thin as 1 ¼". LMC should be limited to a 3" depth due to the expense.

- Pensacola Dam Site Visit.

  Prior to our meeting, Mr. Martens made a site visit to Pensacola Dam to investigate the condition of the bridge deck and the other superstructure elements. He does not believe total bar exposure (Deep Cutting) is needed, and full-depth blow outs are unlikely. If GRDA opts to remove more material than the Fast Track procedure, a different method for cleaning up the debris would be required. Mr. Martens indicated that the Pensacola Dam deck rehabilitation project was a good Fast Track candidate.

- Quantities for the hydrodemolition process.

  -Price bid is per SY, regardless of the depth

  -Fast Track can perform cutting at a rate of 100 SY/ hour. The deep cutting procedure can only perform 20 SY/ hour and is 3-4 times more expensive.

-If restricted to weekend work, up to 1000 SY per robot can be performed.

-35 gallons/SY water is required for Fast Track operations, and approximately 3 times that volume for deep cuts.

-For a typical project, a figure of $200/SY would cover the costs of milling, hydrodemolition, and LMC. For a larger project, $120/SY should be adequate. The breakdown of unit prices is approximately $20/SY for milling, $25-30/SY for hydrodemolition, and $80/SY for LMC.

-Curing of LMC is approximately 24-48 hours for wet cure, or 48-72 hours for dry cure. Very early strength LMC can obtain 2,500 psi in 3 hours, and is a good option for overnight or weekend work.

-A typical Fast Track schedule for weekend work is:

- Friday 9pm close bridge,
- 10pm remove existing overlay,
- 12am start hydrodemolition,
- 12 pm Saturday complete hydrodemolition and vacuum operation. Start very early strength LMC.
- Sunday evening, re-open to traffic.

-The weight of a typical vacuum truck is 48k without debris. The strength of the deck will need to be investigated for the axle loads.

- Questions for Mr. Martens and general discussion:

-Contractors want to be paid for extra pockets of LMC. Mr. Martens suggests adding a pay item note: "Any variable depth placed over the calculated volume will be paid at $600/CY". The payment would be based on how much CY latex is placed vs. the square yard estimate times the required 1 ½" depth.

-To Mr. Martens knowledge, at most a tire has gone through a deck. If bad areas are encountered, repair them first with traditional Class C deck repairs, perform the milling operations, then hydroblast.

-Night construction is possible, but expensive.

-There was some discussion on the logistics for Pensacola, whether to widen first and then hydrodemolition and overlay afterwards, or to perform the hydrodemolition and overlay first and widen afterwards. More thought and discussion is required, but to widen first and follow with hydrodemolition and overlay would provide a smoother deck ride. The construction joint could be sealed with HMWM.

The deck requires additional reinforcing to raise the load rating. The positive moment areas can be reinforced with Carbon Fiber Wrap material. The recommendation for negative moment areas over the transverse beams was to sawcut a thin groove approximately 3/8" wide by 5/8" wide by 6' long, fill it with a carbon strand, and epoxy into place. This seems best done after the overlay, versus the expense of deep cutting. We had originally considered a deeper hydrodemolition to allow placement of a heavier upper mat of reinforcement.

The transverse beams are also a consideration. The transverse beams at the construction joints in the arch section are potentially less sound than can be addressed with carbon fiber wrap. They not only need a degree of soundness to allow rehabilitation, but also need to pass the pull-off tests necessary for carbon fiber wrap to be effective. CEC had performed the last in-depth bridge inspection.

- LMC is considered structural, acting compositely with the original deck. It can be considered a part of the structural section.

-Illinois has incorporated poly fibers in their latex modified concrete to reduce shrinkage cracks.

Action Items			
What	Who	When	Status
Did CEC sound the transverse beams during their inspection, particularly at the transverse beams at the joints?	Benham	5/17/2018	

SH-28 Pensacola Dam – 60% Plan Review Meeting

Project Name: GRDA SH-28 Widening over Pensacola Dam
Project Number: GRDA: 41806
Benham #: 1400204
Location: Division 8 Conference Room
Date: May 8, 2018 | 9:00 AM
Attendees:

Steve Jacoby | GRDA VP Hydro Operations
Randle White | ODOT Division 8 Engineer
Aaron Beats | ODOT Division 8 Claremore Residency
Joe Brutsché | ODOT PM Division
Betsy Abraham | ODOT PM Division
Sue Tryon | Benham PM
Karen Jones | Benham Structural Engineer
Larry Wicks | Benham Roadway/Traffic Engineer
Paul Green | Freese and Nichols
Ralph Nguyen | Aguirre & Fields

We believe the following record to be an accurate summary of decisions and related discussions. We will appreciate notification of exceptions to this record within 10 (ten) days of its receipt. Failing such notification, we will consider this a statement of fact in which you concur.

Discussion

- BUILD Grant Application
  - Opportunities for new federal grants have become available. These grants will not compete with any grants ODOT may pursue.
  - Critical grant milestone dates to work towards:
    - June 4, 2018 – Grants.gov application period begins
    - July 12, 2017 – Application completed (narrative, support letters, BCA, registration etc.)
    - July 19, 2018 – Application due via Grants.gov
    - December 18, 2018 – Anticipated Award
    - September 30, 2025 – Project Completion
  - Funding Availability:
    - Maximum grant award: $25 million with no more than $150 million to a single state
    - Minimum grant award: $5 million (urban); $1 million (rural)
    - Rural Preference: 30% or $450 million of appropriation to rural projects with an "equitable geographic distribution of grant funds"
    - Match: 20% but can be reduced in rural areas
- ODOT hosted a meeting with Patrick Martens, PE, of Bridge Preservation & Inspection Services on April 15, 2018. Patrick is a former MODOT Bridge Engineer, and expert on hydrodemolition and overlays. Following discussion with him regarding this project, the general consensus was that the best approach for the widening and rehabilitation project would be to widen the bridge prior to hydrodemolition and overlay, seal the longitudinal

joint with HMWM, perform milling and hydrodemolition, and place a Latex Modified Overlay over the new and existing bridge deck.

- Impact on Project Schedule
  - The current letting date for the superstructure rehabilitation is May 2019, with the start work order after Labor Day. GRDA and ODOT have discussed the BUILD Grant schedule, and have agreed to delay the development of 90% plans until after the announcement of grant awardees and moving the letting date.

  - **ODOT stressed the importance of completing construction within one lake season to minimize impact on the communities.** The proposed project schedule as follows:
    - December 18, 2018 | Anticipated grant award announcement
    - December 2018 | Decision for rehabilitation only or widen and rehabilitate.
    - January or February 2019 | Public Meeting. ODOT and GRDA will notify the communities.
    - May 2019 | Submit PS&E
    - July 2019 | Letting | Requires expedited 60-day Office Engineer review
    - August 2019 | Project Award
    - September 2019 | Begin construction after Labor Day
    - May 2020 | Re-open bridge to traffic (other than during the Big Meat event).

  - The schedule will be revised to accommodate the above dates, and action items developed that can be prepared in the interim between submittal of 60% plans with comments incorporated and the announcement of grant award.

- Construction Considerations
  - Plans were prepared prior to the decision to widen the bridge prior to rehabilitation. To show the widening construction ahead of the overlay during the 9 month closure of the dam, Phase 1 as shown on Sheet 0020 will be removed. Phase 1 depicted one-lane signalized traffic on the Main Bridge (Pensacola Dam) during the widening using channelizing cones to provide a wider construction work zone. Division 8 indicated portable longitudinal barrier needs to be used rather than channelizer cones in the work areas where the bridge parapet has been removed. Due to the width of portable longitudinal barrier, insufficient widths for thru traffic and construction would remain. For the bridge widening, the decision was made to completely close the Main Bridge during construction as displayed in Phase 2, Sheet 0021. Therefore the widening and hydrodemolition/overlay for all 3 bridges need to be performed within one lake season.

  - Additional construction may occur after re-opening the deck, while maintaining two way traffic in one lane with temporary signals at each end. The majority of the work is anticipated to be under the bridge.

  - Division 8 requested the Main Bridge construction between Langley and Disney be completed first before construction on the two Spillway Bridges begins.

  - GRDA requested the construction phasing take into consideration The Big Meat Run that occurs annually on a March weekend with 15,000 participants and spectators in the area that weekend. He suggested having a window a week before and after this event to have SH-28 and the bridges open for this event.

  - The rehabilitation projects are currently fully funded by the State (GRDA and ODOT). If the grant is won, the Federal funding will give the State Highway Preservation Office (SHPO) standing to become involved in the project.

- Paul Green will discuss widening project constructability and construction sequence with construction industry personnel to obtain feedback on widening project construction techniques and duration.

- GRDA and ODOT Division 8 anticipate portions of the deck may still have partial or full-depth blow-out. Class C Bridge Deck Repair will be included in the plans for use to maintain the deck during construction, including repair as needed prior to hydrodemolition.

- Pavement Section for Widening
  - The 60% Plans currently do not show a typical section for the roadway widening of SH-28 adjacent to the bridge ends. A concrete pavement section has been assumed for cost estimating purposes to date. Currently there is no geotechnical investigation or report of this area to determine the pavement section for the roadway widening. ODOT will investigate internally the review and approval process of the pavement design for this project.

- Bridge End Treatments | Guardrail with 5.5' widening & fill, except as noted.
  - Pensacola Dam (Main Dam & Spillway), Sheet 0017
    - West End
      - The sidewalk on the north and south sides, and the substation driveway on the south side are impacted by the length of guardrail. The retaining wall on the south side of the highway is impacted by the widening, requiring positive barrier to protect the blunt end.

      - Speed Limit. The current posted speed limit is 45 mph. In the case of rehabilitation only, reducing the speed limit would reduce the clear zone and therefore reduce the length of TR-4 rail required at the west end. ODOT mentioned that even if speed limit is lowered, people will still drive faster than the posted limit. The speed limit reduction can be revisited if the BUILD grant is not awarded for the widening and the project becomes bridge rehabilitation only. Reducing the speed limit for rehabilitation only case does not improve the required length of TR-4.

