Conceptual-Level Cost Estimates Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

TO:	Tulsa County
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Introduction

Tulsa County, as part of the Arkansas River Corridor Master Plan (Carter & Burgess, 2004; C. H. Guernsey and Company et al., 2005), is undertaking an improvement project on the Arkansas River. The primary goals of the overall project are to improve least tern habitat, improve fish habitat and fish passage, improve the function of the river system itself, enhance economic development, increase recreational opportunities, and increase connectivity between the river and surrounding communities. The conceptual project components are described in detail in the Technical Memorandum (TM) entitled *Baseline Project Summary for the Arkansas River Corridor Project* (CH2M HILL, 2009). Key components include:

- Design of habitat improvements along the corridor
- Design of bank stabilization in select areas
- Design of a new Sand Springs low-head dam, pedestrian bridge, and amenities
- Design of modifications to Zink Dam and lake with whitewater features
- Design of a new South Tulsa/Jenks low-head dam, pedestrian bridge, and amenities

Purpose

This TM presents conceptual-level cost estimates for key projects outlined in the Arkansas River Corridor Master Plan (Carter & Burgess, 2004; C. H. Guernsey and Company et al., 2005). Estimates were developed for the following projects:

- New Sand Springs low-head dam, pedestrian bridge, and amenities
- Modifications to the Zink low-head dam and whitewater recreation facilities
- New South Tulsa/Jenks low-head dam, pedestrian bridge, and amenities

The Arkansas River Corridor Master Plan defined these improvement projects to enhance the river's recreation opportunities, habitats, and function. This TM includes a brief description of these projects, followed by conceptual-level cost estimates and a basis for the estimates.

Project Descriptions

Brief descriptions of the aforementioned projects are presented below for reference. Detailed project descriptions can be found in the Baseline Project Summary TM noted above (CH2M HILL, 2009).

As part of the dam projects, river bank restoration and stabilization will occur in the impoundment areas upstream of the dams. The chosen rehabilitation method is a combination of stone-toe riprap and live staking. The extent of rehabilitation is expected to vary based on existing bank conditions. A detailed description of the bank stabilization and rehabilitation methods, as well as a description of the existing bank conditions, can be found in the *Arkansas River Corridor Projects, River Bank Stabilization and Concept Design* Technical Memorandum (CH2M HILL, 2010).

Sand Springs Low-Head Dam

This project includes the construction of a low-head dam spanning the Arkansas River. The new impoundment structure will be 12 feet high and 1,900 feet long. The dam will include ten 12-foot-high flood gates. The project includes a pedestrian bridge and approximately 3.4 miles of restored and stabilized river banks.

The project does not include a fish passage flume, on-bank amenities, or water recreation provisions. Additionally, it is assumed that all property required for construction of the dam, abutments, and access points either is owned by the City of Sand Springs or can be obtained at no cost through landowner agreements.

Zink Low-Head Dam

The project includes modifications to the existing Zink Dam. The modifications include the construction of six new full-height flood gates. The gate sections will be 11 feet tall and 100 feet wide. Additionally, the dam height will be raised from 8 to 11 feet by installing four 3-foot-tall, 100-foot-long crest gates. This project includes a whitewater flume, recreation facilities, public access, and approximately 1.3 miles of restored and stabilized river banks.

The project includes improvements to the Tulsa Wave on the west bank and Shoreline Beautification included in the Vision 2025 funding allocation. The project does not include additional amenities on the banks, such as establish trail connections and public access at locations other than the low-head dam, other than those included as part of the Shoreline Beautification program.

It is assumed that the property/right-of-way (ROW) required for construction of the dam, abutments, and access points is currently controlled by the River Parks Authority's existing agreements or that access will be granted at no cost through additional agreements.

South Tulsa/Jenks Low-Head Dam

This project includes the construction of a low-head dam spanning the Arkansas River. The new impoundment structure will be 8 feet high and 1,800 feet long. The dam will include nine 8-foot-high flood gates. The project includes a pedestrian bridge and approximately 2.6 miles of restored and stabilized river banks.

The project includes a separate line item cost for a fish passage flume, which may or may not be constructed as part of the project. The project does not include any on-bank amenities.

It is assumed that all property required for construction of the dam, abutments, and access points on the west bank can be obtained at no cost through agreements with the existing landowner. The estimate does not include costs associated with obtaining ROW, purchasing land on the east bank for construction of the abutment and access roads, establishing trail connections, or other maintenance access requirements.

