APPENDIX A

TABLES

Table 1
Estimated Installation Cost
Turtle Creek Watershed, Nebraska
(Dollars)[1]

Installation Cost Item, Structural Measures	PL 83-566 Funds	Other Funds	Total
Structure 2	$417,600	$134,400	$552,000

Note:
[1] *Price base February 2006.*

Table 2
Cost Allocation and Cost-Sharing Summary
Turtle Creek Watershed, Nebraska
(Dollars)[1]

Item	Installation Costs - Public Law 83-566 1/						Installation Costs - Other Funds 1/								Total Installation Cost
	Construction 3/	Engineering	Real Property	Relocat. Payments	Project Admin.	Total Federal Cost	Construction 3/	Engineering	Real Property 4/ 5/	Natural Resouce Rights	Relocat. Payments	Required Permits	Project Admin. 2/	Total Non Federal Cost	
Rehabilitation of dam	$249,600	$131,000	$0	$0	$37,000	$417,600	$124,400	$0	$8,000	$0	$0	$0	$2,000	$134,400	$552,000

1/ Price Base: February 2006
2/ Includes $0 for relocation assistance advisory service
3/ Includes $0 of PL-566 funds and $0 of non-federal funds for cultural resource protection and mitigation measures
4/ Includes $0 for real property costs for mitigation
5/ Includes $0 for surveys, legal fees, and other costs

Table 3
Structural Data - Grade Stabilization Structure
Turtle Creek Watershed, Nebraska

Item[1]	Unit	2
Class of structure		Full flow GSS
Seismic zone		N/A
Drainage area	sq. mi.	0.94
Runoff curve No. (1-day) (AMC II)		76
Time of concentration (T_c)	hours	2.0
Principal spillway design storm (NRCS Type II 24-hour)	cfs	1510
Principal spillway type		none
Auxiliary spillway design storm (NRCS Type II 24-hour)	cfs	2186
Auxiliary spillway type		Chute[2]
Auxiliary spillway bottom width	feet	80
Auxiliary spillway exit slope	percent	25
Elevation top dam	feet	1085.0
Maximum height of dam	feet	22.5
Drop	feet	17.5
Volume of fill	cy	19,800[3]
Surface area		
Chute spillway crest elevation	acres	6.8 [4]
100-year water surface elevation	acres	21.4 [4]
Principal spillway design storm (25-year)		
Rainfall volume (24-hour)	inches	5.3
Capacity at principal spillway design storm	cfs	1510
Auxiliary spillway design storm (100-year)		N/A
Rainfall volume (24-hour)	inches	6.7
Capacity at auxiliary spillway crest elevation	cfs	2186
Maximum reservoir water surface elevation	feet	1085.0

Notes:
N/A = Not Applicable
1 *Data Complied: May 2006.*
2 *Chute spillway lined with Articulated Concrete Block (ACB)*
3 *Remaining volume after removal of the top 7.8 feet of embankment*
4 *Based on 2005 topographic survey, no floodwater retarding volume assumed for design*

Table 4
Estimated Average Annual NED Costs
Turtle Creek Watershed, Nebraska
(Dollars)[1]

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation, Maintenance, and Replacement Cost	
Grade Stabilization			
Structure 2	$28,500	$2,800	$31,300

Notes:
1 Price base February 2006 amortized over 100 years at a discount rate of 5.125 percent.

Table 5
Estimated Average Annual Watershed Protection
Damage Reduction Benefits
Turtle Creek Watershed, Nebraska
(Dollars)[1]

Item	Estimated Average Annual Damages[2]		Damage Reduction Benefit
	Without Project	With Project	
Onsite			
Other Urban – Greenway Property Benefits	$0	$40,000	$40,000
Offsite/Public			
Grade Stabilization Benefits	$0	$29,000	$29,000
Grand Total	**$0**	**$69,000**	**$69,000**

Notes:
1 Price base February 2006.
2 All benefits are agriculture related, as the community's population is less than 50,000.
3 Damage Reduction Benefit compares the difference in benefits provided for this site between the No Action/Future Without Federal Project Alternative and the Selected Alternative.

Table 6
Comparison of NED Benefits and Costs
Turtle Creek Watershed, Nebraska
(Dollars)[1]

Evaluation Unit	Average Annual Benefits[2]	Average Annual Costs[3]	Benefit- Cost Ratio
Grade Stabilization			
Structure 2	$69,000	$31,300	2.20

Notes:
1 Price base February 2006.
2 From Table 5.
3 From Table 4.

