APPENDIX D

INVESTIGATION AND ANALYSIS REPORT

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This report provides supplementary information to the Supplemental Watershed Plan and Environmental Assessment (EA) for the Switzler Creek Watershed. Additional information relevant to each of the sections provided in this report is available as part of the administrative record for the Project.

1.0 SEDIMENTATION

The purpose of the existing structure is to retard and then release floodwaters in a controlled manner. Site No. 7 appears to be functioning adequately as there has been no record of downstream flooding.

Site No. 7 was designed for a 50-year sediment storage life and constructed with a 2-stage drop inlet riser (low flow orifice and open top weir). The majority of sediment is deposited in the normal pool (the area below the principal spillway [low flow orifice] crest). The remaining sediment is deposited in the floodwater retarding pool (the area between the principal spillway crest and the auxiliary spillway crest). If sediment were to fill to the elevation of the principal spillway crest, the pool would no longer have permanent water storage. If the floodwater retarding pool loses storage due to sediment deposition, the auxiliary spillway would flow more frequently. If the auxiliary spillway flows more frequently, the amount of erosion would increase, causing an increase in operation and maintenance costs.

The primary source of sediment in the floodwater retarding structure results from sheet, rill, and gully erosion. During the summer of 2007, the Kansas Biological Survey (KBS) performed a bathymetric survey of the impoundment. The survey was carried out using acoustic echosounding apparatus and manual spot measurements of depth as necessary. The bathymetric survey was georeferenced to both horizontal and vertical reference datums, allowing the survey to be compared with pre-impoundment engineering data. The surveys were then used to compute historical sediment yield and the size of the sediment pool needed to extend the project life of the structure for 100 years after rehabilitation.

1.1 POST-CONSTRUCTION GROUND SURFACE

The as-built drawings illustrate pre-construction contours and provide reservoir capacity table data, final construction quantities, and borrow site limits. By reviewing the table of quantities, the as-built drawings indicate that a small percentage of the borrow material necessary to build the embankment came from the auxiliary spillway and outlet ditch. The remaining material was excavated from the area upstream of the structure and below the normal pool area. Based on inspection of the 2007 bathymetric contours, the majority of the borrow volume needed to build the embankment came from below the principal spillway low orifice elevation. Table D1-1 summarizes the earthwork quantities.

Table D1-1 Estimated "In-Pool" Borrow Volume

Recorded In-Place Embankment[1] (cy)	Recorded Auxiliary Spillway and Outlet Channel Excavation (cy)	Estimated "In-Pool" Borrow (cy)
116,200	2,300	113,900

Note:
[1] Data obtained from as-built drawings.

1.2 ANNUAL SEDIMENT ACCUMULATION

The historical annual sediment accumulation of Site No. 7 was computed based on the estimated capacity, including the in-pool borrow, and the 2007 surveyed capacity. The volume of storage trapped by Site No. 7 was used to estimate the sediment storage requirements.

Table D1-2 summarizes the annual sediment accumulation results. The capacity shown on the as-built drawings was adjusted to reflect the estimated borrow volume developed, as described in Section 1.1. Based on the years of accumulation, the annual sediment accumulated at Structure No. 7 is 4.3 acre-feet per year. Review of the stage-storage curves indicates that most of the sediment has accumulated below the principal spillway crest elevation.

Table D1-2 Annual Sediment Accumulations

Estimated End of Construction Capacity Including In-Pool Borrow (acre-feet)[1]	2007 Surveyed Remaining Capacity to Low Orifice El. 1075.0 (acre-feet)[1]	Sediment Accumulated (acre-feet)	Years of Accumulation	Annual Sediment Accumulated (acre-feet/year)	Annual Sediment Accumulated (acre-feet/square mile)
241.4	48.18	193.2	45	4.3	0.88

Note:
[1] Estimated capacity remaining between the 2007 surveyed bathymetric surface to the principal spillway low orifice elevation.

1.3 HISTORICAL WATERSHED SOIL LOSS RATE

The estimated soil loss rates were used to predict sediment yields over a 100-year time period to assess sediment storage requirements. Table D1-3 illustrates the 2007 surveyed sediment storage capacity as well as the cumulative deposited sediment volumes predicted over the next 100 years.

Table D1-3 Predicted 100-year Sediment Accumulation

2007 Surveyed Remaining Sediment Storage Capacity[1] (acre-feet)	Required 100-Yr Sediment Storage (acre-feet)	Required Aerated Sediment Storage (acre-feet)
48.2	429.3	381.1

Note:
[1] Estimated capacity remaining between the 2007 surveyed bathymetric surface to the flowline of the principal spillway orifice.