Conceptual-Level Costs

These estimates are considered "Class 4," as defined by the Association for the Advancement of Cost Engineering (AACE International) and are generally considered accurate from –15 percent to –30 percent on the low range side and +20 percent to +50 percent on the high range side.

Tables 1, 2, and 3 present the conceptual-level cost estimates for the Sand Springs Low-Head, Zink Low-Head, and South Tulsa/Jenks Low-Head Dams, respectively. Included in these tables, for reference, is the progression of the estimated costs from when they were presented in the 2005 Arkansas River Master Plan (C. H. Guernsey and Company et al., 2005), to the 2007 estimates prepared by the Tennessee Valley Authority (TVA), to the current 2010 conceptual-level estimates.

The 2010 conceptual-level estimates include river bank stabilization/restoration upstream of the impoundment structures. A detailed breakdown of these river bank improvement costs is provided in Attachment A. A detailed breakdown of the costs for the three dams is provided in Attachment B.

TABLE 1
Conceptual-Level Cost Estimate, Sand Springs Low-Head Dam
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

Item	2006 Master Plan	2007 TVA	2010 Concept
Low Water Dam	$17.5 M	$ 40.5 M	$ 56.2 M
Pedestrian Bridge	$ 3.4 M	$ 7.9 M	$ 10.7 M
Fish Passage/ Recreation	Not estimated	Not estimated	None
Habitat Restoration/ Bank Stabilization	Not estimated	Not estimated	$ 12.0 M
Right-of-Way	Not estimated	Not estimated	Not required
On-bank Amenities	Not estimated	Not estimated	Not included
Subtotal	**$ 20.9 M**	**$ 48.6 M**	**$ 78.9 M**

TABLE 2
Conceptual-Level Cost Estimate, Zink Low-Head Dam
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

Item	2006 Master Plan	2007 TVA	2010 Concept
Weir Modification/Gates	$ 2.1 M	$ 5.8 M	$ 25.5 M
Tulsa Wave	$ 1.5 M	$ 1.5 M	$ 1.5 M
Shoreline Beautification	Not estimated	Not estimated	$ 2.5 M
Fish Passage/ Whitewater Course	Not estimated	Not estimated	$ 10.1 M
Habitat Restoration/ Bank Stabilization	Not estimated	Not estimated	$ 4.3 M
Right-of-Way	Not estimated	Not estimated	Not estimated
On-bank Amenities	Not estimated	Not estimated	Not estimated
Subtotal	**$ 3.6 M**	**$ 7.3 M**	**$ 43.9 M**

TABLE 3
Conceptual-Level Cost Estimate, South Tulsa/Jenks Low-Head Dam
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

Item	2006 Master Plan	2007 TVA	2010 Concept
Low Water Dam	$17.5 M	$27.6 M	$ 38.7 M
Pedestrian Bridge	$ 3.4 M	$ 7.9 M	$ 10.1 M
Fish Passage/ Recreation	Not estimated	Not estimated	$ 5.4 M
Habitat Restoration/ Bank Stabilization	Not estimated	Not estimated	$ 9.5 M
Right-of-Way	Not estimated	Not estimated	Not estimated
On-bank Amenities	Not estimate	Not estimated	Not estimated
Subtotal	**$ 20.9 M**	**$ 35.5 M**	**$ 63.7 M**

Basis of Estimates

The estimates were prepared in accordance with the guidelines of AACE International. According to AACE International estimating classifications, Class 4 estimates are defined as follows:

- Class 4 estimates are prepared based on limited information, where the preliminary engineering is from 1 percent to 5 percent complete.
- The Class 4 estimate can be used for detailed strategic planning, business development, project screening, alternative scheme analysis, confirmation of economic and technical feasibility, and preliminary budget approval.

- Estimating methods incorporate equipment and/or system process factors, scale-up factors, and parametric and modeling techniques.
- The expected accuracy ranges from –15 percent to –30 percent on the low side and +20 percent to +50 percent on the high side.

The cost estimates shown in Tables 1, 2, and 3, which include any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared from the information available at the time of the estimates and are provided for guidance in project evaluation and implementation. The final costs of the project and resulting feasibility assessment will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimates presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

CH2M HILL's estimates are based on material, equipment, and labor pricing as of August 2010.

The cost estimates exclude the following:

- Non-construction or "soft" costs for design, services during construction, land, legal, and owner administration costs
- Material adjustment allowances above and beyond what is included at the time of the cost estimates

The costs provided in Tables 1, 2, and 3 are considered a "bottom rolled up" type of estimate, meaning all costs are summed into a final number before overhead, profit, markup, etc., are added. The costs include detailed cost items and a breakdown of labor, materials, and equipment. Additionally, Table 4 provides the typical contractor markups applied to each of the estimates.

