ARKANSAS RIVER CORRIDOR

Appendix G: Civil Engineering

ARKANSAS RIVER CORRIDOR, TULSA COUNTY, OKLAHOMA

Introduction

The Arkansas River is a water resource serving numerous nationally significant purposes. The river has historically served as a nationally significant resource for aquatic and terrestrial habitat of the nation's wildlife that live, breed, and migrate through the Arkansas River ecosystem. This includes federally endangered Interior Least Tern (Least Tern, *Sterna antillarum*), a nationally significant resource, and one federally threatened bird species, the Piping Plover (*Charadrius melodus*) as well as a plethora of native species and migratory waterfowl that support a healthy and functional riverine ecosystem. Keystone Lake and its dam located along the Arkansas River play vital roles in supporting the continued provision for these species, as well as many other purposes. In particular, the lake and dam provide flood risk management benefits, contribute to the eleven reservoir system operation of the McClellan-Kerr Arkansas River Navigation System, provide clean and efficient power through the associated hydropower plant, and provide a source of water for municipal and industrial uses. However, construction, operation, and maintenance of the Keystone Dam, lake, associated hydropower operations and other multipurposes have significantly degraded the riverine ecosystem structure, function, and dynamic processes below Keystone Dam on the Arkansas River within Tulsa County, Oklahoma.

Purpose

This study is in response to the Section 3132 authorization of the 2007 WRDA. The purpose of this study is to evaluate the aquatic ecosystem restoration components of the October 2005 Arkansas River Corridor Master Plan (ARC Master Plan) and determine if there is a Federal Interest that aligns with the Corps of Engineers' ecosystem restoration mission.

Study Authority

The Arkansas River Corridor study is authorized in the Water Resources Development Act (WRDA) of 2007, Section 3132.

Section 3132. Arkansas River Corridor.

- (a) IN GENERAL. The Secretary is authorized to participate in the ecosystem restoration, recreation, and flood damage reduction components of the Arkansas River Corridor Master Plan dated October 2005. The Secretary shall coordinate with appropriate representatives in the vicinity of Tulsa, Oklahoma, including representatives of Tulsa County and surrounding communities and the Indian Nations Council of Governments.
- (b) AUTHORIZATION OF APPROPRIATIONS. There is authorized to be appropriated \$50,000,000 to carry out this section.

Non-Federal Sponsor

Tulsa County is the non-federal sponsor for the Arkansas River Corridor feasibility study. An amended feasibility cost-sharing agreement was executed in May 2015.

Recommended Plan

Alternative 5 is the National Ecosystem Restoration (NER) Plan and includes construction of a pool structure at River Mile 530 to regulate flow in the Arkansas River, a rock riffle feature associated wetland plantings at Prattville Creek, and construction of a sandbar island near Broken Arrow, OK. With the implementation of the NER plan, more natural river flow would return to 42 river miles of the Arkansas River within the study area. The NER plan would provide approximately 2,144 acres of additional riverine habitat, nearly doubling the amount of currently available habitat under low flow conditions. Also five acres of restored wetlands, and three acres of reliable sandbar island habitat where none currently succeed, would be restored as part of the NER plan. Shoreline, river, backwater, slackwater, wetland, and sandbar island habitat quality would all be improved generating an overall increase in the ecosystem quality and carrying capacity of the corridor. Current operation of Keystone Dam would not be changed. Additional water and flow would remain within the existing banks of the river and would not increase the flood elevation, nor downstream or backwater flooding.

GENERAL DESCRIPTION

The purpose of this appendix is to outline conceptual engineering designs for the measures identified during the study process. The measures are outlined in the main body of this study report. Civil engineering efforts were conducted to provide a foundation for the development of a government estimate as well as a visualization of the measures. The management measures included two possible locations (but not both) for a pool structure; rock riffle structures; and wetland and riparian plantings at Prattville Creek and/or I-44/Riverside. These measures were combined into 11 plans, consisting of stand-alone plans and partially formed plans, for populating Institute for Water Resources (IWR) Planning Suite to generate alternatives, or combination of the plans. All plans assumed South Tulsa/Jenks low water dam is in place and functioning as the Future With Project Condition. Benefits and first costs were developed for each of the 11 partially formed/stand-alone plans as described in the main body of this report. The array of plans are:

- Pool structure located at river mile 531 (former site of Lake Keystone Project reregulating dam)
- Pool structure located at river mile 530
- Constructed Least Tern Island
- Rock Riffle Structures at Prattville Creek
- Rock Riffle Structures and Wetland Plantings at Prattville Creek
- Rock Riffle Structures and Riparian Planting at Prattville Creek
- Rock Riffle Structures, Wetland Plantings, and Riparian Plantings at Prattville Creek
- Rock Riffle Structures at I-44 Riverside
- Rock Riffle Structures and Wetland Plantings at I-44 Riverside
- Rock Riffle Structures and Riparian Planting at I-44 Riverside
- Rock Riffle Structures, Wetland Plantings, and Riparian Plantings at I-44 Riverside