2.0 BREACH ROUTING ANALYSIS

A breach analysis was conducted for Site No. 7 to provide a prediction of the extent and timing of flooding from a catastrophic breach of the dam. The results from this analysis are sufficient for developing an inundation map and/or an emergency action plan. Due to limitations in modeling the flow dynamics of a severe, abrupt, and debris-laden breach wave, the modeling and results should be considered approximate. The dam breach analysis was performed using equations in NRCS Technical Release 60 (TR-60), NRCS Technical Release 66 (TR-66) criteria, and Dave Froehlich's peak flow equation (Froehlich, 1995) to develop an analytical breach hydrograph. The U.S. Army Corps of Engineer's Hydrologic Engineering Centers - River Analysis System (HEC-RAS) software

model was used to route the floodwater downstream to determine peak discharges and water surface elevations through the reach below the modeled breach failure.

2.1 BREACH CRITERIA

The catastrophic breach failure scenario evaluates a breach using a pool elevation equal to the auxiliary spillway crest elevation or the 100-year, 6-hour event. The highest pool elevation is considered as long as the elevation does not exceed the top of dam elevation. This scenario results when the reservoir is at its maximum flood storage elevation volume and there is little warning of the potential flows prior to structure failure.

2.2 MODEL DEVELOPMENT

As documented by Froehlich in 1995, the International Commission of Large Dams reports the majority of embankment dam failures are caused by overtopping due to inadequate spillway capacity, piping failure, embankment sliding, embankment settlement, and inadequate wave protection. Several methods exist or are being developed for predicting dam breach hydrographs of any failure type. Common methods include parametric models, physically based models, and predictor equations.

Parametric models (offered in NWS DAMBRK & FLDWAV) require defining numerous variables, including embankment breach width, depth, side slope, breach initiation time, and breach formation time. Breach initiation time is defined as the time from when flow first begins to flow over or through a dam until the start of the breach formation phase. Breach formation time is defined, for overtopping events, as the time after the overtopping flow has eroded the downstream face and throughout the crest width to the point of the upstream face. The magnitude of peak outflow has been found to be more correlated with failure time for smaller reservoirs while, conversely, peak outflow has a greater correlation with breach width for larger reservoirs (Wahl, 1998). Hence, breach formation time is key in defining the steepness of the flood wave hydrograph. Conversely, breach initiation time is not particularly helpful in a breach routing analysis since it does not significantly affect the peak outflow or the routing of an actual flood event, but it is certainly helpful in developing a dam breach warning and evacuation plan. It is important to note that a lengthened breach initiation time due to downstream embankment armoring can create greater endurance in the case of an overtopping/head cutting scenario, allowing time for the overtopping event to be reduced to only the use of principal and auxiliary spillways before a full breach occurs. In any case, such methods rely heavily on case study data; and these data are sparse due to the limited number of actual dam breaches analyzed.

Physically based models utilize principles based upon hydraulics, sediment transport, and soil mechanics. These models are not yet fully developed, and are being researched by NRCS and Agricultural Research Service (ARS) staff.

This analysis utilizes the method of predictor equations. NRCS engineers and hydrologists use this method to directly estimate peak discharge from an empirical equation based on case study data of actual breaches. According to the addendum to TR-60 in 1990, the criteria for peak flow prediction for an embankment of this height are as follows:

$Q_{max} = 1100Br^{1.35}$ (Eq. A)

$Br = V_sH_w/A$

But not less than: $Q_{max} = 3.2H_w^{2.5}$ (Eq. B)

And not more than: $Q_{max} = 65H_w^{1.85}$ (Eq. C)

Where: V_s = Reservoir volume at time of failure (ac-ft)
H_w = Depth of water at time of failure (ft)
A = Cross-sectional area of embankment at location of breach (ft^2)

The Froehlich equations are:

$$Q_{max} = 40.1*(V_s^{0.295})*(H_w^{1.24})$$

$$T = 0.32175*V_w^{0.53}*H_w^{-0.90}$$

Although the predictor method is likely to have a high level of uncertainty associated with the peak discharge estimates, a simple curvilinear hydrograph was developed based on the equations in TR-66. The TR-66 model data requirements include reservoir storage, stage, and embankment information as well as elevation-area-flow data at each downstream cross section.

The peak flow computed from the equations above is the point of initiation for hydrograph development in NRCS TR-66 and decays at the rate represented by the following equation:

$$Q_i = Q_{max}*e^{(-t*Qmax/Vl)}$$

Where: Q_i = Outflow from breach at time t
t = Time (s)
V_l = Reservoir volume at time of failure (ft^3)

The downstream flows were routed until the water surface profile was reduced sufficiently to remain within the approximate channel banks or the delineated 100-year floodplain.