    - East End
      - Beach Drive Relocation | Drainage Flume | Terrain | Width of Drive
        - Relocate Beach Drive intersection with SH-28 as shown on 60% plans
        - The east side of the drive is bordered by a deep concrete drainage flume. The roadway alignment can be improved by starting the realignment closer to the parking area.

  - West Auxiliary Spillway (East Spillway No. 1), Sheet 0018
    - No comment on either end of the bridge.

  - East Auxiliary Spillway (East Spillway No. 2), Sheet 0019
    - West End
      - Close the east connection to SH 28 of circular drive on the south side of SH 28 across from Disney State Park. Relocate the west connection to SH 28 of the circular drive to align with Disney State Park entrance on the north side of SH 28.

      - The existing guardrail in the northwest quadrant of the bridge protects the bridge end and also appears to serve as a physical separation between the Disney State Park parking lot and SH 28. Extend the proposed guardrail in the northwest quadrant of the bridge further west to the approximate length of the existing guardrail.

- East End
  - Proposed guardrail extends into Delaware County will not be a problem.
  - Homeowner on the south side of SH 28 could be impacted by widening. Temporary ROW or Construction Easement may be required. GRDA will pull Right-of-Way information, if available.

- Emergency Detour Route
  - Include two available Emergency Detour Routes, labeled upper and lower routes across the Main Spillway, and a typical section in 60% Plans w/ Comments Incorporated. The upper route is currently preferred because it would be flooded less often then the lower route.
  - A 404 permit will not be required due to GRDA's jurisdictional authority.
  - For 90% Plans, add details for locked gates at beginning and end of Emergency Detour Route to keep non-emergency traffic from accessing the route.

- Miscellaneous 60% Plan Comments
  - Sheet 0017, Plan of Main Dam & Spillway West End – replace 42" F-Shaped Concrete Parapet, See Std. FSHP-42-2 with Concrete Traffic Rail (TR4), See Std. TR4-2.
  - Sheets 0022 & 0023 – show the deck overlay on the traffic control typical section in the upper left portion of the sheet.

- Upcoming Submittal:
  - Submit 60% Plans with Comments Incorporated | June 25, 2018. This set of plans will be used for the BUILD grant application.
  - Grant Application July 19, 2018.

Action Items			
What	Who	When	Status
Schedule meeting with John Jackson from Sherwood and a representative from Manhattan for insight on construction methods and sequencing	Paul Green	May 31, 2018	
Determine if geotechnical investigation is required for pavement design	Betsy Abraham, Joe Brutsché	May 31, 2018	
Review CEC inspection report to determine quantity of hinges at Main Dam that require repair	Sue Tryon	May 18, 2018	
Update Schedule | Develop list of Items to complete during the waiting period of the grant.	Sue Tryon	May 18, 2018	
Determine right of way limits for homeowner on southeast side of East Spillway No. 2	Steve Jacoby	June 29, 2018	

5/8/18
9AM Div 8

GRDA SH28 Pensacola Dam Widening & Rehab

Sue Tryon	Benham	sue.tryon@benham.com	918-599-4242
Larry Wicks	Benham	larry.wicks@benham.com	918-492-1600
Karen Jones	Benham	karen.jones@benham.com	492-1600
Ralph Nguyen	Aguirre & Fields	ralph.nguyen@aguirre-fields.com	405-759-6200
Paul Green	Freese and Nichols	paul.green@freese.com	405-974-0743
Betsy Abraham	ODOT	babraham@odot.org	405-522-2301
Steve Jacoby	GRDA	sjacoby@grda.com	918.610.9727
Joe Brutsche	ODOT PMD	jbrutsche@odot.org	405-522-7604
Randle White	ODOT Div 8	rwhite@ODOT.org	918-889933
Aaron Beats	ODOT-Claremore	abeats@odot.org	918-271-8330

APPENDIX C

UPDATED
CONSTRUCTION COST ESTIMATES

GRDA SH-28 Pensacola Dam Bridge
Widening & Rehabilitation Cost Estimate
July 18, 2018

Our core values guide every project, every team member and every workplace.

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Team | Excellence | Service | Trust

SUMMARY of ESTIMATED COSTS WIDENING & REHABILITATION | GRDA PORTION		
TOTAL BRIDGE A	$	16,929,000.00
TOTAL BRIDGE B	$	1,931,000.00
TOTAL BRIDGE C	$	1,735,000.00
SUBTOTAL BRIDGES A, B, & C	$	20,595,000.00
MOBILIZATION, STAKING, SWPPP, FIELD OFFICE	$	1,159,000.00
5% CONTINGENCY	$	1,095,000.00
TOTAL ESTIMATE WIDENING & REHABILITATION | GRDA PORTION	**$**	**22,849,000.00**

SUMMARY of ESTIMATED COSTS WIDENING & REHABILITATION | ODOT & GRDA		
TOTAL ESTIMATE WIDENING & REHABILITATION | GRDA PORTION	**$**	**22,849,000.00**
TOTAL ESTIMATE DECK REHABILITATION | ODOT PORTION	**$**	**5,000,000.00**
TOTAL ESTIMATE WIDENING AND REHABILITATION | ODOT & GRDA	**$**	**27,900,000.00**

JOB NO. 41806 NBI NO. 27569

BRIDGE "A" PAY ITEMS

0200 BRIDGE A

WIDEN & REHAB EXISTING BRIDGE WITH 51 ARCH SECTIONS @ 84', 21 GRAVITY OVERFLOW SECTIONS @ 41', AND 11 GRAVITY NON-OVERFLOW SECTIONS;
19'-8" CLEAR ROADWAY, SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 38+68.85 SH 28 MAIN BRIDGE OVER PENSACOLA DAM & SPILLWAY.

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	QTY	UNIT PRICE	TOTAL
303(A)	2100	AGGREGATE BASE TYPE A		CY	55	$ 45.00	$ 2,475.00
307(K)	4300	STABILIZED SUBGRADE		SY	325	$ 6.00	$ 1,950.00
325	5271	SEPARATOR FABRIC		SY	400	$ 2.00	$ 800.00
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	30	$ 70.00	$ 2,100.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	55	$ 80.00	$ 4,400.00
414(B)	5725	DOWEL JOINTED P.C.C. PAVT. (PLACEMENT)		SY	100	$ 15.00	$ 1,500.00
414(G)	5275	P.C. CONCRETE FOR PAVEMENT		CY	30	$ 120.00	$ 3,600.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 2,860,000.00	$ 2,860,000.00
503(A)	xxxx	PRESTRESSED BOX BEAMS (TEXAS)	(BR-1)	LF	4284	$ 500.00	$ 2,142,000.00
503(A)	xxxx	ARCH BEAM	(BR-1)	EA	51	$ 30,000.00	$ 1,530,000.00
503(A)	1313	PRESTRESSED CONCRETE BEAMS (TYPE IV)	(BR-1)	LF	1320	$ 475.00	$ 627,000.00
504(D)	6245	CONCRETE RAIL (TR4)	(BR-1)	LF	220	$ 80.00	$ 17,600.00
504(D)	xxxx	CONCRETE RAIL TYPE C411 (TEXAS)	(BR-1)	LF	5600	$ 400.00	$ 2,240,000.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	1720	$ 25.00	$ 43,000.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	400	$ 650.00	$ 260,000.00
506(A)	1322	STRUCTURAL STEEL		LB	6810	$ 3.00	$ 20,430.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	12420	$ 20.00	$ 248,400.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	4000	$ 800.00	$ 3,200,000.00
509(B)	1328	CLASS A CONCRETE	(BR-1)	CY	70	$ 650.00	$ 45,500.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	915400	$ 1.20	$ 1,098,480.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	3000	$ 30.00	$ 90,000.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	250	$ 100.00	$ 25,000.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	1000	$ 550.00	$ 550,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	6000	$ 4.00	$ 24,000.00
523(B)	6560	SEALER RESIN		GAL	70	$ 110.00	$ 7,700.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER		SF	16000	$ 35.00	$ 560,000.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	1000	$ 25.00	$ 25,000.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	20	$ 5,000.00	$ 100,000.00
540	4525	(PL) REPAIR BRIDGE ITEM (TYPE B)	(BR-3)	EA	20	$ 15,000.00	$ 300,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	1200	$ 30.00	$ 36,000.00
619(B)	2500	REMOVAL OF BRIDGE ITEMS	(BR-5)	LSUM	1	$ 500,000.00	$ 500,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	140	$ 20.00	$ 2,800.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	2	$ 2,800.00	$ 5,600.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	2	$ 2,000.00	$ 4,000.00
871(A)	8325	IMPACT ATTENUATOR		EA	2	$ 25,000.00	$ 50,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 300,000.00	$ 300,000.00

TOTAL BRIDGE A $ 16,929,383.00

JOB NO. 41806 NBI NO. 29642

BRIDGE "B" PAY ITEMS

0201 BRIDGE B

WIDEN & REHAB BRIDGE WITH 11 CONCRETE GIRDER SPANS @ 41', 20'-0" CLEAR ROADWAY,
SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 2+25.50 SH 28 OVER EAST SPILLWAY NO. 1