RECOMMENDED PLAN

SUMMARY OF MEASURES

Pool Control Structure: In April of 2015 CH2M Hill produced the "Arkansas River Low Water Dams and Public Access/Recreational Improvements" report for Tulsa County, the Non-Federal sponsor. The report included schematic designs and cost estimates including an analysis and concept for a low water dam in the Sand Springs area. The CH2M efforts serve as the design basis for the pool control structure measure carried forward in this study. The concept design and basis of estimate for the pool control structure are the same regardless of chosen location for the structure at this stage in the project.

The key to reaching the restoration goals is being able to deliver the full pool of water

when needed for sustained flow and providing at least seasonal fish/egg passage, particularly during spring when there are sustained flood pool releases from Keystone. Delivery a sustained flow and fish/egg passage are key design requirements and will be considered constraints during the design phase following feasibility. The initial design concept featured a combination of full and partial height gates. Full height gates allow the passage needed during bigger flow events and the ability to use the full pool and the partial height gates allow for water management when maintaining the restoration goal of 1,000 cfs.

Design Constraints

Constraints were identified based on meetings with US Fish and Wildlife Service and OK Department of Environmental Quality on July 19, 2017 and a site visit to observe 1000 cfs flow on September 11, 2017. The resource agencies provided input into dam design and operation.

- Pool Structure should be located to provide storage to sustain 1000 cfs during times of non-hydropower production ~ about three days.
- Operation of structure will not affect hydropower production, or other operations of Keystone Dam.
- Pool Structure should be able to open gates allow fish eggs to tumble downstream on the river bed. Obermeyer gates allow this.
- Pool Structure should allow fish passage both up and downstream during spawning season.
- Design will fully consider life safety issues that have been previously associated with structures below Keystone Dam.

The pool control structure is shown in the conceptual images and design drawings below. The images depict gates in operation to maintain pool between peak demand weekday hydropower generation and gates down to allow for unregulated river flow and unobstructed fish/egg/sediment passage. Design drawings are conceptual and will be further developed during the PED phase to account for the project location described in this study and the appropriate elevations. The structure will have a crest elevation of 638.5 feet. The Geotechnical Appendix contains rationale for an assumed founding depth of 610.0 feet. This is in line with the bottom elevation depicted on the concept design drawings developed by CH2M Hill. The structure is 1,900 feet in length with a total gate area of 8,192 square feet. The full-height gate section is 10 feet high.

Additional design assumptions for the pool control structure include: Rock anchors will be required; concrete will need to be cooled for mass placement; the river will be diverted using the sand material excavated from the dam footprint to construct a temporary earthen coffer dam in conjunction with a portable cofferdam system; dewatering will be required; rock excavation will be required; grouted rock will be placed on the downstream side of the dam for ballast and scour protection; Obermeyer Gates will be used for water control (concept shown below); gate equipment will be housed in new maintenance structure; a maintenance access bridge will span the structure; soldier pile retaining walls with cast in place concrete facing will extend up and down river on each bank from

midpoint of pool structure.

Operation of Structure

The structure will be designed to sustain the 1000 cfs flow during non-hydropower production. Hydropower production at Keystone Dam is for peak power only. Typically hydropower pulses from Keystone occur each weekday evening from about 1700-2100. As hydropower pulses are released from Keystone Lake, water will be stored behind the recommended pool structure downstream of Keystone Dam. Any water released during hydropower production that is not needed to maintain the 1000 cfs flow will be released from the downstream pool structure. When hydropower is not being produced the pool control structure would operate to release 1000 cfs flows. It is estimated that storage in the pool will last approximately 2.5 days during the weekend when hydropower is not typically produced. The operation will be closely monitored during the adaptive management phase until performance of system is optimized.

Safety Considerations

From 1968 to 1985 a reregulation dam located 7.8 miles downstream of Keystone Dam was in operation for the purpose of smoothing hydropower releases and providing water quality control flows. This reregulation dam was removed in part due to safety concerns. The design of the former dam created a roll over effect on the downstream side due to the shape of the structure. If a person were to fall into the water, the strength of the churning water would create a life threatening hazard. Design features (e.g. a gentler slope on the downstream side of the structure) will be incorporated to reduce dangerous roll over churn seen in the previous design.

In addition, project security requirements for the non-federal sponsor to ensure public safety and physical security of the structure will be developed in the PED phase of this project. Physical security plans will be developed in accordance with ER 111-2-1150.