TABLE 4
Markups Used in the Cost Estimates
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

Markup	Percent Used
Contractor Overhead	10%
Profit	5%
Mobilization/Bond/Insurance	5%
Estimate Contingency	30%

Major Assumptions

The estimates are based on the assumption that the projects will be implemented on a competitive bid basis and that the contractors will have a reasonable amount of time to

complete the work. It was also assumed that all contractors are equal, with a reasonable project schedule, no overtime, constructed under a single contract, and no liquidated damages. Additionally, the following assumptions were used in developing these estimates:

- Cost development for the new low-head dams was based on conceptual design sketches with cast-in-place and roller-compacted concrete.
- River bank stabilization bioengineering methods were based on sketches and design details with cost development per costs from the U.S. Army Corps of Engineers (CH2M HILL, 2010), updated using the *Engineering News-Record* Construction Cost Index (ENR CCI).
- The projects would not require hazardous waste mitigation or remediation.
- The projects would not require landscaping unless specifically mentioned otherwise.
- Pedestrian bridges include allowances for lighting, but do not include architectural features. Bridge spans are based on sections that are 100 feet long and 12 feet wide. Budget quotes were obtained from CONTECH Construction Products, Inc.
- Unit costing for various elements of the dams and components to develop the costs were based on 100-foot-long increments.
- For the bank stabilization and erosion repair work, it was assumed that reasonable access to the work sites would be available; no extra costs were included for easements or ROW purchases.

Escalation Rate

No escalation was included in the costs shown in Tables 1, 2, and 3, because the exact timing for construction of the projects has not been identified. When the project timing has been identified, the respective projects costs should be escalated to the mid-points of construction using the escalation factors at that time, to represent the expected costs at the time of actual construction.

Market Conditions

The current market conditions are significantly impacting construction across the country. This observation is based upon recent bids and comparisons with Engineer's Estimates. Recent bids have been between 10 percent to 20 percent and even 30 percent lower than Engineer's Estimates. Despite the estimator's best practices and adjustments, bids are driven by current market conditions. Currently, at CH2M HILL, the estimating policy is to include a 0 percent to a negative market adjustment factor, depending on the location.

This market adjustment factor is above and beyond the typical contractor markups, normal estimating contingency, and current escalation factors noted above. This addresses the fact that there are contractors without any current work, as well as an unusually high number of contractors actively bidding jobs.

TABLE 5
Conceptual-Level Cost Estimate
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects

Item		2010 Conceptual-Level Cost Estimate
Sand Springs Low-Head Dam		
Low-Head Dam		$ 56.2 M
Pedestrian Bridge		$ 10.7 M
Habitat Restoration/ Bank Stabilization		$ 12.0 M
	Subtotal	***$ 78.9 M***
Zink Low-Head Dam		
Weir Modification/Gates		$ 25.5 M
Tulsa Wave		$ 1.5 M
Shoreline Beautification		$ 2.5 M
Fish Passage/ Whitewater Course		$ 10.1 M
Habitat Restoration/ Bank Stabilization		$ 4.3 M
	Subtotal	***$ 43.9 M***
South Tulsa/Jenks Low-Head Dam		
Low-Head Dam		$ 38.7 M
Pedestrian Bridge		$ 10.1 M
Fish Passage/ Recreation		$ 5.4 M
Habitat Restoration/ Bank Stabilization		$ 9.5 M
	Subtotal	***$ 63.7 M***
Arkansas River Corridor Dam Improvement and River Bank Stabilization Projects		
	Total	**$ 186.5 M**

Note:

Markups used for cost estimate include: 10% for contractor/overhead, 5% for profit, 5% for mobilization/bond/insurance, and 30% contingency.

References

Carter & Burgess. 2004. Final Arkansas River Corridor Master Plan, Phase I Vision Plan. Prepared for the Indian Nations Council of Governments.

CH2M HILL. 2009. *Baseline Project Summary for the Arkansas River Corridor Project.* Technical Memorandum prepared for Tulsa County – AR River Projects.

CH2M HILL. 2010. *Arkansas River Corridor Projects, River Bank Stabilization and Concept Design.* Technical Memorandum to Tulsa County. March.