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	TOTAL	UNIT PRICE	TOTAL
303(A)	2100	AGGREGATE BASE TYPE A		CY	70	$ 45.00	$ 3,150.00
307(K)	4300	STABILIZED SUBGRADE		SY	425	$ 6.00	$ 2,550.00
325	5271	SEPARATOR FABRIC		SY	515	$ 2.00	$ 1,030.00
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	40	$ 70.00	$ 2,800.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	85	$ 80.00	$ 6,800.00
414(B)	5725	DOWEL JOINTED P.C.C. PAVT. (PLACEMENT)		SY	140	$ 15.00	$ 2,100.00
414(G)	5275	P.C. CONCRETE FOR PAVEMENT		CY	40	$ 120.00	$ 4,800.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 500,000.00	$ 500,000.00
503(A)	1313	PRESTRESSED CONCRETE BEAMS (TYPE IV)	(BR-1)	LF	451	$ 475.00	$ 214,225.00
504(D)	xxxx	CONCRETE RAIL TYPE C411 (TEXAS)	(BR-1)	LF	451	$ 400.00	$ 180,400.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	240	$ 25.00	$ 6,000.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	50	$ 650.00	$ 32,500.00
506(A)	1322	STRUCTURAL STEEL		LB	475	$ 3.00	$ 1,425.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	1100	$ 20.00	$ 22,000.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	500	$ 800.00	$ 400,000.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	229400	$ 1.20	$ 275,280.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	30	$ 30.00	$ 900.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	2	$ 100.00	$ 200.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	20	$ 550.00	$ 11,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	50	$ 4.00	$ 200.00
523(B)	6560	SEALER RESIN		GAL	1	$ 110.00	$ 110.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER	(BR-1)	SF	1400	$ 45.00	$ 63,000.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	20	$ 25.00	$ 500.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	5	$ 5,000.00	$ 25,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	120	$ 30.00	$ 3,600.00
619(B)	2500	REMOVAL OF BRIDGE ITEMS	(BR-5)	LSUM	1	$ 50,000.00	$ 50,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	100	$ 20.00	$ 2,000.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	4	$ 2,800.00	$ 11,200.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	4	$ 2,000.00	$ 8,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 100,000.00	$ 100,000.00

TOTAL BRIDGE B $ 1,930,818.00

JOB NO. 41806

NBI NO. 29645

BRIDGE "C" PAY ITEMS

0202 BRIDGE C

WIDEN & REHAB BRIDGE WITH 10 CONCRETE GIRDER SPANS @ 41', 20'-0" CLEAR ROADWAY,
SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 2+05.00 SH 28 OVER EAST SPILLWAY NO. 2

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	TOTAL	UNIT PRICE	TOTAL
303(A)	2100	AGGREGATE BASE TYPE A		CY	70	$ 45.00	$ 3,150.00
307(K)	4300	STABILIZED SUBGRADE		SY	425	$ 6.00	$ 2,550.00
325	5271	SEPARATOR FABRIC		SY	515	$ 2.00	$ 1,030.00
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	40	$ 70.00	$ 2,800.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	105	$ 80.00	$ 8,400.00
414(B)	5725	DOWEL JOINTED P.C.C. PAVT. (PLACEMENT)		SY	140	$ 15.00	$ 2,100.00
414(G)	5275	P.C. CONCRETE FOR PAVEMENT		CY	40	$ 120.00	$ 4,800.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 500,000.00	$ 500,000.00
503(A)	1313	PRESTRESSED CONCRETE BEAMS (TYPE IV)	(BR-1)	LF	410	$ 475.00	$ 194,750.00
504(D)	xxxx	CONCRETE RAIL TYPE C411 (TEXAS)	(BR-1)	LF	410	$ 400.00	$ 164,000.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	220	$ 25.00	$ 5,500.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	50	$ 650.00	$ 32,500.00
506(A)	1322	STRUCTURAL STEEL		LB	440	$ 3.00	$ 1,320.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	1000	$ 20.00	$ 20,000.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	380	$ 800.00	$ 304,000.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	176800	$ 1.20	$ 212,160.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	30	$ 30.00	$ 900.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	2	$ 100.00	$ 200.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	20	$ 550.00	$ 11,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	50	$ 4.00	$ 200.00
523(B)	6560	SEALER RESIN		GAL	1	$ 110.00	$ 110.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER	(BR-1)	SF	1300	$ 45.00	$ 58,500.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	20	$ 25.00	$ 500.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	5	$ 5,000.00	$ 25,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	110	$ 30.00	$ 3,300.00
619(B)	2500	REMOVAL OF BRIDGE ITEMS	(BR-5)	LSUM	1	$ 50,000.00	$ 50,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	300	$ 20.00	$ 6,000.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	4	$ 2,800.00	$ 11,200.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	4	$ 2,000.00	$ 8,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 100,000.00	$ 100,000.00

TOTAL BRIDGE C $ 1,734,018.00

GRDA SH-28 Pensacola Dam Bridge
Rehabilitation Cost Estimate
July 18, 2018

Our core values guide every project, every team member and every workplace

BENHAM a Haskell Company

Team | Excellence | Service | Trust

SUMMARY of ESTIMATED COSTS REHABILITATION | GRDA PORTION		
TOTAL BRIDGE A	$	8,262,000.00
TOTAL BRIDGE B	$	734,000.00
TOTAL BRIDGE C	$	668,000.00
SUBTOTAL BRIDGES A, B, & C	$	9,664,000.00
MOBILIZATION, STAKING, SWPPP, FIELD OFFICE	$	716,000.00
5% CONTINGENCY	$	519,000.00
TOTAL ESTIMATE REHABILITATION | GRDA PORTION	**$**	**10,899,000.00**

SUMMARY of ESTIMATED COSTS REHABILITATION | ODOT & GRDA		
TOTAL ESTIMATE REHABILITATION | GRDA PORTION	**$**	**10,899,000.00**
TOTAL ESTIMATE DECK REHABILITATION | ODOT PORTION	**$**	**5,000,000.00**
TOTAL ESTIMATE REHABILITATION | ODOT & GRDA	**$**	**15,900,000.00**

JOB NO. 41806 NBI NO. 27569

BRIDGE "A" PAY ITEMS

0200 BRIDGE A

REHAB EXISTING BRIDGE WITH 51 ARCH SECTIONS @ 84', 21 GRAVITY OVERFLOW SECTIONS @ 41', AND 11 GRAVITY NON-OVERFLOW SECTIONS; 19'-8" CLEAR ROADWAY, SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 38+68.85 SH 28 MAIN BRIDGE OVER PENSACOLA DAM & SPILLWAY.

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	QTY	UNIT PRICE	TOTAL
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	30	$ 70.00	$ 2,100.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	55	$ 80.00	$ 4,400.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 2,000,000.00	$ 2,000,000.00
503(A)	xxxx	PRESTRESSED BOX BEAMS (TEXAS)	(BR-1)	LF	4284	$ 500.00	$ 2,142,000.00
504(D)	6245	CONCRETE RAIL (TR4)	(BR-1)	LF	220	$ 80.00	$ 17,600.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	1720	$ 25.00	$ 43,000.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	400	$ 650.00	$ 260,000.00
506(A)	1322	STRUCTURAL STEEL		LB	6810	$ 3.00	$ 20,430.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	1420	$ 15.00	$ 21,300.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	2000	$ 700.00	$ 1,400,000.00
509(B)	1328	CLASS A CONCRETE	(BR-1)	CY	70	$ 650.00	$ 45,500.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	315400	$ 1.20	$ 378,480.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	3000	$ 30.00	$ 90,000.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	250	$ 100.00	$ 25,000.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	1000	$ 550.00	$ 550,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	6000	$ 4.00	$ 24,000.00
523(B)	6560	SEALER RESIN		GAL	70	$ 110.00	$ 7,700.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER		SF	16000	$ 35.00	$ 560,000.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	1000	$ 25.00	$ 25,000.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	20	$ 5,000.00	$ 100,000.00
540	4525	(PL) REPAIR BRIDGE ITEM (TYPE B)	(BR-3)	EA	20	$ 15,000.00	$ 300,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	1100	$ 30.00	$ 33,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	140	$ 20.00	$ 2,800.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	2	$ 2,800.00	$ 5,600.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	2	$ 2,000.00	$ 4,000.00
871(A)	8325	IMPACT ATTENUATOR		EA	2	$ 25,000.00	$ 50,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 150,000.00	$ 150,000.00

TOTAL BRIDGE A $ 8,261,958.00

JOB NO. 41806

NBI NO. 29642

BRIDGE "B" PAY ITEMS

0201 BRIDGE B

REHAB BRIDGE WITH 11 CONCRETE GIRDER SPANS @ 41', 20'-0" CLEAR ROADWAY,
SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 2+25.50 SH 28 OVER EAST SPILLWAY NO. 1

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	TOTAL	UNIT PRICE	TOTAL
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	40	$ 70.00	$ 2,800.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	85	$ 80.00	$ 6,800.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 75,000.00	$ 75,000.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	240	$ 25.00	$ 6,000.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	50	$ 650.00	$ 32,500.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	140	$ 15.00	$ 2,100.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	220	$ 700.00	$ 154,000.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	169400	$ 1.20	$ 203,280.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	30	$ 30.00	$ 900.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	2	$ 100.00	$ 200.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	20	$ 550.00	$ 11,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	50	$ 4.00	$ 200.00
523(B)	6560	SEALER RESIN		GAL	1	$ 110.00	$ 110.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER	(BR-1)	SF	1400	$ 45.00	$ 63,000.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	20	$ 25.00	$ 500.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	5	$ 5,000.00	$ 25,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	120	$ 30.00	$ 3,600.00
509(A)	1326	REMOVAL OF BRIDGE ITEMS	(BR-5)	LSUM	1	$ 50,000.00	$ 50,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	100	$ 20.00	$ 2,000.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	4	$ 2,800.00	$ 11,200.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	4	$ 2,000.00	$ 8,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 75,000.00	$ 75,000.00

TOTAL BRIDGE B $ 733,238.00

JOB NO. 41806

NBI NO. 29645

BRIDGE "C" PAY ITEMS

0202 BRIDGE C

REHAB BRIDGE WITH 10 CONCRETE GIRDER SPANS @ 41', 20'-0" CLEAR ROADWAY,
SKEW 0°, CONCRETE PARAPETS AT ℄ STA. 2+05.00 SH 28 OVER EAST SPILLWAY NO. 2