Quantity Summary for Pool Control Structure: Quantification of concept design elements based on the above criteria and assumptions was performed by CH2M Hill and included in the detail report of their cost estimate (shown below but refer to Cost Appendix for detail). This includes 269 rock anchors, 26 Obermeyer Gates, and a 20 foot by 40 foot maintenance building. These quantities have been included in the new MCACES estimate found in the Cost Appendix to this report. Quantity verification or checks performed as back up for the estimate are included in the Cost Appendix.

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			UNEXTRE Configuration of the Class Know Frier Dayset 2 Submots for Factors In Order Constite young submots of a Hartweet sea Dridge Constite young submots at a Hartweet sea Farm large risk. All die Ja Constite young submots for Disk Methods and the Constitution of the Constitution Constitution of Constitution of the Constitution of the Constitution Constitution of Constitution of the Constitution of Constitution Constitution of Constitution of Constitution of Constitution Constitution of Constitution of Constitution of Constitution Constitution of Constitution of Const	1,6008 st 7,6008 st 388.89 CV 18014 cr 8,51036 st 78,5560 B 1814 CV 5,91035 st 5,11035 st 5,11035 st 118,14 CV	200.0 14.0 1.343.7 019.9 88.9 255.5 19.2 1.274.2	10,152 536 \$3,125 41,555 3,402 8,817 3,802 8,817 3,802 8,817 3,802 8,817 3,802 8,817 3,802 8,817 3,802 8,817 8,917 8	218 283 100.273 7,664 14,768 14,768 7,38 7,38 7,39 7,39 7,31 2,31	20,222			1.57 / # 0.17 /# 523.60 /G Y 12.03 /# 0.671 /b 125.03 /CY	10.692 018 2009 A22 1,458 40,227 20,675 14,758	148 1,1 202,4 2,0 87,0
			Control King Wirking Dann Ende Freis Dagenit Calumas für Facture Ende Freis Dagenit Calumas für Facture Ende Endersteinen Sterner Kingenit Andersteinen Sterner Kingenit Andersteinen Sterner Kingenit Andersteinen Kingenit	,,0008 S 388,85 CV 10814 cr 5,1035 d' 78,5508 b 10814 CV 598 cg 11814 cr 5,1035 d' 5,1035 d' 5,1035 d'	113 1,543.7 019.8 019.8 255.5 10.2 1,274.2	3.00 \$3,125 41,566 - - - - - - - - - - - - - - - - - -	289 100.273 7,666 14,766 14,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,766 7,666 7,766 7,666 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,776 7,777 7,776 7,776 7,777 7,776 7,776 7,776 7,776 7,776 7,7777 7,7777 7,7777 7,7777 7,77777 7,777777	20,222			6 13 78 623 56 70 Y 12 03 78 6 63 78 0 73 76 12 50 3 70 Y	1,418 2003.822 1,418 49,207 20,675 14,758	202 A 200 A 2,0 67,0
			Prior Daymer Caluments for Protections Diright Concentry paymers, submitty, cond, in 197 Mail Farming payses, columny, cond, in 197 Mail Provide State (State State) Concentry, any other, State State Concent, any other State Concent, any other State Provide State State Provide State State Concent, any other State Concent	11014 or 5,11035 of 2955500 ib 1014 CY 598 or 5,11035 of 5,11035 of 118,14 CY	014.9 014.9 255.5 10.7 1.274.2	41,555 2,402 9,812 392 50,162	7,064 14,768 14,768 7,38 153 2014	1,410 5,807			1203 /iy 0.63 /if 0.73 /ib 12503 /01	1,410 49,221 20,675 14,258	2,0