2.2.1 Reservoir Storage

Stage-storage volume curves were taken from as-built drawings of the structure. Any future modifications to increase the permitted design storage curve will require re-evaluation of the breach analysis. Since unconsolidated sediments will likely be restricted to the breach vicinity, a substantial impact to the breach discharge volume is not expected. Therefore, the total pool volume was not increased.

2.2.2 Reservoir Stage

The analysis utilized guidelines developed by the Kansas Department of Agriculture, Division of Water Resources and NRCS for conducting dam breach analyses. The guidelines specify using a pool elevation equal to the 100-year, 6-hour event or the auxiliary spillway crest elevation, whichever is higher, as long as the elevation does not exceed the top of dam elevation. For Site 7, the reservoir level at the 100-year, 6-hour water surface elevation 1088.4 is 2.6 feet below the auxiliary spillway crest elevation of 1091.0 feet. Based on hydraulic modeling, the auxiliary spillway crest elevation was used for maximum pool elevation.

The guidelines recommend the use of the channel invert to define H_w or the depth of water at the dam at the time of failure when the channel occupies a significant portion of the dam section. In cases where the channel portion is significantly less than the floodplain area at the dam section, a representative floodplain elevation is appropriate for the H_w datum.

2.2.3 Dam Embankment

The cross-sectional area of Site No. 7 (perpendicular to the structure axis) was determined from the as-built drawings. Deposited sediments in the reservoir pool following construction were not included, as they were assumed not to add to the structure's integrity.

2.2.4 Hydraulic Characteristics of Downstream Reach

The HEC-RAS one-dimensional computer program was used to determine the hydraulic characteristics and stage discharge capacity of each downstream section. This data was then used along with the breach discharge hydrograph to route the flood wave downstream and to determine elevations at each section.

The dimensions of each section were taken from U.S. Geologic Survey (USGS) quadrangle maps. The cross section at the centerline of the dam was taken from the as-built drawings. The routings are dependent on section geometry and hydraulic characteristics. Manning's "n" value is used to compute resistance to flow, and can range from 0.04 to 0.10 or more. Manning's "n" values were assigned during site observations and based on published references. The site has a wooded area along the stream and cropped or grassed flood plains. Since debris will be carried by a sudden breach wave, the "n" value is higher than under normal flow conditions. A Manning's "n" value of 0.06 was applied to the channel and the right flood plain, while a value of 0.07 was used on the left floodplain to represent more timber.

2.3 BREACH ROUTING RESULTS

The catastrophic breach failure scenario investigated is considered a worst-case scenario, as there is little to no warning of the potential flows when the reservoir is at its maximum flood storage elevation volume. It identifies areas potentially inundated in the event that the structure should fail and was conducted using the techniques described in TR-60, Earth Dams and Reservoirs.

This breach was evaluated with the reservoir level at the auxiliary spillway crest water surface elevation. The downstream flows were routed until the water surface profile was reduced sufficiently to remain within the approximate channel banks or the delineated 100-year floodplain.

A simple curvilinear hydrograph was developed, based on the equations in TR-66. Peak flow estimates were generated from NRCS equations in TR 60 (NRCS 1990) with some supporting documentation in the report "A Study of Predictions of Peak Discharge from a Dam Breach" by Kalkanis, Alling, and Ralston (NRCS National Bulletin No. 210-6-19) and Dave Froehlich's peak flow equation (Froehlich, 1995). The results are as follows:

	NRCS EQ. A	NRCS EQ. B	NRCS EQ. C	Froehlich
Q_{max} at ASW crest	38,805	17,122	37,319	25,862

The geometry for the cross section at the dam centerline, assuming no structure, was taken from the as-built drawings. The HEC-RAS computer model predicted water surface elevations and

cross-sectional flow areas for the downstream sections. Roadway crossing structures immediately upstream and downstream of the structure were included to allow the impacts of the crossing structures to be represented.

The breach analysis at Site No. 7 was conducted with the reservoir pool at the auxiliary spillway crest elevation of 1091.0 feet and a volume of 1799 acre-feet. A peak breach discharge of 37,319 cubic feet per second was computed using the NRCS Eq. C. Using the Froehlich equation for breach development, the time for the peak flow was computed to be 0.78 hours. A plan view and inundation limits are shown in Appendix C: Support Maps, Figure 1.

The stream channel that would carry the breach flow moves into Burlingame approximately one mile downstream. At Burlingame, it goes under U.S. Highway 56 and an Amtrak railway. Several houses are low in the floodplain and may be endangered by a catastrophic breach of the dam site. The highway and railroad may suffer damage as a result of a breach event.