ITEM NO.	CODE NO.	DESCRIPTION	NOTES	UNIT	TOTAL	UNIT PRICE	TOTAL
407(B)	0250	TACK COAT		GAL	8	$ 6.00	$ 48.00
411(B)	5945	SUPERPAVE, TYPE S3(PG 64-22 OK)		TON	40	$ 70.00	$ 2,800.00
411(C)	5960	SUPERPAVE, TYPE S4(PG 64-22 OK)		TON	105	$ 80.00	$ 8,400.00
502	6116	(PL) FALSEWORK JACKING		LSUM	1	$ 75,000.00	$ 75,000.00
504(G)	6390	RAPID CURE JOINT SEALANT	(BR-1)	LF	220	$ 25.00	$ 5,500.00
504(H)	6389	ELASTOMERIC MORTAR	(BR-1)	CF	50	$ 650.00	$ 32,500.00
509	xxxx	SPECIAL CONCRETE FINISH (BLEND CFRP TO EXISTING)		SY	110	$ 15.00	$ 1,650.00
509(A)	1326	CLASS AA CONCRETE	(BR-1)	CY	200	$ 700.00	$ 140,000.00
511(B)	6010	EPOXY COATED REINFORCING STEEL	(BR-1)	LBS	126800	$ 1.20	$ 152,160.00
520(A)	6058	PREPARATION OF CRACKS, ABOVE WATER		LF	30	$ 30.00	$ 900.00
520(C)	6060	EPOXY RESIN, ABOVE WATER		GAL	2	$ 100.00	$ 200.00
521(A)	6210	PNUEMATICALLY PLACED MORTAR		SY	20	$ 550.00	$ 11,000.00
523(A)	6550	SEALER CRACK PREPARATION		LF	50	$ 4.00	$ 200.00
523(B)	6560	SEALER RESIN		GAL	1	$ 110.00	$ 110.00
524(A)	6610	(SP) CARBON FIBER-REINFORCED POLYMER	(BR-1)	SF	1300	$ 45.00	$ 58,500.00
535	6130	(SP) CORROSION INHIBITOR (SURFACE APPLIED)		SY	20	$ 25.00	$ 500.00
540	4515	(PL) REPAIR BRIDGE ITEM (TYPE A)	(BR-2)	EA	5	$ 5,000.00	$ 25,000.00
616(B)	xxxx	4" POLYVINYL CHLORIDE (PVC) PIPE	(BR-1,4)	LF	110	$ 30.00	$ 3,300.00
509(A)	1326	REMOVAL OF BRIDGE ITEMS	(BR-5)	LSUM	1	$ 50,000.00	$ 50,000.00
623(A)	0932	BEAM GUARDRAIL W-BEAM SINGLE		LF	300	$ 20.00	$ 6,000.00
623(G)	8590	GUARDRAIL END TREATMENT (31")		EA	4	$ 2,800.00	$ 11,200.00
623(I)	8700	GUARDRAIL BRIDGE CONN-THRIE BEAM (31")		EA	4	$ 2,000.00	$ 8,000.00
880(J)	8905	CONSTRUCTION TRAFFIC CONTROL		LSUM	1	$ 75,000.00	$ 75,000.00

TOTAL BRIDGE C $ 667,968.00

APPENDIX D

UPDATED HISTORIC PRESERVATION ALTERNATIVES ANALYSIS

ALTERNATIVES ANALYSIS

PENSACOLA DAM AND SPILLWAYS

DESCRIPTION OF PROJECT SCOPE

The purpose of the project is to extend the life of three bridges carrying State Highway 28 (SH-28) over the Grand Neosho River in Mayes County, Oklahoma. The bridge structures cross the Pensacola Dam and Spillways constructed in 1940 and require substantial rehabilitation to continue serving the needs of Grand River Dam Authority (GRDA), the Oklahoma Department of Transportation (ODOT), and the adjoining communities. GRDA and ODOT are committed to restoring the strength of the aging structures and are coordinating their efforts in order to minimize the impacts of the rehabilitation to the public.

The main bridge and auxiliary bridges cross the Pensacola Dam and Spillways. The Dam includes a hydroelectric powerhouse at the west end, supplying electricity to Northeastern Oklahoma. The intake structures for the powerhouse take water from the upstream portion of the lake through the arch structures, and into the powerhouse. The spillway sections are used to control the lake level, for recreational use of the lake as well as for flood control on the Grand Neosho River system. A platform is located on the upstream side of the spillway, allowing a gantry crane to traverse the length of the spillway to raise and lower the gates, and also to raise and lower stoplogs to close a section of the spillway for maintenance of the gate and/or spillway.

Working from west to east, the main bridge is identified by three primary sections based on the type of support from the dam: (1) Arch Section, supported by the arches forming the dam on the bridge; (2) Spillway Section, supported by piers extending upwards through the main spillway; and (3) Non-Overflow Section, supported by piers extending up from a gravity dam.

The two bridges over the Auxiliary Spillways are supported by the same construction as the main Spillway Section. They do not have arch or non-overflow sections.

The dam and spillways on which the bridges are located are components of the National Register of Historic Places (NRHP) - listed Pensacola Dam Historic District. As such, the proposed project is being carefully planned to preserve the character and aesthetic of the bridges, as well as to avoid or minimize adverse effects to the historic district. Although the proposed project has not yet been classified as a federal action to which Section 106 of the National Historic Preservation Act would pertain, the application of the criteria of effect, in accordance with 36 CFR 60 and 36 CFR 800.11, provides a useful framework for the discussion below about how each of the proposed alternates may affect the Pensacola Dam Historic District.

EXISTING CONDITIONS

Main Bridge over Pensacola Dam (NBI 27569)

The main bridge over Pensacola Dam was last inspected during the routine inspection cycle in October 2016. The concrete bridge decks on the Arch Section, Spillway Sections, and the Non-Overflow Section are integral with the superstructure members. The bridge deck is covered with an asphaltic overlay that has extensive deterioration throughout the length of the bridge. The overlay has been patched in multiple locations in both driving lanes. The deck joints are leaking, which has caused the superstructure elements to show signs of water deterioration. The deck soffit, the underside surface of the bridge deck, is in good condition, with minor spalls and efflorescence present. The deck drains in the arch sections drain onto the superstructure members. The water has discolored the concrete at the drain pipe locations.

The superstructure on Arch Section, Spans 1 to 51, consists of the reinforced concrete deck supported by transverse floor beams. The floor beams are supported by spandrel arches and a continuous longitudinal reinforced concrete beam. The spandrel arches tie into the buttresses of the dam. The continuous longitudinal beams rest on the buttresses.

The buttresses were not inspected as part of the October 2016 inspection; therefore, the buttress condition is unknown at this time. The dam has minor spalls and scaling. Minor spalling is present on the arches below the expansion joints. Span 19 has a moderate spall on the spandrel arch. Discoloration and scaling are present on the arches and longitudinal beams from water as a result of the deck drain flow. The longitudinal concrete beams have hairline cracking at various locations. The cracks are more frequent near midspan. The location along the beams indicate that stress from live-load could be the source of the cracking. The hinge locations approximately 7 feet from end of arch bearing points at beam ends) on the continuous longitudinal beams have shear cracks. Despite these spalls and cracks, the spandrel arches and longitudinal concrete beam are in satisfactory condition.

The transverse floor beams at the expansion joints for Arch Spans 1 to 51 are in fair condition. The floor beams typically show water discoloration, cracking, spalls, scaling, and some delamination. The floor beams have been repaired in the past. The previous floor beam repairs consisted of patching spalls, adding galvanized steel angle to the top of beams and adding bearing pads. The bearing pads have failed and are no longer in position. The transverse beams in between expansion joints are in good condition.

At the Spillway Section and Non-Overflow Sections, Spans 52 to 83, the superstructure consists of the reinforced concrete deck supported by transverse floor beams. The longitudinal beams spans rest on piers. The pier caps for these spans have minor spalls. The east abutment has moderate spalls and cracking on the face of the seat. The floor beams are supported by longitudinal reinforced concrete beams. The longitudinal concrete beams are in good condition. Water discoloration is present, but no major deterioration is present. The transverse floor beams for longitudinal beam spans 52 to 83 are in good condition with minor spalls.

In addition to the existing conditions discussed above, the bridge is load posted for 16-tons for a single two-axle truck, 29-tons for a single trailer (three-axle truck), and 45-tons for double trailer units. The deck controls the load rating of the bridge. It is likely the bridge was originally designed for an H15 or H20 truck, which is a two-axle truck weighing a total of 15 or 20 tons, respectively. To remove the load posting from the bridge, the capacity will need to reach the required operating rating of H23, or 23 tons.

Grand Lake Spillway Bridges (NBI 29642, 29645)

The spillway bridges were last inspected during the routine inspection cycle in October 2016. The concrete bridge decks on the reinforced concrete girder spans are integral with the superstructure members. The bridge decks are covered with an asphaltic overlay that has extensive deterioration throughout the length of the bridge. The overlay has been patched in multiple locations. The bridge decks have visible spalls and scaling. The deck joints are filled with debris and are leaking, which has caused the superstructure elements to show signs of water deterioration. The deck drains drain onto the superstructure members. The water has discolored the concrete at the drain pipe locations.

The superstructures consist of the reinforced concrete deck that is integral with the longitudinal beam and transverse floor beam system. The longitudinal girders and floor beams have some hairline cracks and spalls. The beams have discoloration from the deck drains. The superstructures of the spillway bridges are in satisfactory condition.

The substructures of the spillway bridges consist of reinforced concrete abutments and piers. The substructures are in fair condition. The pier caps below the expansion joints have water staining, minor spalls and cracks.

As with the Main Bridge over Pensacola Dam, the spillway bridges are load posted for 16-tons for a single two-axle truck, 29-tons for a single trailer (three-axle truck), and 45-tons for double trailer units. The floor beams control the load rating of the spillway bridges. To remove the load posting from the bridges, the capacity will need to reach the required operating rating of H23, or 23 tons.