			Consort proving userine 1, et al. tesne prior Parani prass, consort or 1, et al. Breature pras, consort and an experiment Consorte, seyr mit, 400 pil And te conset water, 400 pil And te conset water, 400 pil Brain da Brain generality, constra scrap Brain da Brain da and and an experiment for an and tesne and an experiment Brain da Brain da and Brain da Brain	1014 or 5,11035 of 2955508 b 11014 CY 598 or 11014 CY 5,11035 of 5,11035 of 5,11035 of 5,11035 of	916.9 98.5 255.5 10.2 1,274.2	41,555 - - - - - - - - - - - - - - - - - -	7,006 14,208 14,208 738 738 153 254	1,419 5,307			12.03 /iy 9.63 /if 0.73 /b 126.03 /CY	1,410 40,227 20,675 14,758	2,0
			Family praces, statemet, load, or 17 Ba Rendering makes, and 0 a 20, prevalents, Consists, servir mit, state Jan Render, State Janes, State Jan Barra, Barrana, Statemet, State Jan Barra, Barrana, Statemet, Statemet, Barlage Prier Bayowit, Statemet, Str. 20, State A-100 State A-100	5,110.35 d 29,556.08 B 110.14 CY 590 cr 110.14 cr 5,110.35 d 5,110.35 d 110.14 CY	019.9 89.5 255 5 10.2 1,274.2	41,666 - - - - - - - - - - - - - - - - - -	7,006 14,208 14,208 738 153 204	5,907 			9.63 /af 0.73 /b 125.03 /CY	40,221 20,675 14,768	47,6
			Pereference on palace. Addi 5 or 20, prevedentes. Concrete, neur (m. 1460 pal. Anal ten concrete neues, colo pal. Pereference on participation and palace Concrete neutral and palace Pereference on participation and participation and palace Pereference on participation and palace Pereference on participation and palace Pereference on participation and participation and palace Pereference on pala	29,525,00 B 110,14 CY 5,99 cy 110,14 cy 5,110,35 d 5,110,35 d 110,15 g 110,15 g	88.5 255.5 10.2 1,274.2	3,402 9,817 360 55,162	14,768 14,758 738 153 204	5,907			0.73 JB 125.03 JCT	20,675	20.0
			Currenter (a very min, 4000 pla Palanis constrate, convents currents Storme na Current, mentrionen (polar) Pales Supports Caluments for Pedestitian Bridge Reck, Boltan - 170° cas. 1 (P. Bonder) Rock Boltan - 170° cas. 1 (P. Bonder)	598 cy 11811 cy 5,11035 d 5,11035 d 118,14 CY	88.8 255.5 10.2 1,274.2	2,402 9,812 392 55,162	153			2	125.03 761	14,708	
			Placing controls, controls comp Store to B Curreng: netrotaxies (staty Plant Stuppent C obturnes for Pediestrian Bridge Rock Blocks - 170° via at 10° Bonded Dick bolts nuclei bendel - 170° via 10° Bonded Dick bolts nuclei bendel - 170° via 10° Bonded	11814 cr 5,11035 d 5,11035 d 5,11035 d 118,14 CY	88.8 255.5 10.2 1,274.2	2,402 9,817 392 60,162	153				125.03 Jtv	738	11
			Shine Init County, membrane Iptar Plant Support & dumms for Pedestrian Bridge Rock Bolts - 1.70° dia 1.10° Bonded Rock bolts and rain-tail-bond	5,110.35 d 5,110.35 d 118.14 CY	255.5 10.2 1,274.2	9,812 392 65,162	153				28.93 Juy	3,403	4
			Cutry, nembraid gray Pier Support Columns for Pedestrian Bridge Rock Bots - 1.75" dia 1.15" Bonded Rock bas super sub-beasts - 12" dia 15"L. ADTM A-100	5,110.35 S 118.14 CY	10.2	392	234 1		-	· · · · · · · · · · · · · · · · · · ·	1.95.1#	R.965	12
			Prer Support Country for Pedestruit Bridge Rock Botts - 1.75" dis 1.15" Bonded Rock bots super sub-testis 1.75" dis 15" L ATM A-100	118.14 CY	1,274,2	00,16Z	1004		-	+	0.12 str	597	
			Rock bots super high-besile 1.70° dis 15° L ADTW A-100				40,239	Tytep	-		624/26 /61	100/80	PACI