The NRCS National Engineering Manual (NEM) 520.14 describes physical parameters that can be used to assess the potential risk to property and human life. It states that some areas may tolerate depths of 1 to 3 feet without being considered hazardous to life. Warning time and the velocity of water flow, either alone or in combination with depth, should also be considered. The manual also states that a product (depth x velocity) of 5 or 7 has been used as a limit for “people safety,” and a product of 15 or 20 has been used for “structural safety.”

In analyzing the results in total, it appears that a High Hazard Class designation of Site No. 7 is appropriate. A catastrophic breach has the potential to affect several houses, a major U.S. highway, and an Amtrak rail line.

3.0 AGENCY COORDINATION

Appendix B contains notification letters sent to agencies and organizations.

4.0 OPINION OF PROBABLE CONSTRUCTION COSTS

Table D4-1 Federal Decommissioning Alternative Costs

	Item	Quantity	Units	Unit Cost $ 1/	Cost $
1	Excavation	25,000	CU YD	$3	$75,000
2	Earthfill	2,000	CU YD	$4	$7,000
3	Riprap	3,200	CU YD	$50	$160,000
4	Geotextile	3,800	SY	$5	$19,000
5	Bedding Sand	650	CU YD	$15	$9,750
6	Seeding - Native Grass	7	AC	$1,000	$7,000
7	Principal Spillway Removal		LUMP SUM		$10,000
8	Real Property Acquisition & Relocation		LUMP SUM		$1,744,200
9	Realignment of US Highway 56 3/		LUMP SUM		$500,000
10	Highway 56 Bridge Replacement 2/		LUMP SUM		$150,000
		Subtotal			$2,681,750
		Construction Contingency	10.0%		$268,200
		Opinion of Probable Cost			$2,949,950

Notes
1/ Unit costs based upon recent construction bids.
2/ Hwy 56 bridge replacement cost based upon recent bridge replacement bids in Ellsworth and Kearny Counties
3/ Road realignment costs based on recent road reconstruction projects in Barber and Rice Counties

Table D4-2 Federal Decommissioning Property Acquisition Costs

Property Address	Acreage	Value of Improvements	Land Value	Total Value
221 E. Lincoln Avenue	0.16	$ 75,140	$ 5,200	$ 80,340
233 E. Lincoln Avenue	0.16	$ 113,810	$ 6,990	$ 120,800
241 E. Lincoln Avenue	0.16	$ 32,730	$ 3,420	$ 36,150
213 E. Lincoln Avenue	0.16	$ 45,860	$ 5,200	$ 51,060
306 N. Kansas Avenue	0.16	$ 29,060	$ 7,640	$ 36,700
315 N. Kansas Avenue	0.16	$ 12,290	$ 8,320	$ 20,610
324 N. Kansas Avenue	0.16	$ 64,990	$ 11,800	$ 76,790
306 N. Kansas Avenue	0.16	$ 29,060	$ 7,640	$ 36,700
312 N. Kansas Avenue	0.16	$ 29,430	$ 5,370	$ 34,800
426 E. Santa Fe Avenue	12.13	$ 139,560	$ 10,340	$ 149,900
432 E. Santa Fe Avenue	6.90	$ 115,810	$ 19,050	$ 134,860
514 E. Santa Fe Avenue	2.70	$ 90,590	$ 20,610	$ 111,200
546 E. Santa Fe Avenue	4.40	$ 28,310	$ 19,820	$ 48,130
614 E. Santa Fe Avenue	5.00	$ 93,210	$ 23,600	$ 116,810
628 E. Santa Fe Avenue	11.11	$ 84,870	$ 20,450	$ 105,320
Cropland (Easements)	200.00		$ 318,000	$ 318,000
SUB-TOTAL	43.68	$ 984,720	$ 175,450	$ 1,478,170
Relocation Payments				$ 150,000
Relocation assistance advisory services				$ 116,000

Grand Total	$1,744,170

Table D4-3 No Federal Action – High Hazard Costs – Year 2010

	Item	Quantity	Units	Unit Cost $	Cost $
1	Earthfill	27,000	CU YD	$10	$270,000
2	30” Dia HDPE Pipe Liner	200	LIN FT	$193	$38,600
3	Seeding – Native Grass	12	AC	$1,000	$12,000
4	Water for Compaction	500	MGAL	$35	$17,500
5	Riprap	800	SQ YD	$92	$73,600
6	Clearing and Grubbing	15	AC	$200	$3,000
7	4-inch Diameter Drain Pipe Extension	40	LIN FT	$10	$400
		Subtotal			$415,100
		Construction Contingency	10.0%		$41,510
		Opinion of Probable Cost			$456,610

Estimated Engineering Cost (30% of construction cost) = $136,983
Estimated Project Administration Cost (15% of construction cost) = $68,492
Total Phase 1 Cost = $662,100