APPENDIX B

COMMENTS

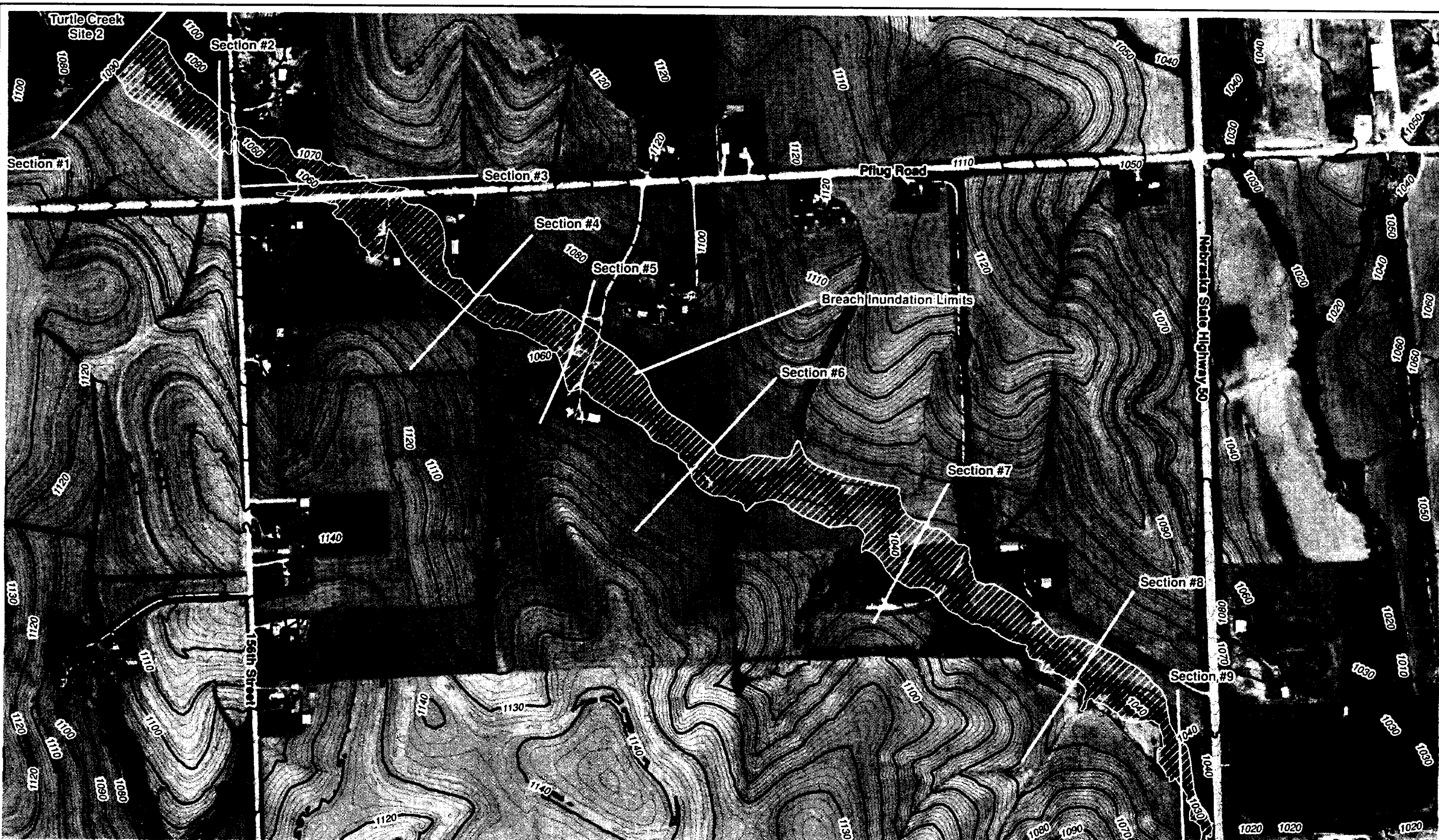
To be Incorporated into Final Watershed Plan and Environmental Assessment After Review of Draft Document

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C

SUPPORT MAPS

THIS PAGE INTENTIONALLY LEFT BLANK



Source: Aerial Photography, Metropolitan Area Planning Agency, Flown by Horizons Inc. in April 2004.

0 500 1,000 Feet

HDR

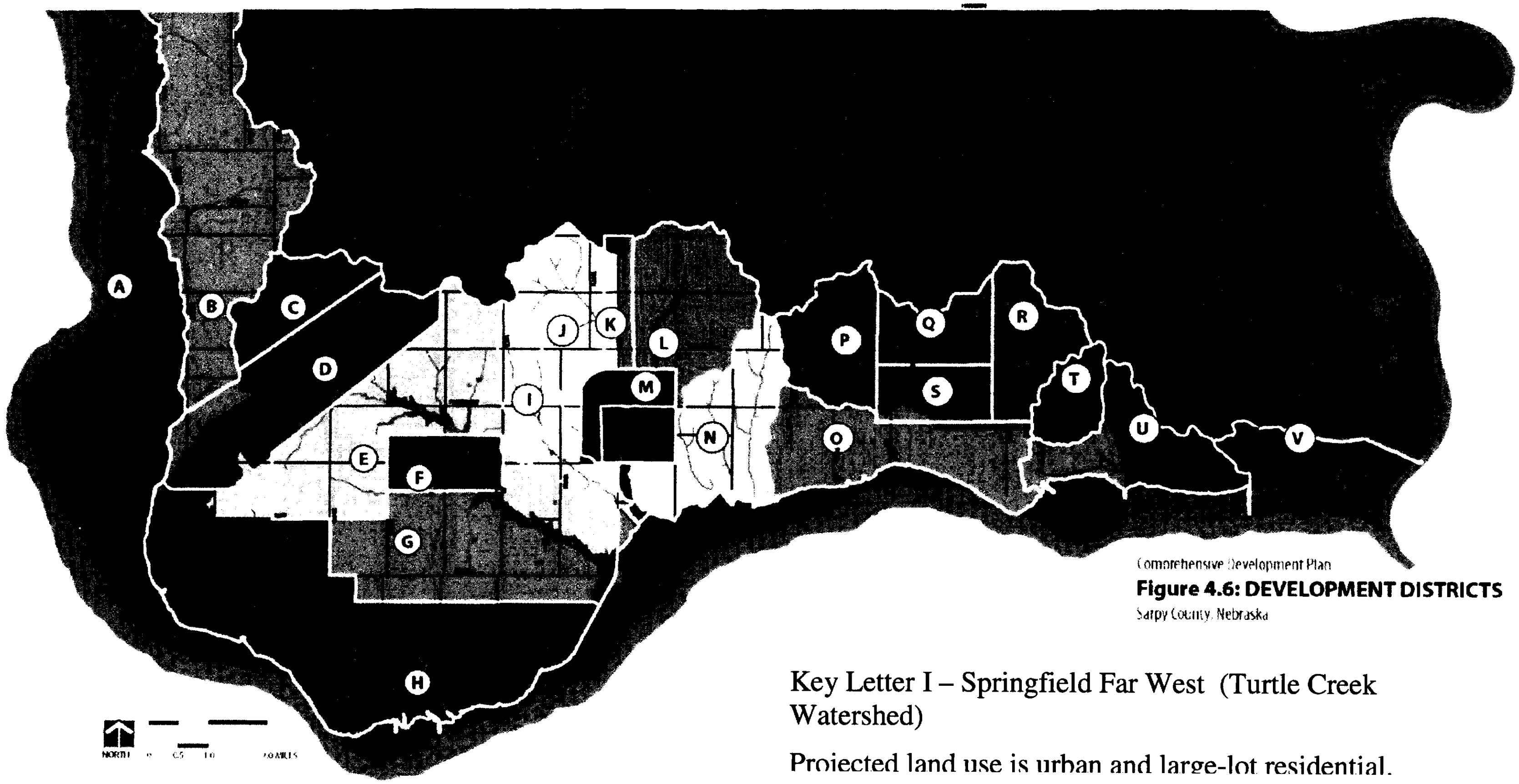
Flood Inundation Map
Turtle Creek Watershed Structure 2