HISTORIC PRESERVATION AND CULTURAL RESOURCES

Significance of Pensacola Dam Historic District

The Pensacola Dam Historic District is listed in the National Register of Historic Places under Criterion C as an excellent example of multiple arch dam engineering. With 51 arches, the dam is the longest multi-arch dam in the United States, the only Oklahoma example of a multi-arch dam, and the state's first hydroelectric dam. The historic district is comprised of three contributing buildings and four contributing structures - dam, the powerhouse, a substation, two spillways, and a pumping/intake structure – and one non-contributing observation house. The dam and spillways carry SH-28 on bridges incorporated into the structures. Components of the historic district, such as the buildings and the bridge railings, reflect the Streamline Moderne architectural style.

Description of Pertinent Components

The following provides a description of the components pertinent to the proposed project. For description of other components within the Pensacola Dam Historic District, see the National Register of Historic Places nomination available through the Oklahoma State Historic Preservation Office's website.

Constructed between 1938 and 1940, the Pensacola Dam complex is located on the Grand River, which is a major contributor to the Arkansas River basin. The underlying limestone and chert of the river channel's bottom made for the ideal foundation for the dam. The top of the dam is 150 above the channel bottom and is 6,565 feet long, including the spillways. The arched section of the dam is comprised of 51-barrel arches that are each 140 feet in height. The clear span width of each arch is 60 feet at the base and 24 feet at the top. They rest on double-wall hollow buttresses that are 84 feet center to center. The three spillways are gravity type gated spillways that are shaped in an elongated S fashion, or ogee, from gate to river bottom. At 861 feet in length, the main spillway is incorporated into the east end of the dam. Two smaller spillways are located east of the dam.

The SH-28 bridges have a 20-foot-wide bridge and a four-foot-wide sidewalk along the upstream side. On the dam section, girders rest on top of spandrel arch barrels to support the bridge on the upstream side and open spandrel arches extend out from the buttresses to support the bridge on the downstream side. Over the spillways, the bridges are comprised of concrete girders.

Character-defining Features

When considering a proposed project's effects on a historic property, establishing the character-defining features is important. Character-defining features are the distinctive and visible aspects, qualities, or characteristics of a historic property that convey its significance. Character-defining features may include engineering design, and structural and decorative details. Historic fabric may also be an important consideration. Historic fabric may be a character-defining feature, but it can also be found on other elements of a historic property that are not identified as character-defining.

The Pensacola Dam Historic District is significant as the only multi-arch dam in Oklahoma, the longest multi-arch dam in the United States, and the state's first hydro-electric dam. As such, the following are the character-defining features of the historic district:

- 51 arches comprising the dam
- Overall length of the dam and spillways
- System comprised of the dam, powerhouse, intake/pumping structure, and substation to generate electricity

While the bridges that are subject to the proposed rehabilitation and widening project are not character-defining features of the historic district, they are elements of the district's historic fabric, and thus, must be considered when developing the plans for the proposed project. The application of the Secretary of the Interior's *Standards for Treatment of Historic Properties* (SOI Standards) discussed in the next section are also an important component of the project planning process.

Applying the Secretary of the Interior's *Standards for Treatment of Historic Properties*

The SOI Standards provides guidance on how to preserve, rehabilitate, restore, and reconstruct historic properties. In the case of the proposed SH-28 rehabilitation and widening project, the SOI Standards for rehabilitating historic properties are most applicable. Compliance with the SOI Standards provides for the preservation of the Pensacola Dam Historic District's integrity while accommodating the rehabilitation and widening of the bridges. The SOI Standards for Rehabilitation are summarized below:

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize the property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Each of these standards has been taken into account in the development of the proposed rehabilitation and widening projects.

Alternatives Analysis

The alternatives analysis includes the proposed rehabilitation and three alternatives for widening SH-28 over Pensacola Dam and Spillways. Each widening alternative would increase the clear roadway from 19'-10" to 24'-0". Widening to the upstream and downstream were considered. Structural members were sized for the Arch Section, Main Spillway, Non-Overflow Section, and East Spillways for each of the three alternatives. Factors taken into consideration during development of the widening alternatives include the following:

- Aesthetic concerns, particularly regarding the visual impact of the bridge railing, arch sections, and spillway piers.
- Available means of construction; the existing bridge is narrow and construction activities may share the roadway with traffic. Short-term closures of the roadway will be required. Specialized equipment and techniques for working above the powerhouse, arches, and spillways will be required.
- Use of precast or prefabricated components to reduce onsite construction time.
- Use of components and techniques that limit the weight of new construction.
- Construction should not obstruct operations of the powerhouse and spillways for any of the alternates.
- Demolition of existing bridge parapet(s) will be evaluated for the cut-line for tie-in to the existing deck, as well as the effect of removal of the existing parapets on the buttresses, piers, and abutments at each end of the bridge.
- Cost of construction

Although the proposed project may not ultimately be classified as federal action to which Section 106 of the National Historic Preservation Act would pertain, the application of the criteria of effect, in accordance with 36 CFR 60 and 36 CFR 800.11, provides a useful framework for understanding how each of the proposed alternatives may affect the Pensacola Dam Historic District. To assess the potential direct and indirect effects, the rehabilitation and three widening

alternatives are presented below with a discussion how each alternative may or may not impact the seven aspects of integrity.

❖ Rehabilitation Alternative

GRDA and ODOT share responsibility for the maintenance of the three bridges. ODOT maintains the driving surface of the bridges between the curbs. GRDA owns and maintains the remainder of the bridge at each location. Additionally, GRDA owns and is responsible for the hydroelectric powerhouse at the west end of the main dam, and the dam itself and its spillways and operations.

ODOT is preparing plans for the deck rehabilitation. The plans will specify that automated water jets will be used to remove unsound concrete from the upper surface of the deck (hydroblast). The depth of the concrete removal is dependent upon the integrity of the deck at each location. With the extent of deterioration on these bridges, the concrete removal may extend from 1 inch to possibly 4 or 5 inches in depth. The removed concrete will then be replaced with a concrete overlay, with a new top mat of reinforcing. The deck joints will be cleaned and sealed to prevent moisture from leaking onto the superstructure below the deck. Deck drains will be improved by installing angled pipes to move water away from the superstructure elements below the deck.

GRDA will prepare plans for the rehabilitation of the remainder of the bridge, as part of this design contract. Spalls in the deck soffits, transverse floor beams, longitudinal beams, spandrel arches and substructure elements will be repaired by removing deteriorated concrete and applying pneumatically placed mortar. Exposed reinforcing steel at spall locations will be cleaned and corrosion inhibitor applied to prevent further deterioration. Cracks that require repair will be cleaned, deteriorated concrete removed, and injected with epoxy resin. Additionally, key locations will be restored with a carbon fiber material which is adhered to the concrete with an epoxy resin, a process called Carbon Fiber Reinforced Polymer (CFRP). On each structure, additional floor beams will be installed between the existing floor beams to provide more strength to the structure. On the main (dam) structure, the added floor beams in the arch section will be supported by box beams that will run from buttress to buttress inside the spandrel arches. On the spillway and non-overflow section of the main (dam) structure and on the two spillway structures, the added floor beams will tie into the sides of the existing longitudinal girders. In development of the design to strengthen the structures to remove the load posting, several alternatives were considered and dismissed, as follows:

1) only use the CFRP for strengthening the structures – will not provide sufficient strength
2) thicken the existing deck – the deck would have to be double the existing thickness to provide sufficient strength but that would increase the overall load of the structures too much; and
3) fully replace the deck – this option would entail removal and reconstruction of all elements of the deck, including the railing, sidewalks, etc. However, it would be very expensive and would not meet the SOI Standards, thus resulting in an adverse indirect effect to the historic property.

The majority of the rehabilitation of the bridges other than the driving surface can be accomplished from the underside of the bridges, with minimal interference with traffic on the highway. Work platforms are anticipated to be suspended underneath the bridges using rigging attached to the parapets, or supported by scaffolding from the downstream side of the dam, allowing access to the entire span as needed. Materials can be lowered over either side of the bridges to the platforms, or lifted from the downstream side of the dam.

The catwalks in the spillway portion of the main structure have localized damage in need of repair. The supporting structure under the ends of some catwalks is spalling and requires the removal of existing unsound concrete and replacement with new concrete. The supports for handrails in some locations require similar removal and replacement.

Evaluation of the bearing system at the hinges and beam supports will be performed during preparation of the plans. Suitable details will be developed to restore their proper function. Provisions will be made for the patching of concrete spalls or the epoxy injection of cracks at isolated locations along exposed areas of the dam. These will be identified during the rehabilitation project and repaired accordingly.

The bridges are load posted for 16-ton single truck, 29-ton for single trailer, and 45-ton for double trailer units. With the addition of the new floor beams and the CFRP, it is anticipated the structures will be sufficiently strengthened to have the load posting removed.

Application of Criteria of Effect

The Criteria of Effect were applied to the proposed rehabilitation discussed above. It is recommended the proposed rehabilitation would pose no adverse direct effect and no indirect effect to the characteristic-defining features for which the Pensacola Dam Historic District is significant. The following discusses the analysis with regard to each aspect of historic integrity.

Location – As a result of the rehabilitation alternative, there would be no change in location for the Pensacola Dam Historic District, as a whole, or any of the contributing resources within the district. As such, integrity of location will not be diminished.

Association – The proposed rehabilitation alternative will not sever the direct link between the historic district and its contributing resources with the engineering significance they convey. Furthermore, the proposed rehabilitation will not affect the character-defining features of the historic property. Thus, integrity of association will not be diminished.

Feeling – As with integrity of association, there will be no effect to the character-defining features of the historic property. Therefore, integrity of feeling will not be diminished.

Setting – The proposed rehabilitation alternative will not have an effect on the historic property's integrity of setting. There will be no change to the environment in which the

historic property is located or its relationship to surrounding features and open space. Thus, integrity of setting will not be diminished.