Table D4-4 No Federal Action – High Hazard Costs – Year 2060

	Item	Quantity	Units	Unit Cost $	Cost $
1	Excavation	5,275	CU YD	$3	$15,825
2	Earthfill	5,275	CU YD	$3	$15,825
3	Concrete	55	CU YD	$500	$27,500
4	Reinforcing Steel	3,200	LB	$1.50	$4,800
5	Trash Rack	1	EA	$3,000	$3,000
6	30” Dia Concrete Pipe	200	LIN FT	$250	$50,000
7	Seeding – Native Grass	2	AC	$1,000	$2,000
8	Water for Compaction	100	MGAL	$35	$3,500
9	12-inch Diameter Valve	1	EA	$3,000	$3,000
10	12-inch Diameter PVC Pipe	40	LIN FT	$50	$2,000
11	4-inch Diameter Drain Pipe	40	LIN FT	$10	$400
		Subtotal			$127,850
		Construction Contingency	10.0%		$12,785
		Opinion of Probable Cost			$140,635

Estimated Engineering Cost (30% of construction cost) = $42,190
Estimated Project Administration Cost (15% of construction cost = $21,095
Total Phase 2 Cost = $203,900

Total Project Cost = $866,000

Table D4-5 FEDERAL RECONSTRUCTION COSTS

	Item	Quantity	Units	Unit Cost $	Cost $
1	Earthfill	65,400	CU YD	$10	$654,000
2	Concrete	60	CU YD	$500	$30,000
3	Reinforcing Steel	3,200	LB	$1.50	$4,800
4	Trash Rack	1	EA	$3,000	$3,000
5	30” Dia Concrete Pipe	200	LIN FT	$215	$43,000
6	Seeding – Native Grass	15	AC	$1,000	$15,000
7	Water for Compaction	1,000	MGAL	$35	$35,000
8	Riprap	800	SQ YD	$92	$73,600
9	Clearing and Grubbing	20	AC	$200	$4,000
10	12-inch Diameter Valve	1	EA	$3,000	$3,000
11	12-inch Diameter PVC Pipe	40	LIN FT	$50	$2,000
12	4-inch Diameter Drain Pipe Extension	60	LIN FT	$10	$600
		Subtotal			$868,000
		Construction Contingency	10.0%		$86,800
		Opinion of Probable Cost			$954,800

5.0 ECONOMIC EVALUATION

The NRCS National Watershed Manual (NWM) was used as a reference for the economic analysis along with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), U.S. Water Resources Council, March, 1983. P&G was developed to define a consistent set of project formulation and evaluation instructions for all federal agencies that carry out water and related land resource implementation studies. The basic objective of P&G is to determine whether or not benefits from proposed actions exceed project costs. P&G also requires that the "National Economic Development" or NED Alternative, which maximizes monetary net benefits, be selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts. The allowance for exceptions to the NED plan recognizes the fact that not all project considerations or benefits can be quantified and monetized when it comes to some ecological system and social effects.

Critical to direction and focus of an environmental assessment (EA) is the project sponsor's purpose and need for requesting assistance. For this EA, the sponsors purpose and need is to maintain floodwater retarding structure #7 (Site 7) as a viable flood control dam that would continue to provide flood reduction benefits to rural areas of Osage County. In this analysis, there were two alternative plans – No Federal Action – High Hazard plan and the Federal Rehabilitation plan - that met the sponsors purpose and need. These alternative plans, which are described in Section 4.2 of this EA, would maintain the same level of flood protection as Site 7 currently provides.

5.1 ECONOMIC BENEFITS

Site 7 is a structure that provides significant flood protection to rural Osage County. The benefit estimate for this EA is based on the 1954 original plan economic analysis. In that analysis, flood reduction benefit categories included crop and pasture, road and bridge, urban, and other agriculture. The original plan analysis also identified more intensive use benefits associated with flood protection. Indexing was the procedure used to update original plan benefits to 2009 dollars.

5.1.1 Flood Control Benefits

Indexing original work plan benefits is an abbreviated procedure for estimating benefits for Site 7. This procedure is supported by sections 1.7.2(a)(4)(ii) and 2.1.1(b)(2) of the P&G which allows for abbreviated procedures in evaluating project benefits. The decision to use this abbreviated procedure, and not undertake a timely and costly hydrologic and economic evaluation of the watershed, did not alter the evaluation of alternatives, nor the selection of the NED alternative, for the following reason:

> All reasonable alternatives examined in detail would maintain Site 7 as a floodwater retarding structure that would maintain the same level of flood protection. Therefore, any land use changes in benefit area that have occurred in the last 50 years, which would positively or negatively impact flood reduction benefits, would impact both alternatives equally.