Guernsey, C.H. and Company, EDAW, Inc., Hisinc, LLC, Alaback Design and Associates, Adaptive Ecosystems, Inc., Schnake Turnbo Frank, Inc. 2005. Final Arkansas River Corridor Master Plan, Phase II Master Plan, and Pre-Reconnaissance Study. Prepared for the U.S. Army Corps of Engineers.

Tennessee Valley Authority (TVA), River Systems Operation and Environment. 2008 Vision for the Arkansas River Corridor at Tulsa.

ATTACHMENT A
Riberbank Improvement Costs
Arkansas River Corridor Dam Improvement and Riverbank Stabilization Projects

Riverbank Stabiliation Costs/ft Calculation

Category	Bank Stability Description	Scour Protection Depth (ft)	Toe Zone Vertical Dimension (ft)	Vertical Dimension above Toe Zone (ft)	Existing Toe Zone Side Slope (xH:1V)	Existing Side Slope above Toe Zone (xH:1V)	Toe Protection Costs ($/ft) Method A*	Method D*	LPSTP	Cut Volume Required to Achieve 2:1 Slope above Toe (cy/ft)	Bank Shaping Unit Cost ($/cy)	Bank Shaping ($/ft)	Live Staking (units/ft)	$ 15.00 per live stake ($/ft)	Bank Shaping and Live Staking ($/ft)	Method D, Bank Shaping and Live Staking ($/ft)
1	Stable	0	8	5	2	2										
2	Stable - Moderate	0	8	8	2	2	$ 136.99	$ 124.69	$ 298.93	0	$ 18.00	$ -	1.7	$ 25.50	$ 25.50	$ 150.19
3	Moderate	3	8	10	2	1.5	$ 207.10	$ 163.45	$ 298.93	0.93	$ 18.00	$ 16.74	2	$ 30.00	$ 46.74	$ 210.19
4	Moderate - Unstable	6	10	13	2	1	$ 334.32	$ 231.32	$ 464.26	3.13	$ 18.00	$ 56.34	3	$ 45.00	$ 101.34	$ 332.66
5	Unstable	6	12	15	2	0.5	$ 363.43	$ 260.43	$ 666.33	6.25	$ 18.00	$ 112.50	3.3	$ 49.50	$ 162.00	$ 422.43

*Assumes a gravel filter thickness of 0.5 ft, rock revetment thickness of 1.5 ft and geotextile fabric.

Riverbank Distances to be Stabilized/Rehabilitated - Distance in Miles

	Bank Stability Description				
	Stable		Moderate		Unstable
Impoundment Area	1	2	3	4	5
Sand Springs	7.3	0.3	7.1	2.1	1.3
Zink	3.7	0.3	3.4	1.1	0.2
South Tulsa/Jenks	1.8	0.7	1.6	1.4	1.3

Riverbank Distances to be Stabilized/Rehabilitated - Distance in Miles

	Bank Stability Description				
	Stable		Moderate		Unstable
Impoundment Area	1	2	3	4	5
Sand Springs	-	-	-	2.1	1.3
Zink	-	-	-	1.1	0.2
South Tulsa/Jenks	-	-	-	1.4	1.3

Bank Stabilization/Rehabilitation Raw Costs

	Bank Stability Description				
	Stable		Moderate		Unstable
Impoundment Area	1*	2	3	4	5
Sand Springs	--	$241,711	$7,858,714	$3,697,579	$2,898,380
Zink	--	$250,450	$3,788,276	$1,872,277	$477,176
South Tulsa/Jenks	--	$533,734	$1,788,898	$2,398,774	$2,801,730

* No rehabilitation is required for stability classification 1, Classification 2 and 3 desired, Classification 4 and 5 required

Bank Stabilization/Rehabilitation Raw Costs

	Bank Stability Description				
	Stable		Moderate		Unstable
Impoundment Area	1*	2	3	4	5
Sand Springs	--	-	-	$3,697,579	$2,898,380
Zink	--	-	-	$1,872,277	$477,176
South Tulsa/Jenks	--	-	-	$2,398,774	$2,801,730

* No rehabilitation is required for stability classification 1, 2 or 3; stability required for Classification 4 and 5

Subtotal Stabilization/Rehabilitation Raw Costs - Classfication 2, 3, 4 and 5

		Contractor Mark Ups				
		Overhead	Profit	Contingency	Mobilization	
Impoundment Area	Raw Costs	10%	5%	50%	5%	Total Estimated Cost
Sand Springs	$14,696,384	$1,469,638.39	$808,301.11	$8,487,161.69	$1,273,074.25	$26,734,559
Zink	$6,388,179	$638,817.93	$351,349.86	$3,689,173.56	$553,376.03	$11,620,897
South Tulsa/Jenks	$7,523,136	$752,313.62	$413,772.49	$4,344,611.17	$651,691.67	$13,685,525