Design – The proposed rehabilitation alternative will not adversely affect the Pensacola Dam Historic District's integrity of design. The proposed rehabilitation will not change the form, plan, space, structure, and style of the overall historic property. The proposed rehabilitation would have a minimal effect on non-contributing elements with the addition of the floor beams. However, there will be no impact to the functions and technologies of the historic property.

Materials – The proposed rehabilitation alternative will have no adverse effect on the Pensacola Dam Historic District's integrity of materials. Repairs to the spalling concrete will be completed in-kind, and strategies to blend the new concrete with the old concrete in color and texture will be employed. Likewise, strategies will be employed to blend the very thin material of the fiber reinforced polymer with the adjacent concrete so that the material will barely be discernable, especially at the distance from which it would be viewed (the material will be applied to bridge members that are not visible to the traveling public or pedestrians, but rather are only visible from the ground below the dam on the downstream side). The proposed rehabilitation alternative will follow the SOI Standards, particularly Standard No. 6, and integrity of materials will not be diminished to such a degree the historic property will no longer convey its significance.

Workmanship – As with integrity of materials, the proposed rehabilitation alternative will have no adverse effect on the historic property's integrity of workmanship. Repairs to areas of spalled concrete and application of the fiber reinforced polymer will not obscure or diminish the features and evidence of the builders' labor and skill in constructing the Pensacola Dam and the associated structures. Per the SOI Standards, spalled concrete repairs will be completed in-kind, and strategies will be employed to blend the repaired areas and areas where the CFRP will be applied with the adjacent concrete. Likewise, the addition of the floor beams will have no adverse effect on the historic property's integrity of workmanship. On the arch portion of the main (dam) structure, the floor beams would be added inside the spandrel arches. On the spillway and non-overflow portion of the main (dam) structure and on the spillway structures, the floor beams would be added inside the fascia girders. These additional floor beams would not diminish the features of the historic property. The new floor beams would be distinguished from the existing floor beams but would not detract from or obscure the overall evidence of the builders' labor and skill. While there will be minor effects to integrity of workmanship, the effects will not rise to such a degree the historic property will no longer convey its significance.

As discussed above, the proposed rehabilitation would not diminish any aspects of the Pensacola Dam Historic District's integrity to such a degree that it can no longer convey its engineering significance. Therefore, the proposed rehabilitation would pose no adverse effect to the historic

property. Additionally, the proposed rehabilitation would pose no indirect effects to the historic property.

❖ Widening Alternative 1, Downstream Side

The Alternate No. 1 design removes the existing downstream curb and parapet and widens downstream by 4'-6" to obtain 2-12' lanes. One additional longitudinal beam line is proposed to be added to support the downstream edge of the new slab and the new parapet. Beam supports would tie into each arch buttress or pier as applicable, depending on location. Construction on the downstream side does not negatively affect stability of the dam. The public view of the dam from the downstream side is not primary, as the downstream side is more secluded and has less access. However, the arch and powerhouse portion of the dam are visually exceptional. Special consideration of the aesthetics for the new barrier and buttress tie-in will be required. The upstream parapet, sidewalk and curb will not be affected or modified.

In addition to the rehabilitation described above, two preliminary designs were developed; one for the Arch Sections of Pensacola Dam, and another design for the Non-Overflow and all spillway sections. The design summaries follow.

- Arch Section (84'-0" span)

  <u>Proposed Preliminary Member Sizes, Downstream</u>

  - Precast Spandrel Arch
  - Arch support is a triangular-shaped corbel that extends along the full width of the buttress face and approximately 5' on the sides
  - Use rail rated with a TL-2 test level for a maximum vehicle speed of 45 mph

  <u>Design Progression</u>

  The design approach for the arch sections keeps the distinctive arch, a feature that provides the dams' elegance and character, as visible as possible. Efforts were made to minimize the beam depth to maintain visibility of the existing arch. Prestressed box beams were investigated, with depths as shallow as 20 inches. However, the prestressed box beams would most likely be fabricated in Texas and cost approximately three times that of an ODOT prestressed concrete beam. Due to the high cost, this beam type was abandoned and a Type III beam was considered. The depth of the Type III beam, 3'-9", allows the existing arch to be visible, although not prominent.

  The location of the existing expansion joints is not at the spans' ends. As the design progressed, it was determined that the original 1938 segmental beam configuration needed to be approximated to minimize the differential movements and deterioration in the deck. Therefore, a 33"x20" (height x width) beam was selected, as the Type III beam cannot be segmentally constructed and supported.

During a preliminary meeting with the SHPO on October 11, 2017, Cox|McLain and Benham. Design discussed the aesthetics of widening to the downstream side, and the visual impact of the widening on the arch section in particular. Maintaining visibility of the arch is highly desirable.

Therefore, a precast arch beam was selected for the downstream widening at the arch section. The arch and spandrels are proposed to be tied into the existing structure and supported by a corbel that is mechanically connected into the face of the buttress. Our investigation determined that precast concrete fabricators are able to fabricate the spandrel arches economically. The arches would be lifted into place using cranes, which would be positioned at ground level on the downstream side of the dam. Two 110-ton cranes would be required to place the precast arches due to the height and reach required to place the arches in the area of the powerhouse.

- Non-Overflow and Spillway sections (41'-0' simple spans)

  Proposed Preliminary Member Sizes, Downstream

  - Type IV prestressed beam
  - Beam support is a triangular-shaped corbel that extends along full width of pier face
  - Use rail rated with a TL-2 test level for a maximum vehicle speed of 45 mph

  Design Progression

  The Main Spillway, Non-Overflow and East Spillways No. 1 and No. 2 sections all have identical span lengths, therefore the same beam design is proposed. Although the design span is not long (41 feet), a Type IV prestressed beam is selected in order for the beam support to be connected to the main structural portion of the spillway piers. The aesthetics for this section are not as critical as at the arch section.

Application of Criteria of Effect

The Criteria of Effect were applied to Widening Alternative No. 1 discussed above. It is recommended the proposed widening alternative would pose no adverse direct effect and no indirect effect to the characteristic-defining features for which the Pensacola Dam Historic District is significant. The following discusses the analysis with regard to each aspect of historic integrity.

Location – As a result of the widening alternative, there would be no change in location for the Pensacola Dam Historic District, as a whole, or any of the contributing resources within the district. As such, integrity of location will not be diminished.

Association – The proposed widening alternative will not sever the direct link between the historic district and its contributing resources with the engineering significance they convey.

Furthermore, the proposed widening will not affect the character-defining features of the historic property because it would not change the length of the dam, directly impact any of the arches, or impact the system's ability to produce hydro-electricity. Thus, integrity of association will not be diminished.

Feeling – As with integrity of association, there will be no effect to the character-defining features of the historic property. Therefore, integrity of feeling will not be diminished.

Setting – The proposed widening alternative will not have an effect on the historic property's integrity of setting. There will be no change to the environment in which the historic property is located or its relationship to surrounding features and open space. Thus, integrity of setting will not be diminished.

Design – The proposed widening alternative will not adversely affect the Pensacola Dam Historic District's integrity of design. The proposed widening would have no impact on the functions and technologies of the historic property, and will not change the form, space, structure, and overall style of it. However, there will be a minor change in the plan of the bridges that carry SH-28 across the top of the dam and spillways. The proposed widening would increase the width of the three bridges by four feet to the downstream side. The widened sections would be cantilevered off the side of the dam and spillways and would be supported by bracing at the buttresses. New floor beams would be added between the existing floor beams on each structure to increase the structures' strength and to allow for the load posting to be removed. On the main (dam) structure, the added floor beams in the arch section will be supported by box beams that will run from buttress to buttress inside the spandrel arches. On the spillway and non-overflow section of the main (dam) structure and on the two spillway structures, the added floor beams will tie into the sides of the existing longitudinal girders.

A new railing would be installed on the downstream side of each structure that would be compatible in design to the existing railing but would be obviously new. Several options for the new railing were considered: open concrete parapet, closed concrete parapet, and combination of concrete and steel parapet. After review of potential options, it was determined the Texas Classic Traffic Rail, Type T411 would be a compatible design that is clearly differentiated from the historic railing.

While the widening alternative would be a minor impact to the overall design of the dam and spillways, the widening would not directly affect the historic property's character-defining features and would not affect spatial relationships that characterize the historic property. The new work would be differentiated from the old and would be compatible with the historic materials, features, size, scale and proportion, and massing. Therefore, integrity of design would not be diminished to such a degree that the Pensacola Dam Historic District would no longer be able to convey its significance.

Materials – The proposed widening alternative will have no adverse effect on the Pensacola Dam Historic District's integrity of materials. The widened sections would be constructed of concrete and strategies to blend the new concrete with the old concrete in color would be employed to avoid having bright white new concrete. The widened section would be differentiated from the old but would be compatible with the historic materials. Integrity of materials will not be diminished to such a degree the historic property will no longer convey its significance.

Workmanship –The proposed widening alternative will have no adverse effect on the historic property's integrity of workmanship. As discussed above, the widened section would be compatible with the historic materials, features, size, scale and proportion, and massing of the existing bridges. Likewise, the addition of the floor beams will have no adverse effect on the historic property's integrity of workmanship. On the arch portion of the main (dam) structure, the floor beams would be added inside the spandrel arches. On the spillway and non-overflow portion of the main (dam) structure and on the spillway structures, the floor beams would be added inside the fascia girders. They would not diminish the features of the historic property. The new floor beams would be distinguished from the existing floor beams but would not detract from or obscure the overall evidence of the builders' labor and skill. While some of the historic features on the buttresses and spandrel columns may be obscured by the new, cantilevered section, and the historic railing would be replaced on the downstream side, these elements are not considered character-defining features of the historic property. Therefore, the proposed widening alternative does not rise to such a degree the historic property will no longer convey its significance.