				140.08 .09	125.0	6.179	79,529	~		+	\$61.75 /mm	86.098	120.0
			Rock bots, cril tole, 2.9' da, 15' long, for 1.75" bot	148.08 00	607.0	21,479	1.0.041		17,967	1	20511 /20	39,238	\$4,0
	_	_	Rock Bolts - 1.75" dia z 16' Bonded	142.00 EA	632.8	28,053	79,920		17,257		846.35 /EA	125,336	182.5
	_	-	Rock Bolts - 2.6" disk 20' Fended	124 48	152.5	2.045	47.472		-		84924 S	10.000	
			Hock bots super high bensile, 2 25 dia 20 L. ASTW A-108 Rock bots cell liste 3 5 dia 10 liste ful 2 25 bot	121.00 es	121.0	5,943	87,128	1	26.008		76812 Jap	13,063	1385
			Rock Bolts - 2.5' dia x 20' Bonded	121.00 EA	890.4	29,003	87,120		26,598		1,254,30 /EA	102,987	221.8
			Dental Concrete Allowance									-	
			Fine grade, for dab on grade, by hand	111,206.08 of	779.1	29,916	1,113		· · ·		0.21 /#	31,029	42,1
	-	-	Concrete pumping, subcontract, all inclusive price	2,060.00 c/			-	24,720		1	12.03 Jty	24,729	
	-		Concrete, reserving, room pre-	2.00008 cv	1.545.0	59.320	216,300		-	1	28.83 /04	58,300	115
		-	Dental Concrete Allowance	2.050.00 CY	2.324.1	89,242	217,413	24,720			160.86 /C Y	331,376	482.8
			Concrete Gravity Dam			8000000							
	_		Concrete pumping, subcontract, sill inclusive price	46,830.74 cy		1.1		652,360			12.00 /ty	552,368	016,1
	-		Concrete Cooling	46,930.74 (#	17109-3	643 297	871 The	345,231		+	7.53 Jty	345,297	510/
	-		Bale gab builthead form	116,812,88 4	35.043 8	1.563,142	145,016				14.82 /m	1,729 198	2366
			Waterstop, FVC, ribord, wit enter builb, SFIP thick, 87 wide	2,114.08 H	131.1	6,375	9,471			a la	7.52 /1	15,648	22/
			Reintering in place, A616 Gr 60, pre ed per lbb.	4,607,874.00 18		-	2,301,637	020,816			0.73 /16	2,222,152	4,006,0
	-	-	Concrete, warry mis, 4000 pris	48,030.74 CY	-	.*	5,753,643			1	125.03 /01	5,753,(43	0,616,2
	-	-	Placing concrete, concrete ports, for belie size 34" to 30"	46,030,74 cz	46,038.7	1,707,534	979,304		1		38.43 /14	1,747 534	2,390.0
			Finishing fbors, monolithic, broom finish	\$11,296.08 dr	7,459.7	222, 250	2,226			4	2.01 /#	225,605	440,0
			Cuting, reimbrarie spray	111,296.08 af	222.6	8,547	4,452			+	0.32 /d	12,008	18,3
	-	-	Concrete Gravity Dain	45,030.74 CY	100,874.0	4,732,245	8,853,058	1,818,214	15.015		323.77 /CY	14,903,517	21,663,2
-	-	-	03-13 Cast-In-Place Concrete Work	48,597.77 CY	107,944.2	4,527,191	9,376,080	1,800,481	43,898		325.48 /CY	16,817,617	22,990.6
	31.0		Site Civil	40,007.77 6.1	107,344,2	+,047,191	9,375,980	1,610,461	47,010		320.48 761	10,017 (617	22,395,6
	1000	31-10	Temporary Works										
		1000	Coffer Dati										
			Pote-can, ricb	1.00 ms	24.0			15,000		+	15,000.03 /##	15,008	72,
-		-	Porte dam incluiètice	2,500.00 H	800.0	29,146	5,008	141.000	25,291	-	23.61 /f	\$9,021	12
-			Pota-can renal	2 500.08 H	750.0	36,922		2#3/000	52641	4	10,00003 /96	49.623	354
		-	Porta-cam, certos	1.00 49	24.0	20.434		15.000			15,800.02 /86	15.000	22
				32,876.58 cr	201.7	17,005		-	32,277	÷	1.34 Juy	44,217	52
			Dkf il, sbl, no compact, 300 HP cozer, 53' haut, common earth	32,976.68 bes	263.7	11,226			30,952	1	1.28 5204	42,178	\$Q.
-			Did III, shi, no compart, 300 HP dozer, 53' haul, common earth Excarcting, bulk bank monourin, 3 C.Y. capacity = 258 C.Y./hoer,	Contraction (Mail							3 74	- aprene	