The original work plan indicated that cropland was a relatively small portion of floodplain land use. However, the original work plan captured economic benefits resulting from conversion of non-cropland areas to cropland due to a reduction in floodplain flooding. This analysis assumes this conversion has occurred as previously credited. Another difference between then and now is the crop mix, which includes more soybeans and less sorghum. The proportion of wheat and corn

grown on the floodplain appears to have changed little in the last 50 years. County roads and bridges that were considered beneficiaries of Site 7 in the 1950's still exist and have had no fundamental improvements (i.e. gravel roads then are still gravel roads now). Moreover, there has been little, if any, development in the benefit area. According to the U.S. Census, the population of Burlingame, currently at 1,021, has dropped by four people in the last 50 years.

Total average annual benefits of Site 7 are estimated at $84,100 (2009 dollars). Crop and pasture benefits, which represent the reduction in flood-damaged yields, are estimated at $17,000 (2009 dollars). Floodplain scour represents lost production land due to flood damages, and account for $5,100 in benefits. Other agricultural benefits, estimated at $5,300, represent reduced flood damages to fence lines, stored grains, etc. Finally, intensification represents greater agricultural use of floodplain due to less frequent flooding. In the absence of Site 7, flood frequency will increase and floodplain land use will revert to pre-dam conditions. Intensification benefits represent $34,300 in annual benefits.

The above benefits were indexed to 2009 dollars using a land value index. Land values would more likely reflect the wide range of changes in the value of flood damage prevented by Site 7. The value of land should accurately reflect changes in the land's use for various crops, changes in price, and the dramatic improvements in productivity. Crop yields, for instance, in Osage County have increased 100 to 300 percent since the 1950's. Kansas Agricultural Statistical Service, *Land Value,* is the source of the land value index.

Reduced flood damages to infrastructure such as houses, roads, and bridges were indexed using the Engineering News Record Construction Cost Index. Roads and bridge benefits are estimated at $8,400, while flood reduction benefits to the City of Burlingame are estimated at $14,000. Table 4-3, Comparison of Alternatives, and Table D5-4, Comparison of Benefits and Costs, displays all the benefits associated with Site 7 in 2009 dollars.

As per NWM and P&G guidance, the benefits and costs of these alternative plans were compared. As expected, and as indicated by Table A-5, there is no net difference in flood reduction benefits when comparing one plan to the other. Therefore, the NED alternative plan for this EA is the plan that costs the least to implement.

Table D5-1 1954 Work Plan Benefits Indexed to 2009 Dollars

	1954 Value	1954 Value Indexed to 2009 Dollars
Without Project		
Flood Damage Reduction:		
Crop and Pasture [1]	$1,356	$31,200
Other Agricultural [1]	$534	$12,300
Roads and Bridges [2]	$1,314	$18,000
Nonagricultural [2]	$2,006	$27,500
Flood Plain Scour [1]	$368	$8500
Total Flood Damage	**$5,578**	**$97,500**
With Project		
Crop and Pasture [1]	$616	$14,200
Other Agricultural [1]	$305	$7,000
Roads and Bridges [2]	$704	$9,600
Nonagricultural [2]	$983	$13,500
Flood Plain Scour [1]	$149	$3,400
Total Flood Damage	**$2,756**	**$47,700**
Non-Flood Damage Reduction: Intensification [1]	$1,492	$34,300
Total Non-Flood Benefits	$1,492	$34,300
Average Annual Damage Reduction Benefit		
Flood Damage Reduction:		
Crop and Pasture [1]	$739	$17,000
Other Agricultural [1]	$230	$5,300
Roads and Bridges [2]	$620	$8,400
Nonagricultural [2]	$1,023	$14,000
Flood Plain Scour [1]	$219	$5,100
Total Net Flood Benefits	**$2,822**	**$49,800**
Intensification [1]	$1,492	$34,300

Notes:
[1] Source: KASS, USDA based on average value for Kansas of $69 per acre in 1954 and $1,590 in 2009.
[2] Source: Engineering News Record Construction Cost Index in 1954 of 628 and August 2009 of 8596.

5.2 PROJECT COSTS

The 2009 No Federal Action – High Hazard Alternative includes the rehabilitation of the structure to minimum State of Kansas criteria for a High Hazard structure. This alternative includes the lining of the principal spillway and raising the top of dam elevation. An opinion of approximate construction cost for these repairs is $456,600. The existing principal spillway and liner have an expected design life of 50 years, after which the principal spillway will need replaced. An opinion of approximate construction cost for these future repairs is $140,635 in 2009 dollars.