NRCS Rehabilitation Program

DATE Feb. 2006
Revised June 2006

FIGURE 1

Z:\Projects\NRCS\28686_Dam_Rehab_Task_Order_2\map_docs\arcmap\Turtle_Creek\Figure_1_Dam_Breach_Inundation_Turtle_Creek.mxd



Key Letter I – Springfield Far West (Turtle Creek Watershed)

Projected land use is urban and large-lot residential.

Source: The Sarpy County Plan, A Comprehensive Development Plan for Sarpy County, Nebraska December, 2005, Prepared by RDg.

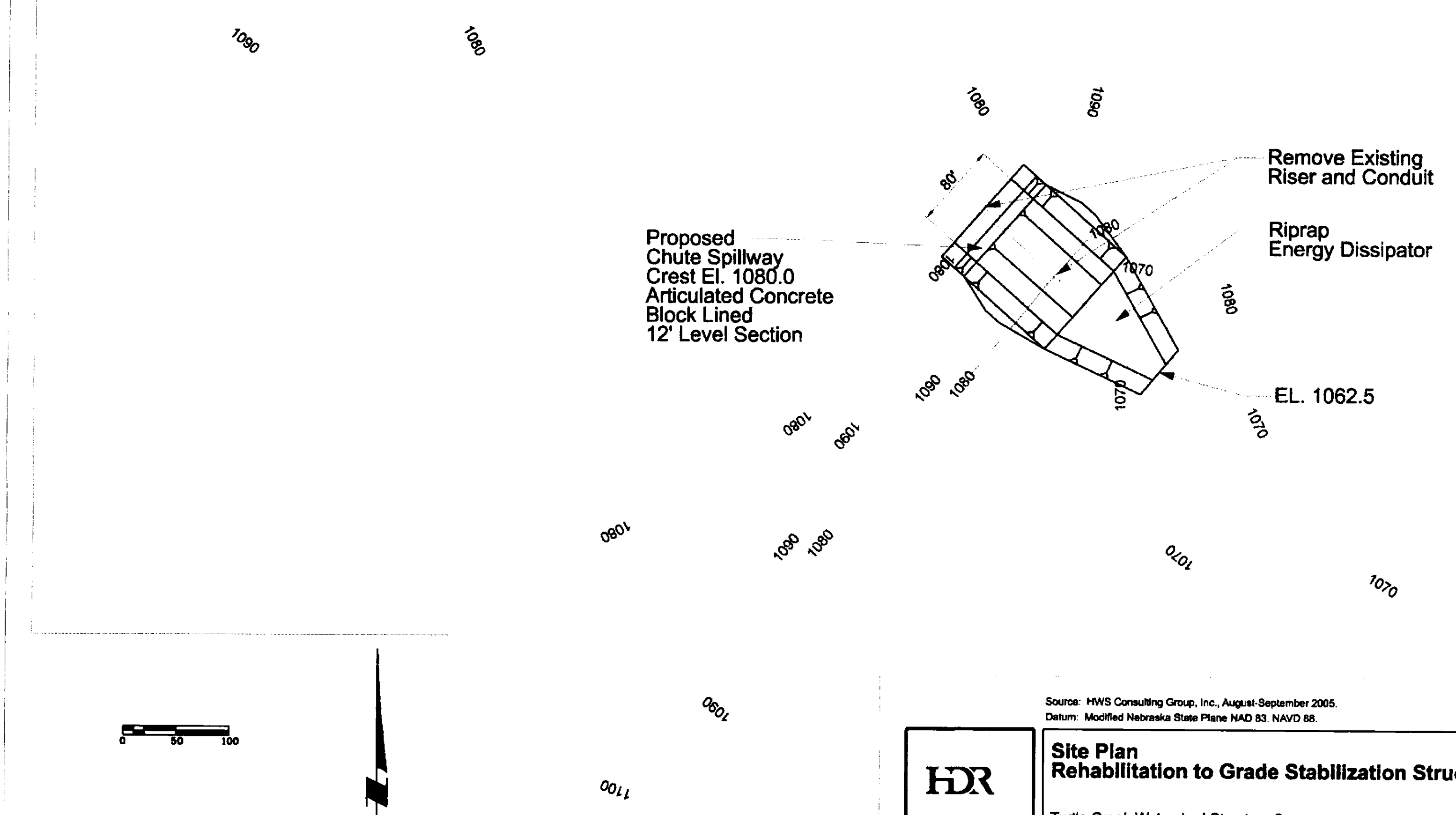
HDR

Future Land Use Plan
Sarpy County

Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE
JUL 2006

FIGURE
2



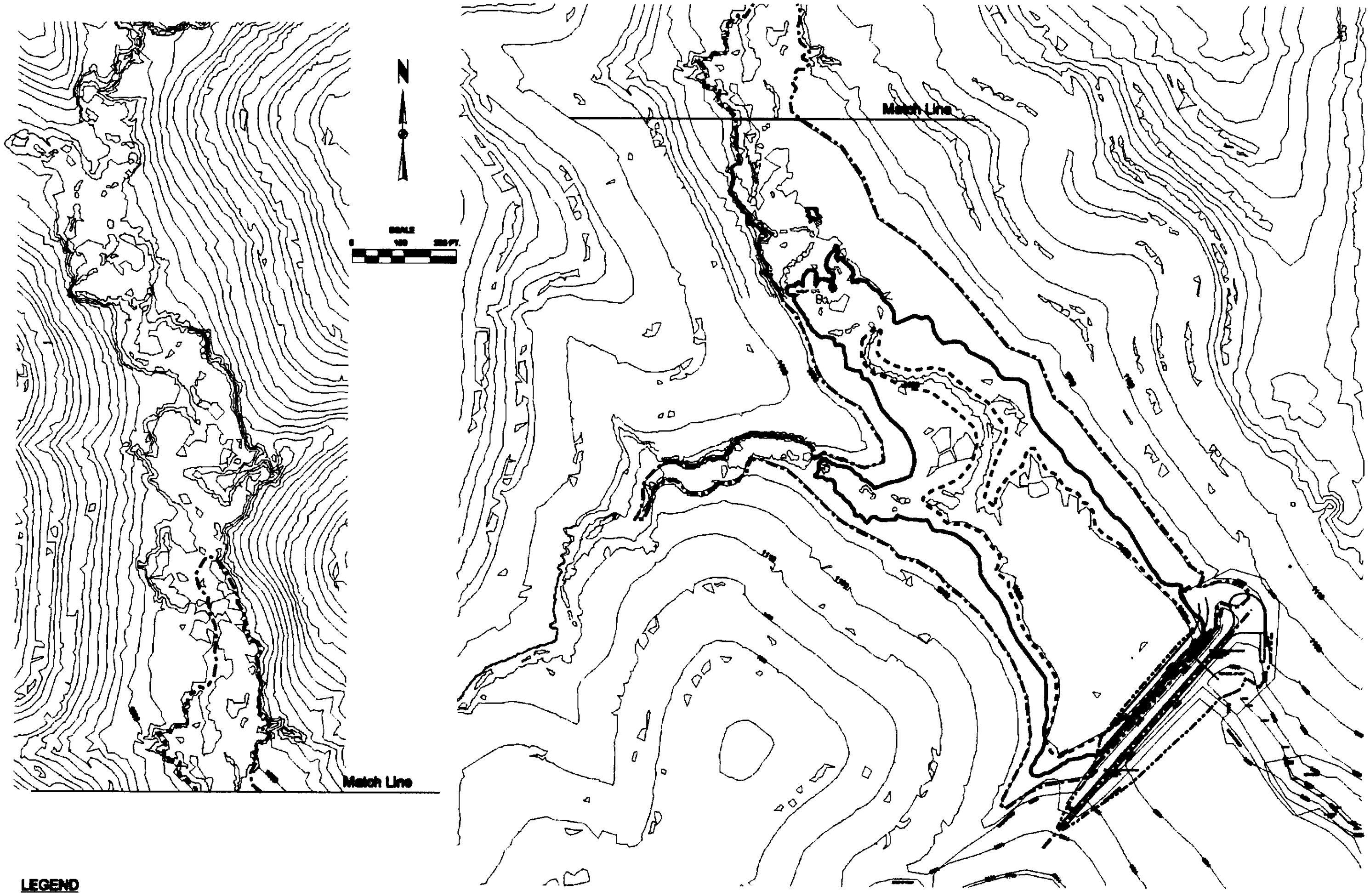
Source: HWS Consulting Group, Inc., August-September 2005.
Datum: Modified Nebraska State Plane NAD 83. NAVD 88.

HDR

Site Plan
Rehabilitation to Grade Stabilization Structure

Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE JUN 2006
FIGURE 3



LEGEND

-----	Normal Pool Elev. (Existing/Low Hazard)	1080.2
-·-·-	Flood Pool Elev. (Existing/Low Hazard)	1087.3
——	GSS 100 Year, 24-Hour Water Surface Elev.	1085.0