As discussed above, the proposed widening would not diminish any aspects of the Pensacola Dam Historic District's integrity to such a degree that it can no longer convey its engineering significance. While the proposed widening would result in some changes to the design, materials, and workmanship, these changes would not directly impact the historic property's character-defining features. There would be no direct effect on the arches of the dam; there would be no change in the length of the structure; and there would be no impact on the system's ability to produce hydro-electricity. Therefore, the proposed widening would pose no adverse effect to the historic property. Additionally, the proposed widening would pose no indirect effects to the historic property.

❖ Widening Alternative 2, Upstream Side

Alternate No. 2 removes the existing upstream curb, sidewalk, and parapet and widens the bridge by 6'-2" to obtain 2-12' lanes. The existing sidewalk is only 4'-0" wide and decreases to about 3'-0" at the light poles. The replacement sidewalk is reconstructed to 6'-0" wide to accommodate the light poles and an ADA compliant sidewalk. The primary public view of the dam is from the upstream side. Special consideration of the aesthetics, historic preservation and pedestrian safety

for the new parapet and sidewalk are required. The downstream side parapet and curb would not be affected or improved.

Widening to the upstream side presents many complications. The upstream side of the bridges have gate hoist structures which are used for the spillway gate operations. Each bridge has a gate hoist platform, which is fitted with rails to allow a gantry crane to move along the spillway to raise and lower the spillway gates, and to allow installation and removal of stoplogs for maintenance. To widen the bridges to the upstream side would require extensive modification to the gate hoists and gantry cranes.

Several potential suppliers of the replacement hoist system were contacted. The most responsive supplier was the David Round Company, headquartered Ohio. Based on a review of the drawings of the existing equipment and Alternative 2, the David Round representative generally confirmed that it would be possible to replace the existing gate hoists with new hydraulic equipment. Depending on the final specifications for the gate hoists, including the capacity, drive mechanism, control systems, and other details, the representative estimated the cost per gate hoist to likely be in the $250,000 to $500,000 range. The gantry platform and gantry crane are still required for the stoplog operations, and would require a new minimal height gantry crane to provide for clearance to the planned roadway and walkway modifications.

In addition to the rehabilitation activities described above, two preliminary designs were developed; one for the Arch Sections of Pensacola Dam, and another design for the Non-Overflow and all spillway sections. The design summaries follow.

- Arch Section (84’-0” span)

<u>Preliminary Member Sizes, Upstream</u>

- 48”x26” segmental prestressed beam
- 5’x5’ concrete angled brace for widening support located at buttresses
- Existing arches shall not directly support any new loads
- Use rail rated with a TL-2 test level for a maximum vehicle speed of 45 mph

<u>Design Progression</u>

Similar to the downstream widening of the arch spans, consideration of the expansion joint location was evaluated and the upstream beam is proposed to be constructed in segments matching the original upstream beams at the arch sections.

The additional weight and forces from the widening are not applied to the arch portion of the dam. Instead a 5’x5’ brace that extends from the new upstream beam to the buttress is proposed to transfer the loads to the buttress.

- Non-Overflow and Spillway sections (41'-0' simple spans)

Proposed Preliminary Member Sizes, Downstream

- Type II prestressed beam
- Beam Supports undetermined at this time
- Due to high costs to modify the gate hoists and gantry crane, Alternate No. 2 is not
- practical or economical, and further analysis is not warranted.

Design Progression

The shorter, simple spans of the Non-Overflow and spillways allow for a reasonable beam size.

An additional option for the upstream widening was considered. Benham proposed to raise the sidewalk over the gate structures to save the cost to modify the gate structures. This option was deemed unacceptable by all parties.

Application of Criteria of Effect

The Criteria of Effect were applied to Widening Alternative No. 2 discussed above. It is recommended the proposed widening alternative would pose an adverse indirect effect to the characteristic-defining features for which the Pensacola Dam Historic District is significant due to the substantial amount of historic fabric that would be removed to accommodate the widening alternative. The following discusses the analysis with regard to each aspect of historic integrity.

Location – As a result of the widening alternative, there would be no change in location for the Pensacola Dam Historic District, as a whole, or any of the contributing resources within the district. As such, integrity of location will not be diminished.

Association – The proposed widening alternative will not sever the direct link between the historic district and its contributing resources with the engineering significance they convey. Furthermore, the proposed widening would not change the length of the dam, directly impact any of the arches, or impact the system's ability to produce hydro-electricity. Thus, integrity of association will not be diminished.

Feeling – As with integrity of association, there will be no effect to the character-defining features of the historic property. Therefore, integrity of feeling will not be diminished.

Setting – The proposed widening alternative would minimally impact the historic property's integrity of setting. The sidewalk overlook would be removed from the dam bridge in widening alternative no. 2, thereby changing the relationship of how pedestrians experience the surrounding features and open space. While a variation to raise the sidewalk over the gantry crane platform was considered, the analysis indicated the variation would introduce a substantial visual element to the setting that would constitute and adverse effect to the

setting. Therefore, the variation was dismissed from further consideration. Widening Alternative No. 2 would minimally diminish integrity of setting.

Design – The proposed widening alternative will not adversely affect the Pensacola Dam Historic District's integrity of design. The proposed widening would have no impact on the functions and technologies of the historic property, and will not change the form, space, structure, and style of it. However, there will be a minor change in the plan of the bridges that carry SH-28 across the top of the dam and spillways. The proposed widening would increase the width of the three bridges by four feet to the downstream side. The widened sections would be cantilevered off the side of the dam and spillways and would be supported by bracing at the buttresses. New floor beams would be added between the existing floor beams on each structure to increase the structures' strength and to allow for the load posting to be removed. A new railing would be installed on the upstream side of each structure that would be compatible in design to the existing railing but would be obviously new. The overlook would be removed and would not be reintroduced with this widening alternative. While the widening alternative would be a minor impact to the overall design of the dam and spillways, the widening would not directly affect the historic property's character-defining features and would not affect spatial relationships that characterize the historic property. The new work would be differentiated from the old and would be compatible with the historic materials, features, size, scale and proportion, and massing. Therefore, integrity of design would not be diminished to such a degree that the Pensacola Dam Historic District would no longer be able to convey its significance.

Materials – The proposed widening alternative would have an indirect adverse effect on the Pensacola Dam Historic District's integrity of materials due to the extent of the historic fabric that would be removed with this widening alternative. To minimize the effects, the widened sections would be constructed of concrete and strategies to blend the new concrete with the old concrete in color would be employed to avoid having bright white new concrete. The widened section would be differentiated from the old but would be compatible with the historic materials. Although integrity of materials would not be diminished to such a degree the historic property would no longer convey its significance, the indirect effects would be adverse.

Workmanship –The proposed widening alternative will have no adverse effect on the historic property's integrity of workmanship. As discussed above, the widened section would be compatible with the historic materials, features, size, scale and proportion, and massing of the existing bridges. Likewise, the addition of the floor beams will have no adverse effect on the historic property's integrity of workmanship. On the arch portion of the main (dam) structure, the floor beams would be added inside the spandrel arches. On the spillway and non-overflow portion of the main (dam) structure and on the spillway structures, the floor beams would be added inside the fascia girders. They would not diminish the features of the historic property. The new floor beams would be distinguished from the existing floor beams

but would not detract from or obscure the overall evidence of the builders' labor and skill. While some of the historic features on the buttresses and spandrel columns may be obscured by the new, cantilevered section, and the historic railing would be replaced on the downstream side, these elements are not considered character-defining features of the historic property. Therefore, the proposed widening alternative does not rise to such a degree the historic property will no longer convey its significance.

As discussed above, Widening Alternative No. 2 would not diminish any aspects of the Pensacola Dam Historic District's integrity to such a degree that it can no longer convey its engineering significance. However, the cumulative extent of the loss of historic fabric, particularly resulting from the changes to the sidewalk, overlook, and gantry platform area, would result in an adverse indirect effect to integrity of materials and setting. The relatively minor changes to the design and workmanship would not constitute direct effects on the historic property's character-defining features. There would be no direct effect on the arches of the dam; there would be no change in the length of the structure; and there would be no impact on the system's ability to produce hydro-electricity. The proposed widening would pose no adverse direct effect, but would pose adverse indirect effects, to the historic property.

- Widening Alternative 3, Downstream and Upstream Sides

Alternate No. 3 is a combination of Alternate No. 1 and Alternate No. 2. Alternate No. 3 provides for additional width for construction and flexibility for traffic access during construction. The downstream side is widened by 4'-6" to obtain 2-12' lanes and the upstream is widened by approximately 1'-0" to increase the sidewalk width from 4'-0" to 5'-0". The 1'-0" upstream widening is the minimum possible without interfering with the gate hoist structures. Both upstream and downstream rails are proposed to be replaced. The light standards would be relocated from the sidewalk to the outside edge of the upstream railing.

The same beam sizes and supports proposed for Alternate No. 1 would be used for Alternate No. 3. An additional beam line would not be added to the upstream side of the bridge.

Alternate No. 3 is essentially Alternate No. 1 with minimal widening gained on the upstream side, and double the cost of the rail replacement. While more practical and achievable than Alternate No. 2, the cost increase over Alternate No. 1 does not provide sufficient benefit to continue the analysis.

<u>Application of Criteria of Effect</u>

The Criteria of Effect were applied to Widening Alternative No. 3 discussed above. It is recommended the proposed widening alternative would pose an adverse indirect effect to the characteristic-defining features for which the Pensacola Dam Historic District is significant due to the substantial amount of historic fabric that would be removed to accommodate the widening alternative. The following discusses the analysis with regard to each aspect of historic integrity.

Location – As a result of the widening alternative, there would be no change in location for the Pensacola Dam Historic District, as a whole, or any of the contributing resources within the district. As such, integrity of location will not be diminished.

Association – The proposed widening alternative will not sever the direct link between the historic district and its contributing resources with the engineering significance they convey. Furthermore, the proposed widening would not change the length of the dam, directly impact any of the arches, or impact the system's ability to produce hydro-electricity. Thus, integrity of association will not be diminished.

Feeling – As with integrity of association, there will be no effect to the character-defining features of the historic property. Therefore, integrity of feeling will not be diminished.