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7	1	2	M	Project Project No. Design Stage	Sand Springs 388594 Schematic Design	ę.			Estimator Rev No. / Estimate	r: / Date: Class:	Jones T 92 - 04/ Class 3	24/2014		
tem	Area	Work Pkg	Trade Pkg	Description	Takeoff Guantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount	Grand Total
				Cottler Dans										
-	_	-	_	Compaction, structural, rock fill, where notice	02,970.58 ecs	50.9	4,199			3,373		0.23 /#59	7,576	10,5
-		-		Cotter Dan	2,500.00 #	2,276.9	102,242	5,000	270,000	104,054		224,00 /#	562,190	610.5
-	-	-	21.46	Site Preparation	1.00 6.0	2,210,0	104,000	5,000	270,000	101,001		000,107.00 768	Dec.198	\$10.0
-				Foundation Cleanua						0.000				
				Final Oese-up	17,366.27 w	111.3	4,739			9.917	1	1.17 /w	14,851	20,6
_			-	Foundation Cleanup	12,366.22 SY	111.2	4,739		1.1	9,912		1.19 /SY	14,651	20.6
-	_			31-15 Site Preparation	1.00 LS	111.2	4,739			9,912		14.651.46 /LS	14,651	20,6
-			31-20	Earthworks, Site		-								
-		-		Device ing	24.08.000					211.041		17410.22 /cm	211 641	24461
				Deviatering Minor, Cenerator and Pumps, Operation - Lobor to maintain /	24.00 mo	12,400.0	491,225			171.078	1	27,595.03 /ma	662.301	910.3
		1 m		check pumps fuel and take										
_	-	-		Bypails Fumping, Pamps and Figing, Mich	308 ea	24.3	7,198		4,500	927		7,718.44 /#2	6,625	9,
-				Bygadis Fumping, Set up Pumpis December 2000 pumpis	12:00 00	192.0	9,586	6,004		3,108	1	1,507.85 /88	18,294	17,
-		-		Byzace Fumping, install Occharge Fiping	2.00 ea	72.0	3,505	1.608		1.001	1	2.161.00 /86	6.405	0.
				Dewstering	720.00 DAY	12,792.0	606,903	7,950	4,500	509,2%		1.428.42 /DAY	1.028,459	1,436,0
				Mass Common Excavition		22.862		1.63	2022	1000			10	
_			_	Marcan Hast Roads will abir 6 Coarabr	10.72 MR	10.7	<811	293		755		141.58 JHR	1,518	74
-		-	-	Duit Control Operations	57.44 HR	86.2	4,026			4,095		(\$1.03 /HR	0,727	12
-		-		Service Track or Doupment, Lake, Oil, Service with amider	32 876 48 Mg	2.4	11.224	05		30353		1.20.47 748	42 178	46
_				backhoe, hydraclic, crawler mounted, excluding track loading	and and and							car ing		
				Having, exclavated borrow miterial/cose cubic yards, 1 mile round (rid, 2.5	23,876.58 Ky	701.5	19,005			60.502	+	3.78 / 49	90,538	128.
-				Icadultr, besie wid rate, 15.5 cy during trailer, off-highway, excludes loading	20.025.00 41	010.1	00.000	240				100.001	640.010	
-				Mess Commen Excavation	32,976.89 61	619.4	26,062	342		117,190		4.34 /GY	143,822	204.3
-		-		Man/an Havi Roads wiGrater & Coaratter	29.74 HR	28.8	1.389	758		2 025		141.53 (HR	4.071	63
				Dust Control Operations	169.34 FR	254.9	11,868			13943		15183 /HR	25,711	35,6
				Service Track for Equipment, Lube, Oil, Service will earnd er	1278 HB	12.8	5.34	141		865	1	120/47 /HR	1,948	- 2,1
-		-	-	Bef il, sbl, no compact, 300 HP coper, 53'haut, common earth	16,806.38 cy	133.4	6,534	4		16,458		1.34 /iy	22,583	31,
-		-		Excepte and partitized white dependence	16,806,38, 44	206.1	15 000	49,018		16.698		2.42 (n/	41 207	60
-		-	-	Having, excavated borrow material loose cubic vards 1 mile round trip 2.5	16.806.30 Icv	184.7	3,813			56 44 8		3.73 /151	83.462	90.
				Acadsfir, base wid rate, 15.5 cy dump trailer, off-highway, excludes loading										
-				Compaction, structural, rock #8, wheel roller	16,806.38 ecg	50.4	2,140			1,718		0.23 /bby	3,051	6,
-		-		Mass Rock Excavation	16,806.30 CY	2,009,6	96,819	49,669		172,370		18.37 /CY	308,657	439.3
-			21.00	Cite Constalling	1.00 6.6	10,419,9	619,684	67,760	4,800	199,114		1,400,/10/02 /25	1,480,718	2,0/9,0
-			0100	Deventryan Greater Rock Fill	15 15 15 15 15 17 1			1000000				10000 C 10		
				Rip-rap and took lining, random, broken starte, 3/0 to 1/4 C.Y. pieces,	46.168.08 sr	32,318.2	1.340,269	2,585,457		488.421	+	\$5.61. / IV	4,414,547	6,386,0
-		-		machine placed for slope protection, grouted			10000							
-		-	-	Downstream Grouted Rock Fill	23,084,44 CY	32,318.2	1,340,269	2,585,457		483,421		191,22 /GY	4,414,147	6,385,6
-		-		01-30 Site Specialties	1.00 LS	02,318.2	1,340,269	2,585,457		403,421		4,414,146,50 /LS	4,414,147	6,085,6
-				01.0 Site/Civil	1.00 LS	00,125.2	2,066,005	2,643,217	274,500	1,402,002		6,471,710,61 /2.5	6,471,714	9,297,5
-		9,01	75.10	Wider Control Onter						-				
-			00.10	Obern ever Cates						1				
				Ar Suppy EquipMechanicalPLC Allovance	1.00 ls		-		229,760	i i	4	228,160.03 F#	728,768	415
				Oberneyer Crest Sales (14 Each)	2,112.00 \$				1,113,024		÷.	\$27.03 /st	1,113,024	1,644
-				Operneyer Full O Kes (12 Each)	6,980.09 %		-		4,687,580			771.03 /uf	4,517,631	6,938,
-			-	Oterneyer Gates	26.00 EA				6,125,464	-		200.748.61 /EA	6,129,454	9,005
-				05.0 Water and Marine Construction Equipment	26.00 EA	-			6,125,464			6 129 464 00 / 1	6,129,494	9,009,
+				010 Low Water Dam	1,008,00 1.5	150,059.4	6,554,125	12,024,297	8.274 445	1.625.927		14,034,55 (1.F	28,418 756	41,044
+	920	0		Pedestrian Bridges						Conce of the second				
		32.0		Exterior Improvements										
			32.34	Fabricated Bridges										
-			28228	Pedestrian Bridge @ Low Dam Crossing						-			1000.001	
-	_	-	-	Curbs, carb and galler, sheel forms, 14' wide, idraight	2,816.08 #	263.3	12,301	41,785				16.17 /1	54,088	
1				Cathe rate of 1-all' dam posts x 42 high, cable 42 4" 0.0, stainless	3.816.00 #	2,442.2	144,415	129,744			1	71.84 //	274,158	385
-+				Plant min and at shore for her word plant, capes a cape and plant	4.740.00 m	84.7	2 2 2 2	35 983		1.631		8.32./w	29,438	44
				the second s	Transa at					1.00		· ···	10,000	