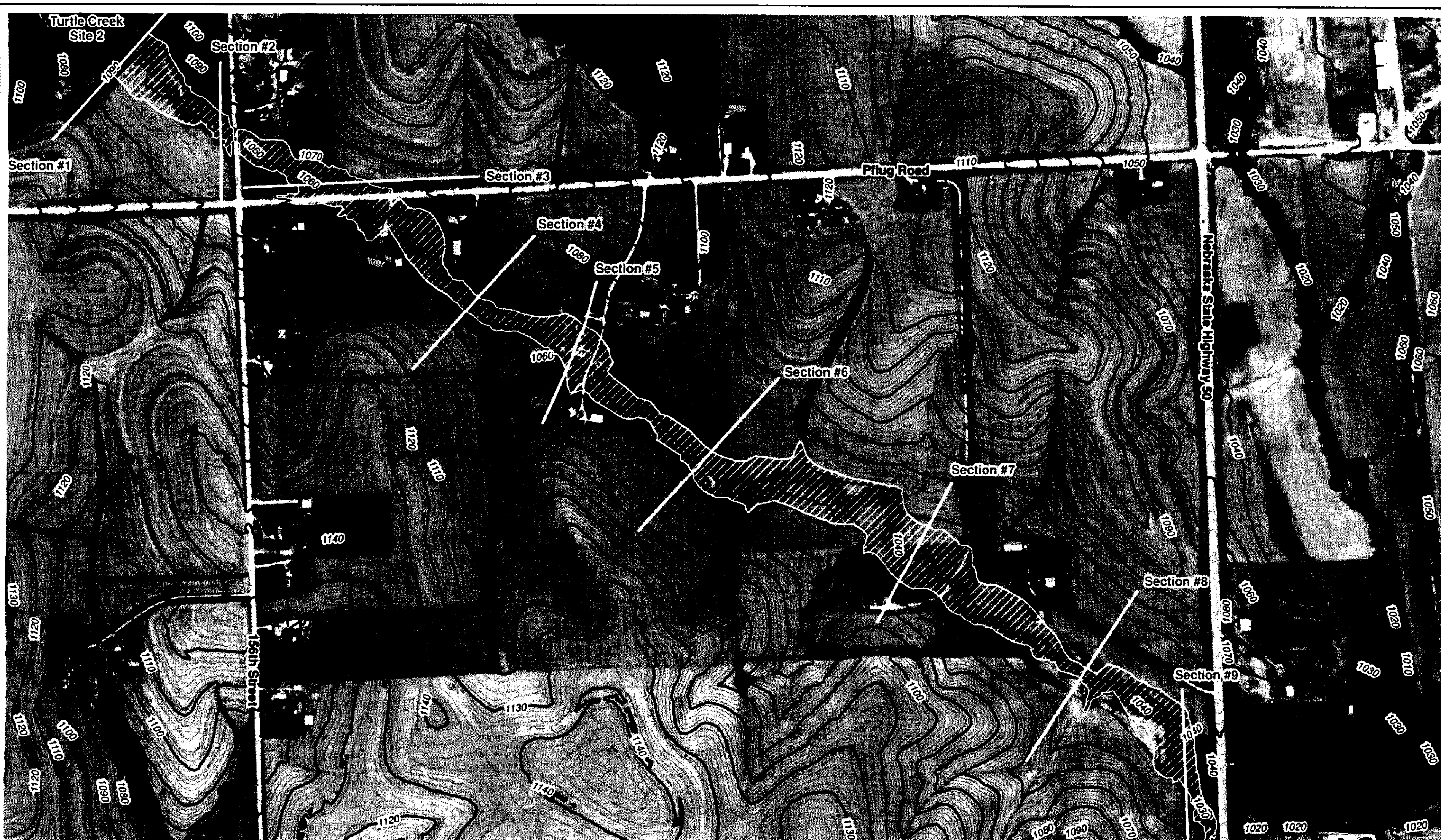
Source: HWS Consulting Group, Inc., August-September 2005.
Datum: Modified Nebraska State Plane NAD 83, NAVD 88.

HDR

Existing/ Low Hazard Class and Grade Stabilization (GSS) Alternative Elevations

Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE: JUN 2006
FIGURE: 4



Source: Aerial Photography, Metropolitan Area Planning Agency, Flown by Horizons Inc. in April 2004.

0 500 1,000 Feet

HDR

100-Year Flood-Prone Inundation Map
Rehabilitation to Grade Stabilization Structure.
Turtle Creek Watershed Structure 2

NRCS Rehabilitation Program

DATE June 2006

FIGURE 5

Z:\Projects\NRCS\28686_Dam_Rehab_Task_Order_2\map_docs\arcmap\Turtle_Creek\Figure_4_Dam_100_Year_Flood_Prone_Inundation_Map.mxd

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX D

INVESTIGATION AND ANALYSIS REPORT

TABLE OF CONTENTS

LIST OF TABLES

EXHIBITS

LIST OF FIGURES (FOLLOWING TEXT)

APPENDIX D
INVESTIGATION AND ANALYSIS REPORT

This report provides supplementary information to the Watershed Plan and Environmental Assessment (EA) for the Turtle 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 provide grade stabilization protection. Incidental floodwater retarding benefits also are realized as floodwaters are released in a control manner. Structure 2 appears to be functioning adequately even though some signs of ephemeral gully erosion upstream of the structure was observed and there has been no record of downstream flooding.

Structure 2 was designed with a 50-year sediment storage life. Sediment is deposited in both the normal pool (area below the principal spillway crest) and floodwater retarding pool (area between the principal spillway crest and the auxiliary spillway crest). When the normal pool has filled with sediment to the elevation of the principal spillway crest, the pool no longer has permanent water storage. As the floodwater retarding pool loses storage due to sediment deposition, the auxiliary spillway operates, or has flowage, more often and is therefore subject to increased erosion. Increased operation and maintenance costs are likely. A potential mode of failure exists as the auxiliary spillway continues to degrade, and depth and frequency of flow increases. The grade stabilization structure will ultimately breach.

The original sediment storage calculation for Structure 2 was based on erosion rates and processes active in the drainage area during the 1950s. Land use changes in the watershed have also occurred, and levels of land treatment have increased. These factors affect erosion rates, delivery rates, and the quantity of sediment delivered to the reservoir pool today, compared to rates and quantities calculated 50 years ago.

The future sediment yield or that portion of the eroded soil which leaves the watershed was forecasted. The primary source of sediment in the grade control structure results from sheet, rill, and gully erosion. The rate of sedimentation impacts the project life of the structure. Bathymetric surveys and the Revised Universal Soil Loss Equation (RUSLE) equation were used to compute sediment yield and the size of the sediment pool to extend the project life of the structure for 100 years after rehabilitation.

1.1 Post-Construction Ground Surface

The as-constructed drawings reflect pre-construction contours and provide reservoir capacity table data, final construction quantities, and borrow site limits. Review of the table of quantities on the as-constructed drawings indicates that approximately one-third of the borrow material necessary to build the embankment came from the auxiliary spillway. The remaining material was likely excavated from the area upstream of the structure and below the principal spillway crest. It appears that no borrow was obtained above elevation 1080 and based on typical borrow pit management practices it is unlikely borrow was obtained below elevation 1074. This elevation allows for a groundwater surface two feet above the adjacent stream bed invert.