The Federal Reconstruction Alternative includes rehabilitation of the structure to NRCS High Hazard Class criteria. This alternative includes raising the dam approximately 6 feet in elevation, raising the auxiliary spillway, and replacing the principal spillway. This alternative has an opinion of approximate construction cost of $954,800, and a design life of 100 years.

Based on the Fiscal Year 2010 federal discount rate of 4.375 percent over the life of each project, the annual installation costs for No Federal Action – High Hazard Alternative are $38,800 plus an estimated $2,400 in annual replacement costs. This results in a total annual project cost of $41,200 over 101 years. The annual installation costs for the Federal Reconstruction Alternative is $62,100 over 101 years. Annual operation and maintenance costs were estimated at $3,800 for a total annualized project cost of $65,900.

Table D5-2 Estimated Average Annual NED Costs

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation and Maintenance[3]	
No Federal Action – High Hazard: [1]	**$38,800**	**$2,400**	**$41,200**
Federal Reconstruction [2]	**$62,100**	**$3,800**	**$65,900**

Notes:
[1] Amortized cost of $866,000 over 101 years at 4.375%
[2] Amortized cost of $1,384,400 over 101 years at 4.375%
[3] Annual Operation and Maintenance costs estimated at 0.4% of construction cost
(Const. Cost = $597,200 for No Federal Action Alternative and $954,800 for Federal Reconstruction Alternative)

Table D5-3 Estimated Average Annual Flood Damage Reduction Benefits

	Average Annual Damages (without Dam)		Average Annual Damages (with Dam)		Net Damage Reduction Benefit	
	No Federal Action – High Hazard	Federal Reconstruction	No Federal Action – High Hazard	Federal Reconstruction	No Federal Action – High Hazard	Federal Reconstruction
1954 Average Annual Benefit	**97,500**		**$47,700**		**$49,800**	

Note: From Table D5-1

5.3 BENEFIT-COST RATIO OF ALTERNATIVES

The No Federal Action – High Hazard Alternative provides a benefit-cost ratio of 2.04 resulting from average annual benefits of $84,100 and 101-year annualized cost of $41,200. The Federal Reconstruction Alternative provides a benefit-cost ratio of 1.28 resulting from average annual benefits of $84,100 and annualized cost of $65,900. Table D5-4 shows the calculation of these benefit-cost ratios.

Net Benefit Effects

Economic benefits and impacts associated with the rehabilitation of the Switzler Creek floodwater retarding structure were calculated based on the flood control benefits the structure was intended to provide. The National Economic Development (NED) alternative is the alternative that has the highest net economic benefits while protecting the nation's resources. Table D5-4 compares each alternative relative to the potential benefits derived or reduced for each.

Table D5-4 Comparison of NED Benefits and Costs

Evaluation Unit	Annual Flood Damage Reduction Benefits[1]	Annual More Intensive Use Benefits[2]	Total Annual Benefits[3]	Average Annual Costs	Benefit-Cost Ratio
No Federal Action – High Hazard	$49,800	$34,300	$84,100	$41,200	2.04
Federal Reconstruction	$49,800	$34,300	$84,100	$65,900	1.28

Notes:
[1] From Table D5-2.
[2] From Table D5-1.
[3] From Table D5-1, Total net benefits plus intensification

Period of Analysis

The period of analysis for the No Federal Action – High Hazard Alternative and the Federal Reconstruction Alternative includes a 100-year design life plus one year for construction.

Project Life

The project life for the No Federal Action – High Hazard Alternative is 100 years based on two 50-year design life cycles. The project life for the Federal Reconstruction Alternative is based on a 100-year design life.

6.0 ENVIRONMENTAL EVALUATION

The environmental evaluation (EE) is a NRCS planning process as described in the NRCS National Planning Procedures Handbook. The EE identifies and analyzes the economic, environmental, and social concerns. This planning process is then documented/summarized on the KS-CPA-52 Environmental Evaluation for Conservation Planning form. This EE planning process started with the identification of problems and opportunities and continues through the application and evaluation of the project.

Additional resources discussed within Section 504.37 of the National Watershed Manual are incorporated into the Scope of the EA.

6.1 KS-CPA-52

The KS-CPA-52 has been developed according to guidance found in the NRCS National Environmental Compliance Handbook and policy from the General Manual. Section J. Special Environmental Concerns of the form addresses the primary laws, executive orders, and policy that are of planning concern. For each of these concerns there is an Evaluation Procedure Guide Sheet that has been developed to assist the planner in determining the status of their project in relation to that particular concern.