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C	12	M	1.
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Project Project No. Design Stage:

Sand Springs 386594 Schematic Design

Estimator: Rev No. / Date: Estimate Class:

Jones T 92 - 04/24/2014 Class 3

Detail Report

Area Work Pkg Trade Takeoff Guarkity Labor Man Labor Amount Amount Sub-Amount Equip Amount Other Amount Eiditem Description Total Cost/Unit Total Amount Grand Total 150.08 cr 1,440.0 67,294 909.13 /iy 1+0,376 211,445 64,008 16,502 381608 # 38,1608 # 38,160.00 # 1,00 EA 1,00 EA 1,00 EA 17001 // 1400 /# 54.52 /0F 2,462,217,53 /EA 2,462,217,53 /L5 2,462,217,53 /EA 1,411,528 534,248 2,462,218 2,462,218 2,462,218 2,462,218 2,462,218 2,086,137 785,349 1,411,970 4,209.7 4,209.7 4,209.7 4,209.7 226,733 226,733 226,733 226,733 226,733 271 221 271 221 271 221 271 221 271 221 18,100 18,100 18,100 18,100 785,343 0,614,001 0,614,001 0,614,001 1,946,160 1,946,160 1,946,160 1,946,160 1,946,160 060 10.0 13.04 10,100.03 /EA 80,000.00 /EA 80,000.00 /EA 80,000.00 /LS 80,000.00 /EA 100 EA 1.00 EA 1.00 EA 1.00 LS 1.00 EA 80,08 000,08 80,000 80,000 80,000 80, 118,201 80,000 80,000 80,000 80,000 80,000 118,201 118,201 118,201 118,201 118,201 CBD 31.0 OPD Environment
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Pool Control Structure Concept Design

Note that the above image depicts gates in the up position maintain pool between peak demand weekday hydropower generation.



Pool Control Structure Concept Design

Note that the above image depicts the full height gates in the down position which will allow for unregulated river flow and unobstructed fish/egg/sediment passage during the monsoon season and associated flood pool releases.



Note that the above is a representative image of an Obermeyer gate. During the Design Phase of the project the gates will be adapted and designed for use at the project location identified in this study.













Least Tern Island: In 2003, the Oklahoma State University Biosystems Engineering Senior Design Team was selected by the U.S. Army Corps of Engineers (USACE) Tulsa District to conduct an analysis for the design of a least tern nesting habitat and the optimal location along the Arkansas River for implementation. The preliminary cost estimate was generated using the design criteria provided in the final report titled, "Designing an Island Habitat for the Interior Least Terns". The design criteria and critical features of work are summarized below.

The original analysis considered four separate design configurations and the design team constructed small scale flume models for testing and collecting data. From this analysis, it was recommended that the configuration shown in SK-1 be constructed in southern Broken Arrow. The selected site is located east of S. 145th E. Ave. and south of E. 131st St. S., directly south of the Indian Springs Sports Complex at the approximate location shown in SK-2.

Quantity Summary for Least Tern Island: This is a 5 acre island with structure dimensions of 43' x 10' x 3' (front) and 56' x 10' x 3' (back) for a total of 110 CY. Riprap should be assumed as 5,400 CY of 24" riprap for the front and back structures.





Prattville Creek Rock Riffle + Wetland Plantings: This alternative includes the design and construction of the rocked riffle and riprap listed in the above alternative, with the addition of wetland type plantings. For this area, the wetland plantings are comprised of ornamental grasses. It is calculated that this alternative will require approximately 6,960 plants across the creek's embankment in order to restore the native habitat for wildlife. Design drawings for the plantings and rock structures are shown in SK-5 and SK-6 below.