The as-constructed drawings do not show borrow pit locations used to build the embankment, but several notes define the borrow as material from the auxiliary spillway, outlet ditch, and the area below contour 1080.0. No notes were made on the record drawings to indicate any borrow was obtained off-site. Based on inspection of the record contours and the 2005 bathymetric contours it appears borrow was obtained from the peninsula between the two tributary channels and an area upstream of the structure. It appears that no borrow was obtained above elevation 1080 and based on typical borrow pit management practices it is unlikely borrow was obtained below elevation 1074. This elevation allows for a groundwater surface two feet above the adjacent stream bed invert.

Borrow volume estimates were based on a factor of 1.3 times the recorded in-place embankment. This factor accounts for typical compaction losses, handling losses, and organic material or otherwise unsuitable materials removed from the ground but not used for embankment.

Assumptions based on typical borrow site management practices, such as preserving existing stream banks to direct runoff around the borrow areas and limiting excavated depth to account for potential groundwater, were used to approximate borrow limits. A distribution was assumed between the borrow site floor elevation and the normal pool elevation to approximate the total available sediment storage volume below the normal pool elevation. Table D1-1 summarizes the earthwork quantities.

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

Recorded In-Place Embankment [1] (cy)	Estimated Borrow[2] (cy)	Recorded Auxiliary Spillway and Outlet Channel Excavation (cy)	Estimated "In-Pool" Borrow (cy)
25,008	32,510	11,580	20,930

Notes:
[1] *Data obtained from as-constructed drawings.*
[2] *Estimated borrow based on factor of 1.3 times the recorded in-place embankment.*

1.2 Annual Sediment Accumulation

Based on the estimated capacity, including the in-pool borrow, and 2005 surveyed capacity, the historical annual sediment accumulation of Structure 2 was computed. Table D1-2 summarizes the results. The capacity shown on the as-constructed 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 2 was 1.2 acre-feet per year. Review of the stage-storage curves indicates that most of the sediment has accumulated below the principal spillway crest elevation. The average annual sediment accumulated in Structure 2 is 0.9 acre-feet per square mile.

Table D1-2
Annual Sediment Accumulations

Sediment Storage Increment	Estimated End of Construction Capacity Including In-Pool Borrow (acre-feet)[1]	2005 Surveyed Remaining Capacity (acre-feet)[1]	Sediment Accumulated (acre-feet)	Years of Accumulation	Annual Sediment Accumulated (acre-feet /year)	Annual Sediment Accumulated (acre-feet/ square mile)[2]
Submerged	52.4	17.0	35.4	43	0.8	0.4
Aerated	144.4	126.0	17.4	43	0.4	0.2
Total	195.8	143.0	52.8	43	1.2	0.6

Notes:
[1] *Estimated capacity remaining between the 2005 surveyed bathymetric surface to the principal spillway crest elevation.*
[2] *Drainage area of 2.1 sq. mi.*

1.3 Historical Watershed Soil Loss Rate

The existing sediment accumulation rate was converted to an eroded soil quantity from the watershed. Submerged sediment storage volume is the volume below the principal spillway crest that is normally submerged. Aerated sediment storage volume is the volume deposited above the principal spillway orifice that is normally not submerged but temporarily submerged during runoff events. The following procedure was used to estimate the watershed soil loss rate:

a. Determine total sediment accumulation based on submerged and aerated sediment deposition. Assumed sediment bulk density of 1,100 ton/AF and 1,600 ton/AF for submerged and aerated sediment respectively. From Table 4, submerged sediment of 35.4 AF *1,100 ton/AF or 38,940 tons and aerated sediment of 17.4 AF * 1,600 ton/AF or 27,840 tons for a total of 66,780 tons. The ratio of submerged to aerated deposition by weight is 60/40 (38,940/66,780 and 27,840/66,780). For 43 years of accumulation, this yields an average of 1,550 tons/year of accumulated sediment.

b. Based on Brune's curve shown in NEH-3, Figure 8.2, with a computed capacity/inflow ratio for Structure 2, of 0.4, the trap efficiency is 91%. Therefore, 1,550 tons/0.91 = 1,700 tons annually delivered to Structure 2.

c. It is assumed that the only sediment that is delivered to Structure 2 from sheet and rill erosion. Per NRCS, National Engineering Handbook, Section 3 (NEH-3), Chapter 6, Table 6-2, typical delivery ratios for sheet and rill erosion is 33%. 1,700 tons/0.33 = 5,150 tons of soil eroded from watershed annually.

d. To convert to an annual tons/acre loss rate divide by the drainage area of 1,315 ac or (5,150 tons/1,315 ac= **3.9 tons/acre annual sediment loss rate.**

The 3.9 tons/acre annual sediment loss rate based on the past 43 years is representative of losses from typical agricultural land use that currently makes up a large portion of the drainage area of Structure 2.

1.4 Future Watershed Soil Loss Rates

In projecting sediment storage life of the detention dam over the next 100 years, two other upstream lands use conditions require consideration: a developing drainage basin and a fully developed drainage basin.

RUSLE provides a method to estimate sheet and rill erosion losses due to water. For the developing and fully developed periods, only the cover-management factor, C, was assumed to vary substantially from existing conditions. The soil loss rate for the developing condition was then estimated by multiplying the existing loss rate by the ratio of the developing and existing C factors. A C factor of 0.1 was used for existing conditions and a soil loss ratio of 10 times the existing rate was used for developing conditions for a C factor of 1.0. Although erosion and sediment control practices are implemented during mass grading operations, the practices are typically removed or rendered ineffective during individual lot construction and grading. Typical C factors for fully developed areas are 0.013. This yields average annual soil losses for developing and fully developed conditions of 39 tons/acre and 0.5 tons/acre, respectively. Table D1-3 summarizes the predicted soil loss rates for existing, developing, and fully developed land use conditions.