Subtotal Stabilization/Rehabilitation Raw Costs - Classification 4 and 5 only

		Contractor Mark Ups				
		Overhead	Profit	Contingency	Mobilization	
Impoundment Area	Raw Costs	10%	5%	50%	5%	**Total Estimated Cost**
Sand Springs	$6,595,959	$659,595.91	$362,777.75	$3,809,166.36	$571,374.95	$11,999,000
Zink	$2,349,453	$234,945.35	$129,219.94	$1,356,809.37	$203,521.41	$4,274,000
South Tulsa/Jenks	$5,200,504	$520,050.44	$286,027.74	$3,003,291.28	$450,493.69	$9,460,000
						$25,733,000

ATTACHMENT B
Dam Improvement Costs
Arkansas River Corridor Dam Improvement and Riverbank Stabilization Projects

Arkansas River Corridor Dams

		Sand Springs (New)				South Tulsa/Jenks (New)				Zink (Existing Upgrades)			
		1,900 Foot Long Dam (11 Ft High)				1,800 Foot Long Dam (8 Ft High)				1,000 Foot Long Dam (11 Ft High)			
Item	**Unit**	**Unit Costs for 100 Foot Section (19 Req'd)**	**Quantity Req'd**	**Segment Cost**		**Unit Cost for 100 Foot Section (18 Req'd)**	**Quantity Req'd**	**Segment Cost**		**Unit Cost for 100 Foot Section (10 Req'd)**	**Quantity Req'd**	**Segment Cost**	
Main RCC Dam Section	Each	$1,301,000	9	$11,709,000		$871,000	8	$6,968,000		$650,500	4	$2,602,000	
Main Dam w/Gate Support Section	Each	$630,000	10	$6,300,000		$463,000	10	$4,630,000		$315,000	6	$1,890,000	
Long Pier & Wall w/Bridge Support	Each	$259,700	8	$2,077,600		$165,600	6	$993,600		$259,700	4	$1,038,800	
Intermediate Pier w/Bridge Support	Each	$129,850	6	$779,100		$82,800	8	$662,400		$129,850	4	$519,400	
Gate Operator Pier & Training Wall w/Bridge Support	Each	$275,000	4	$1,100,000		$208,750	3	$626,250		$275,000	1	$275,000	
Gate Operator Pier & Training Wall	Each	$265,000	0	$0		$198,750	0	$0		$265,000	2	$530,000	
Dam Surface Preparation & Earthwork	Each	$100,800	19	$1,915,200		$62,500	18	$1,125,000		$25,200	10	$252,000	
Demolition of Existing Gates & Concrete	LS		0	$0			0	$0		$990,000	1	$990,000	
Riverbank Abutment Cutoffs	Each	$63,500	2	$127,000		$46,500	2	$93,000			0	$0	
Fish Passage Additions	LS		0	$0		$4,160,000	1	$4,160,000			0	$0	
Whitewater Additions to Exist Dam	LS		0	$0			0	$0		$7,754,000	1	$7,754,000	
Cofferdam & Dewatering Allowance	Each	$253,000	19	$4,807,000		$214,000	18	$3,852,000		$318,000	10	$3,180,000	
Gates w/Controls	Each	$1,440,000	10	$14,400,000		$1,080,000	10	$10,800,000		$1,320,000	6	$7,920,000	
Pedestrian Bridge plus Lighting	Each	$433,750	19	$8,241,250		$433,750	18	$7,807,500		$433,750	1	$433,750	
Subtotal with Bridges ===>				$51,457,000				$41,718,000				$27,385,000	
Contingency ===>	30%			$15,438,000				$12,516,000				$8,216,000	
TOTAL COST ===>				**$66,895,000**				**$54,234,000**				**$35,601,000**	
Subtotal without Bridges ===>				$43,215,000				$33,911,000				$26,952,000	
Contingency ===>	30%			$12,965,000				$10,174,000				$8,086,000	
TOTAL COST WITHOUT BRIDGES ===>				**$56,180,000**				**$44,085,000**				**$35,038,000**	

Notes:
1) Cofferdam & Dewatering Allowance is at 20% of the subtotal of all work items above this cost item.
2) Item costs are complete and include 5% Mobilization, 10% Overhead, 5% Profit and 10% Miscellaneous items not accounted for.
3) Total costs include a risk contingency of 30% to account for this level of design..