For planning purposes of this Watershed Plan Supplement and EA, the KS-CPA-52 has been utilized for scoping and documentation of concerns and then has been updated as the planning process has proceeded. The results of the EE (scoping and documented KS -CPA-52) are used in Chapter 3 of the Watershed Plan Supplement and EA Table 3-1, which identifies the primary resource concerns. When a resource concern was found to be not relevant and sufficient rationale is provided, then the concern was eliminated from further consideration. Each of the resource concerns that are noted in Table 3-1 as “Yes” in the “Relevant to the Proposed Action” column was then carried forward to Chapter 4, Alternatives and Table 4-3 Comparison of Alternatives. It is in Table 4-3 that the scoping concerns were further reviewed to see if they were pertinent to the individual alternatives. Those pertinent concerns were then evaluated for that alternative in Chapter 5, Environmental Consequences. Those noted as “No” in the “Relevant to the Proposed Action” column were not discussed further in this EA.

The KS-CPA-52 and the associated Evaluation Procedure Guide Sheets are included in Appendix E – Supporting Information. These represent the EE process in living, field-type, and documentation form.

7.0 REFERENCES

Bureau of Labor Statistics. Unemployment Rates by County, September 2008-August 2009 Averages. Accessed October 6, 2009. http://www.bls.gov/lau/maps/twmcort.pdf

CNN. Unemployment state by state. Accessed October 6, 2009. http://money.cnn.com/pf/features/lists/state_unemployment/

EPA. Environmental Justice Assessment. Last updated on Friday, January 2nd, 2009. www.epa.gov/compliance/whereyoulive/ejtool.html.

EPA. National Water Quality Inventory Report to Congress (305(b) report). Not dated. http://www.epa.gov/305b/.

EPA. Currently Designated Nonattainment Areas for All Criteria Pollutants. June 05, 2009. http://www.epa.gov/air/oaqps/greenbk/ancl3.html.

Kansas Department of Health and Environment (KDHE), Division of Environment, Bureau of Environmental Field Services. Kansas Integrated Water Quality Assessment 2008. 2008. http://www.kdheks.gov/befs/download/2008IR_040108FINAL.pdf.

KDHE, Division of Environment, Bureau of Environmental Remediation. Identified Sites List. Not dated. http://kensas.kdhe.state.ks.us/pls/certop/ISearch.

KDHE, Division of Environment, Bureau of Water. Marais des Cygnes Basin TMDLs. Not dated. http://www.kdheks.gov/tmdl/marais.htm.

Kansas Biological Survey (KBS), Applied Science and Technology for Reservoir Assessment (ASTRA). Bathymetric Survey of Switzler Creek Site # 7. August 2007.

Kansas Geological Survey (KGS). Geologic Map of Osage County, Kansas, Geology by Howard G. O'Connor. Mapped 1954, Originally published 1955. http://www.kgs.ku.edu/General/Geology/index.html.

Kansas State Historical Society. Randall M. Thies, Archeologist. Archeological Survey of Switzler Creek Site 7, Watershed Rehabilitation Program, An NRCS Project in Osage County, Kansas. May 25, 2007.

Lake Region Resource Conservation and Development Council. Watershed Restoration And Protection Strategy For The Marais Des Cygnes Basin. July, 2003. http://www.kdheks.gov/nps/wraps/MdCWRAPS.PDF.

National Register of Historic Places. Osage County, Kansas. Not dated. http://www.historicdistricts.com/ks/Osage/state.html.

Natural Resources Conservation Service (NRCS). Web Soil Survey. Accessed June 15, 2009. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

NRCS. Electronic Field Office Technical Guides (eFOTGs). Accessed June 15, 2009. http://www.nrcs.usda.gov/technical/efotg/.

NRCS. National Environmental Compliance Handbook, Part 610. Not dated. http://www.nrcs.usda.gov/technical/envicomp.html.

NRCS. Environmental Effects for Conservation Planning, KS-CPA-52. Revised February 2009. http://efotg.nrcs.usda.gov/references/public/KS/KS-CPA-52.xls.

NRCS. Larry Sabata, Soil Scientist. Preliminary Draft of the Wetland Determination Map. e-mail dated January 15, 2008.

NRCS. Kenneth A. Kuiper, State Biologist. Habitat Assessment Letter. Dated July 31, 2007.

NRCS. Edwin W. Radatz, Hydraulic Engineer. Rehabilitation Assessment Report, Switzler Creek Watershed District #63, Site No. 7. July 28, 2005.

Osage County Conservation District. Emergency Action Plan, Switzler Creek Watershed #63, Osage County, Burlingame, Kansas 66413. Not dated.

United States Fish and Wildlife Service (USFWS). National Wetlands Inventory Map. Burlingame, KS. 1994.

US Census Bureau. State & County Quick Facts. Accessed October 6, 2009. http://quickfacts.census.gov/qfd/index.html.