Table D1-3
Predicted Soil Loss Rates

Land Use	RUSLE Cover-Management Factor, C	Predicted Annual Soil Loss Rate (tons/acre)
Existing (Agricultural)	0.1	3.9
Developing	1.0	39.0
Fully Developed (Urban)	0.013	0.5

1.5 Development Time Lines

Structure 2 is within the jurisdiction of Sarpy County. The 2005 Sarpy County Comprehensive Plan projected that the drainage areas above and below Structure 2 would become fully urbanized by 2030.

1.6 Predicted 100-year Sediment Accumulation

The estimated soil loss rates and urbanization time lines were used to predict sediment yields over a 100-year time period to assess sediment storage requirements. The estimated annual soil loss rates shown in Table D1-3 along with the ratio of submerged to aerated sediment deposition by weight of 60/40 was used to predict the sediment accumulated. Table D1-4 illustrates the 2005 surveyed sediment storage capacity as well as the cumulative deposited sediment volumes predicted over the next 100 years.

Table D1-4
Predicted 100-year Sediment Accumulation

2005 Surveyed Remaining Sediment Storage Capacity (acre-feet)	Est. Soil Loss (tons)	Est. Soil Delivered[1] (tons)	Est. Soil Captured[2] (tons)	Required Sediment Storage in Sediment Pool[3,4] (acre-feet)	Sediment Accumulated in Flood Pool (acre-feet)
17.0	252,800	83,400	75,900	41.4	19.0

Notes:

1 *Estimated capacity remaining between the 2005 surveyed bathymetric surface to the riser crest elevation.*

2 *Per NEH, Section 3, Chapter 6, Table 6-2, typical delivery ratio for sheet/rill erosion of 0.33 was used*

3 *Trap efficiency value of 91% was used over 100-yr period*

4 *Observed deposition ratio submerged/aerated pool is 60%/40%*

5 *NRCS typical unit weight for silty soils of 1,100 tons/acre-ft and for clay soils of 1,600 tons/acre-ft used to convert weight to volume*

2.0 BREACH ROUTING ANALYSIS

A breach analysis was conducted for Structure 2 to delineate areas potentially inundated in the event the structure should fail. The dam breach analysis was performed using NRCS TR-60 criteria and U.S. Army Corps of Engineer's software Hydrologic Engineering Centers River Analysis System (HEC-RAS) unsteady flow analysis software to determine the peak discharge rate, hydrograph shape and to route the breach hydrograph downstream. TR-60 determines peak discharges and HEC-RAS determines water surface elevations at each cross section through the valley reach below the breach failure.

2.1 Breach Criteria

The breach failure scenario evaluates a fair weather breach using a pool elevation equal to the 100-year, 24-hour event or the auxiliary spillway crest elevation, which ever is higher, but in no case should the elevation exceed the top of dam elevation. This scenario is considered a worst-case condition as the reservoir is at its maximum flood storage elevation volume and there is little to no warning of the potential flows prior to structure failure.

2.2 Model Development

A spreadsheet has been developed by the NRCS that automates calculation of the peak breach discharge rate and prepares a hydrograph for use in a hydraulic modeling program such as unsteady HEC-RAS. The spreadsheet data requirements include reservoir storage at time of failure, depth of water at time of failure, and cross-sectional area of the embankment. The hydraulic model requires information on the hydraulic characteristics of the downstream reach in the form of valley cross-sections and roughness coefficients.

2.2.1 Reservoir Storage

Stage-storage volume curves were developed for Structure 2 based on the topographic surveys of the pool areas conducted in August/September 2005. The 2005 surveyed elevation-storage curves were used in the breach analysis. Any future modifications to increase the permitted design storage curve will require re-evaluation of the breach analysis.

Mobilization of unconsolidated sediments will likely be limited to the breach vicinity; therefore, a substantial impact to the breach discharge volume is not expected, and the total pool volume was not increased.

2.2.2 Reservoir Stage

Draft guidelines developed by NDNR and NRCS for conducting dam breach analyses were used. The draft guidance document specifies using a pool elevation equal to the 100-year, 24-hour event or the auxiliary spillway crest elevation, which ever is higher, but in no case should the elevation exceed the top of dam elevation. For Structure 2, the reservoir level at the 100-year, 24-hour water surface elevation 1089.2 is 2.2 feet above the auxiliary spillway crest elevation of 1087.0 feet. Based on hydraulic modeling of Structure 2, the 100-year, 24-hour peak elevation was used for breach analysis.

The draft guidance document recommends 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. For

Structure 2, the channel portion is significantly less than the floodplain area at the dam section, so the floodplain elevation was used.

2.2.3 Dam Embankment

The cross-sectional area of Structure 2 (perpendicular to the grade stabilization structure axis) was determined from the as-constructed 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

Cross sections were surveyed for the reach downstream of the Structure 2 in August/September 2006. Sufficient data were collected to route the breach hydrograph of Structure 2 to the confluence with the Springfield Creek floodplain near the Springfield Waste Water Treatment Plant. Data were also collected for downstream roadway crossing structures, including bridge/culvert data and roadway profiles.

Manning's "n" values were assigned during site observations and based on published references such as Chow (1959) and past experience. The Turtle Creek channel is incised (6 feet +/-) with heavily vegetated banks and overbanks consisting of agricultural crop ground upstream of Pflug Road. The channel is incised (6 to 12 feet +/-) with heavily vegetated banks and overbanks consisting of agricultural crop ground downstream of Pflug Road to Hwy. 50. Downstream of Hwy. 50 the channel is deeply incised (over 16 feet +/-). The Turtle Creek floodplain is narrow for the entire reach from Structure 2 to Springfield Creek. Manning's "n" value of 0.10 was applied to the channel and 0.06 was applied to the overbanks.