Setting – The proposed widening alternative would minimally impact the historic property's integrity of setting. The sidewalk overlook would be removed from the dam bridge in widening alternative no. 3, thereby changing the relationship of how pedestrians experience the surrounding features and open space. Thus, integrity of setting would be minimally diminished.

Design – The proposed widening alternative will not adversely affect the Pensacola Dam Historic District's integrity of design. The proposed widening would have no impact on the functions and technologies of the historic property, and will not change the form, space, structure, and style of it. However, there will be a minor change in the plan of the bridges that carry SH-28 across the top of the dam and spillways. The proposed widening would increase the width of the three bridges by 4'-6" to the downstream side and 1'-0" to the upstream side to increase the sidewalk width by 1'-0". The widened sections would be cantilevered off the side of the dam and spillways and would be supported by bracing at the buttresses. New floor beams would be added between existing floor beams, and would be supported by box beams inside the spandrel arches on the main (dam) structure and inside the fascia girders on the spillway structures. A new railing would be installed on both sides of each structure. The overlook would be removed and would not be reintroduced with this widening alternative. The light standards would be moved from the sidewalk to the outside edge of the upstream railing. While the widening alternative would be a minor impact to the overall design of the dam and spillways, the widening would not directly affect the historic property's character-defining features and would not affect spatial relationships that characterize the historic property. The new work would be differentiated from the old and would be compatible with the historic materials, features, size, scale and proportion, and massing. Therefore, integrity of design would not be diminished to such a degree that the Pensacola Dam Historic District would no longer be able to convey its significance.

Materials – The proposed widening alternative would have an indirect adverse effect on the Pensacola Dam Historic District's integrity of materials due to the extent of the historic fabric that would be removed with this widening alternative. To minimize the effects, the widened sections would be constructed of concrete and strategies to blend the new concrete with the old concrete in color would be employed to avoid having bright white new concrete. The widened section would be differentiated from the old but would be compatible with the historic materials. Although integrity of materials would not be diminished to such a degree the historic property would no longer convey its significance, the indirect effects would be adverse.

Workmanship –The proposed widening alternative will have no adverse effect on the historic property's integrity of workmanship. As discussed above, the widened section would be compatible with the historic materials, features, size, scale and proportion, and massing of the existing bridges. Likewise, the addition of the floor beams will have no adverse effect on the historic property's integrity of workmanship. On the arch portion of the main (dam) structure, the floor beams would be added inside the spandrel arches. On the spillway and non-overflow portion of the main (dam) structure and on the spillway structures, the floor beams would be added inside the fascia girders. They would not diminish the features of the historic property. The new floor beams would be distinguished from the existing floor beams but would not detract from or obscure the overall evidence of the builders' labor and skill. While some of the historic features on the buttresses and spandrel columns may be obscured by the new, cantilevered section, and the historic railing would be replaced on the downstream side, these elements are not considered character-defining features of the historic property. Therefore, the proposed widening alternative does not rise to such a degree the historic property will no longer convey its significance.

As discussed above, Widening Alternative No. 3 would not diminish any aspects of the Pensacola Dam Historic District's integrity to such a degree that it can no longer convey its engineering significance. However, the cumulative extent of the loss of historic fabric, particularly resulting from the changes to the sidewalk with the removal of the overlook and full replacement of the railing, would result in an adverse indirect effect to integrity of materials and setting. The relatively minor changes to the design and workmanship would not constitute direct effects on the historic property's character-defining features. There would be no direct effect on the arches of the dam; there would be no change in the length of the structure; and there would be no impact on the system's ability to produce hydro-electricity. The proposed widening would pose no adverse direct effect, but would pose adverse indirect effects, to the historic property.

CONCLUSION

The Rehabilitation and Widening Alternative No. 1 have been developed to minimize the impacts to the historic district to the greatest extent possible while meeting the project needs to provide a safe and efficient transportation system that will continue to serve the traveling public for many years to come. Through the application of the Criteria of Effect set forth in 36 CFR 800.11 provided the framework to assess the potential effects the alternatives may have on the Pensacola Dam Historic District. The assessment resulted in a recommendation that the Rehabilitation and Widening Alternative No. 1 would not pose adverse direct effects and no indirect effects to the historic district.

APPENDIX E

NEPA
STUDY LIMITS

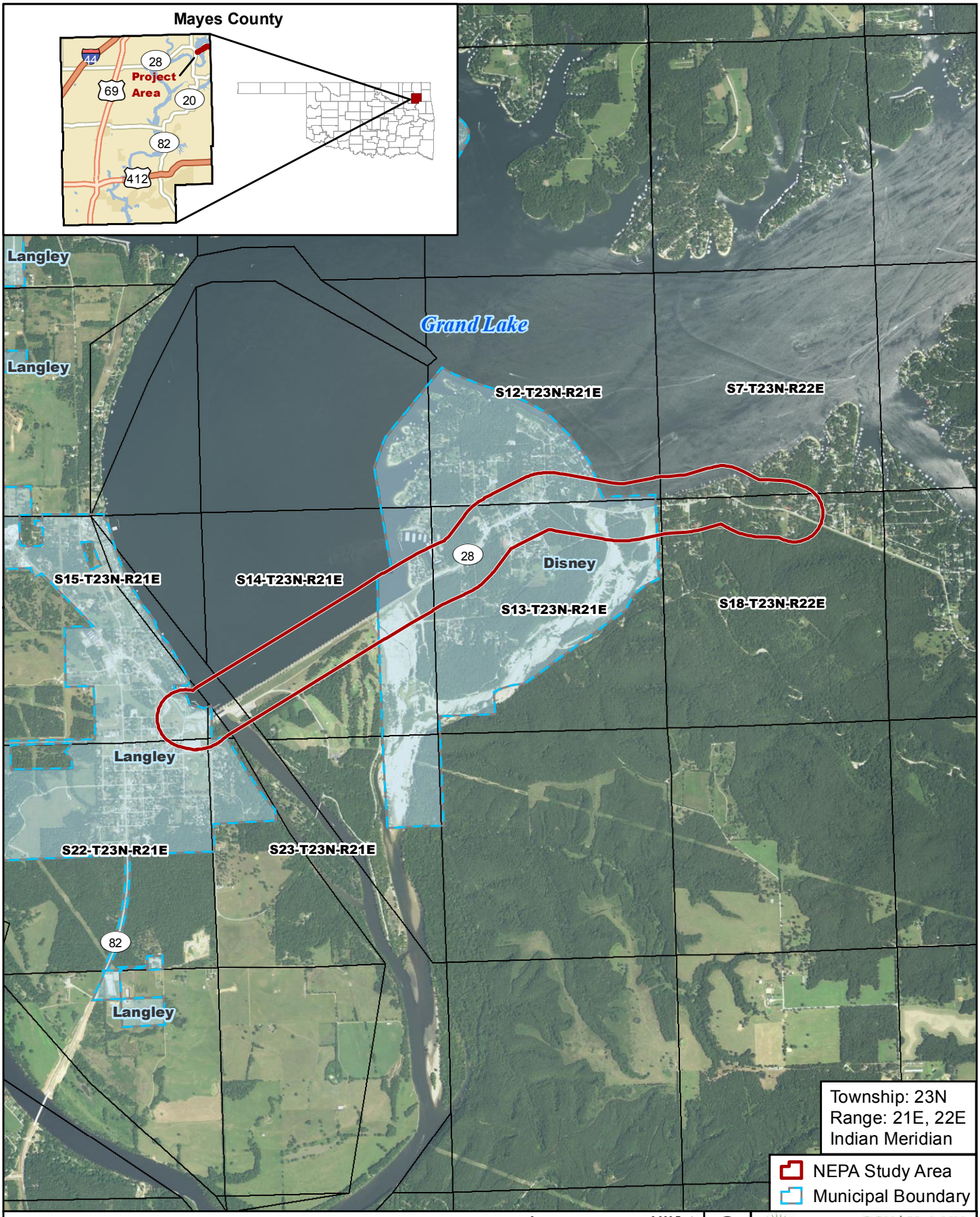

Figure 1

Project Location (Aerial Base)

SH-28 over Pensacola Dam, Mayes County

0 3,000 Feet
0 800 Meters

Data Source: OU CSA (2017)
Aerial Source: NAIP (2015)

COX | McLAIN Environmental Consulting

Prepared for: Benham	1 inch = 3,000 feet
Prepared by: MCS	Scale: 1:36,000
Date: 11/2/2017	

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Preliminary Specialists' Studies Area (Sheet 1 of 3)
Project No. 41806
SH 28: Bridge Widening and Rehabilitation in Mayes County

Specialists' Studies Area
NHD Stream
Improvement Centerline
Match Line
Section Line

Data Sources: OSU CSA (2017), NHD (2014)
Aerial Source: DigitalGlobe (2016)

0 200 Feet
0 60 Meters

Prepared for: Benham, GRDA	1 in = 200 feet
	Scale: 1:2,400
	Date: 5/14/2018

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Preliminary Specialists' Studies Area (Sheet 2 of 3)

Project No. 41806

SH 28: Bridge Widening and Rehabilitation in Mayes County

Specialists' Studies Area
Improvement Centerline
Section Line
NHD Stream
Match Line

Data Sources: OSU CSA (2017), NHD (2014)
Aerial Source: DigitalGlobe (2016)

Prepared for: Benham, GRDA	1 in = 200 feet
	Scale: 1:2,400
	Date: 5/14/2018

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Preliminary Specialists' Studies Area (Sheet 3 of 3)
Project No. 41806
SH 28: Bridge Widening and Rehabilitation in Mayes County

Specialists' Studies Area
Improvement Centerline
Section Line
NHD Stream

Data Sources: OSU CSA (2017), NHD (2014)
Aerial Source: DigitalGlobe (2016)

0 200 Feet
0 60 Meters

Prepared for: Benham, GRDA	1 in = 200 feet
	Scale: 1:2,400
	Date: 5/14/2018

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