Quantity Summary for Prattville Creek: The estimated quantities for this stage in design are 4,640 CY of soil, 44 CY of 6" bedding stone, 383 CY of 24" riprap and 1,160 CY of 12" riprap. For plantings estimator should assume 6,960 wetland plantings (rushes, reeds, bulrushes), 15,600 riparian plantings (red-ossier dogwood & brush willow), and 2.5 acres of invasive species control.

Screened Measures: The below measures were considered in the array and screened out.

Prattville Creek Rocked Riffle and Riprap: Prattville Creek is located east of Highway 97 on the south bank of the Arkansas River in Sand Springs, Oklahoma. The ground elevation is at approximately 634 feet with a mouth width of approximately 80' (according to Google Earth). This alternative includes the construction of a rocked riffle structure made of size 24" riprap with a 6" thick aggregate bedding as well as lining the southern embankment with size 12" riprap. The preliminary design details are shown in SK-5 and SK-6 below.

Prattville Creek Rock Riffle + Riparian Plantings: This alternative includes the design and construction of the rocked riffle and riprap listed in the above alternative, with the addition of riparian type plantings. For this area, the riparian plantings are comprised of Red-Osier Dogwood trees and Brush Willows which have a minimum height of 3'-4' and a minimum caliper of 1". It is calculated that this alternative will require approximately 15,600 plants across the creek's embankment in order to restore the native habitat for wildlife. Design drawings for the plantings and rock structures are shown in SK-5 and SK-6 below.

Prattville Creek Rock Riffle + Riparian Plantings + Wetland Plantings: This alternative includes the design and construction of the rocked riffle and riprap listed in the above alternative, with the addition of the riparian planting alternative and the wetland planting alternative. Design drawings for the plantings and rock structures are shown in SK-5 and SK-6 below.





Screened Measures: The below measures were considered in the array and screened out.

I-44/Riverside Wing Deflectors + Rock Riffle: Three slack water side channels exist along the eastern bank of the Arkansas River at the northwest corner of the intersection between Riverside Drive and Interstate 44. This alternative includes the design and construction of rocked riffle structures and stone wing deflectors within these channels in order to help control erosion and restore the native habitat for wildlife. The rocked riffle design is similar to that of the Cherry Creek structure and can be seen in SK-8 and SK-9 below. The wing deflectors are comprised of size 24" riprap structures which protrude 1/5th of the width of the river at an angle of 20 degrees as shown in SK-8. The combination of these designs prevent the river flows from eroding away the embankment. The preliminary design considered a river flow of 12,000 cubic feet per second (cfs) to 15,000 cfs. The structure is designed to be overtopped during higher flow events.

I-44/Riverside Wing Deflectors + Rock Riffle + Riparian Plantings: This alternative includes the design and construction of the rocked riffle and wing deflectors listed in the above alternative, with the addition of riparian type plantings. For this area, the riparian plantings are comprised of Red-Osier Dogwood trees and Brush Willows which have a minimum height of 3'- 4' and a minimum caliper of 1". It is calculated that this alternative will require approximately 11,100 plants across the creek's embankment in order to restore the native habitat for wildlife. Design drawings for the plantings and rock structures are shown in SK-7, SK-8, and SK-9 below.

I-44/Riverside Wing Deflectors + Rock Riffle + Wetland Plantings: This alternative includes the design and construction of the rocked riffle and wing deflectors listed in the above alternative, with the addition of wetland type plantings. For this area, the wetland plantings are comprised of ornamental grasses. It is calculated that this alternative will require approximately 9,000 plants across the creek's embankment in order to restore the native habitat for wildlife.

Design drawings for the plantings and rock structures are shown in SK-7, SK-8, and SK-9 below.

I-44/Riverside Wing Deflectors + Rock Riffle+ Riparian Plantings + Wetland Plantings: This alternative includes the design and construction of the rocked riffle and wing deflectors listed in the above alternative, with the addition of the riparian planting alternative and the wetland planting alternative. Design drawings for the plantings and rock structures are shown in SK-7, SK-8, and SK-9 below.

Quantity Summary for I-44/Riverside: The estimated quantities for this stage in design are 690 CY of 24" riprap for slack water side channels, 125 CY of 24" riprap and 37 CY of 6" bedding for the rock riffle. For plantings estimator should assume 9,000 wetland plantings, 11.000 riparian plantings, and 1.94 acres of invasive species control.







PED Phase Actions: During the PED phase following feasibility, a civil site survey will be performed from which plans will be developed in accordance with ER 1110-2-1150 to include alignments, control points, and bench marks. A physical security plan will be developed in coordination with the non-federal sponsor and in accordance with ER 1110-2-1150. Construction access points and traffic control requirements will be further developed utilizing project areas as defined in the Real Estate Appendix. Additional geotechnical investigation will be performed as described in the Geotechnical Appendix after which load case analysis can be performed to confirm the design assumptions that CH2M Hill made curing concept design of the pool control structure.