The HEC-RAS model of Turtle Creek extended from the Structure 2 face to the confluence with Springfield Creek, a total length of approximately 7,100 feet. Three roadway crossings, including South 156th Street, Pflug Road and Hwy. 50 were modeled. In addition, three (3) private drive crossings were modeled.

2.3 Breach Routing Results

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

This fair weather breach was evaluated with the reservoir level at the 100-year, 24-hour storm event or the auxiliary spillway crest elevation, whichever is higher. The water flows resulting from the dam breach were routed downstream until the breach water surface profile was reduced sufficiently to remain within the approximate channel banks. A 100-year floodplain has not been mapped for the reaches downstream of Structure 2.

The structure volume, pool height, and embankment information was input into a TR-60 spreadsheet for use in computing the peak breach discharge according to the TR-60 equations. The geometry for the valley cross section at the grade stabilization structure face, assuming no structure, was taken from the as-constructed drawings. The breach hydrograph was entered into the HEC-RAS model to estimate water surface elevations, cross-sectional flow areas, and flow rates for the downstream reaches. At roadway crossing structures, sections immediately upstream and downstream of the structure were included in the HEC-RAS model input to allow the impacts of the crossing structures to be accurately represented.

The breach analysis at Structure 2 was conducted with the reservoir pool at the 100-year, 24-hour water surface elevation 1089.2 (2.2 feet above the auxiliary spillway crest elevation of 1087.0 feet). A peak breach discharge of 3,700 cubic feet per second (cfs) and a breach volume of 204 acre-feet were computed. The breach routing results are summarized in Table D2-1. A plan view and inundation limits are shown in Appendix C: Support Maps, Figure 1.

Table D2-1
Structure 2 Breach Routing Summary

Section Number[1]	Description	Distance Downstream of Dam Axis (feet)	Peak Q (cfs)	WSEL (feet)	Bank Elevation[2] (feet)
1	Dam Section	0	3,700	1089.2	NA
2	Upstream of South 156th Street	606	3,191	1073.6	1073.8
3	Upstream of Pflug Road	1,402	3,157	1070.1	1067.5
4	Downstream of Pflug Road	2,346	3,051	1062.9	1062.5
5	Valley Section	2,564	3,023	1059.4	1058.3
6	Valley Section	3,900	2,911	1055.1	1052.3
7	Upstream of Private Drive	5,398	2,807	1049.4	1046.1
8	Valley Section	6,309	2,723	1044.0	1041.5
9	Nebraska Hwy. 50	7,118	2,527	1040.4	1043.0

Note:
[1] *Section number refers to cross-sections in Appendix C: Support Maps, Figure 1.*
[2] *Top-of-road elevation is given as bank elevation at road crossings.*

The analysis indicates the breach flow would not overtop South 156th Street, but the breach hydrograph would have a velocity of 8.7 fps through the bridge which may compromise the wooden abutments. Flow would have a depth of 2.4 feet and velocity of 3.6 fps over Pflug Road which is deep enough to float a vehicle and force it off the roadway. Upstream of Cross Section 4, the low opening, point of entry of the house (El. 1064.1) on the north side of Turtle Creek would be 0.9 feet below the breach flow water surface elevation (El. 1065.0). The house on the south side of Turtle Creek has a point of entry low opening (El. 1068.8) 0.1 feet above the breach elevation (1068.7) and would be completely surrounded by the breach flow and the floor of the attached garage would be 1.0 feet below the breach elevation. At Cross Section 5, the house on the north side of Turtle Creek has a finished low floor elevation of 1058.7 which is 0.7 feet below the breach water surface elevation (El. 1059.4) but the point of entry low opening (El. 1060.7) of would be 1.3 feet above the breach elevation. The low opening of the house (El. 1060.5) on the south side of Turtle Creek would be 1.1 feet above the breach elevation (El. 1059.4). The house 200 feet upstream of Cross Section 7 is not inundated. The breach flood does not overtop Hwy. 50 and is contained within the deeply incised channel below Hwy. 50 and does not threaten the Springfield wastewater treatment plant.

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 AGENCY COORDINATION

The agencies and organizations that were provided an information packet for their input for initial agency scoping are listed in Table D3-1.

Table D3-1
Agency Scoping Mailing List

First Name	Last Name	Title	Agency/Organization
Lori	Moore		Nebraska Emergency Management Agency
Jay	Ringenberg	Deputy Director	Nebraska Department of Environmental Quality
Ann	Bleed	Acting Director	Nebraska Department of Natural Resources
Curt	Twedt		Nebraska Game and Parks Commission
Robert	Puschendorf	Deputy State Historical Preservation Officer	Nebraska State Historical Preservation Office
Mike	Rabbe	Nebraska Program Manager	U.S. Army Corps of Engineers
Steve	Anschutz	Nebraska Field Supervisor	U.S. Department of the Interior, Fish and Wildlife Service
Greg	Bevirt	Environmental Officer	U.S. Dept. of Housing and Urban Development
Joseph E.	Cothern	NEPA Coordinator	U.S. Environmental Protection Agency, Region VII
Thomas	Taylor	Section 404/Wetlands Program Coordinator	U.S. Environmental Protection Agency, Review Environmental & Coordination Service
Matthew	Judy	Environmental Specialist	Natural Resources Conservation Service
Keith	Admire	NWMC Director	Natural Resources Conservation Service
Scott	Josiah	State Forester	Nebraska Forest Service
Dave	Heineman		Office of the Governor
David	Winningham		Office of Civil Rights
Spencer	Abraham		Secretary of Energy
Scott	Gudes		National Oceanic & Atmospheric Admin.
George	Howell	President	Pawnee Tribal Business Council
Louis	DeRoin	Chairman	Iowa Tribe of Kansas & Nebraska
James	Grant	Chairman	Otoe-Missouri Tribe of Oklahoma
David	Conrad	Water Resources Specialist	National Wildlife Federation
Chuck	Hassebrook	Executive Director	Center for Rural Affairs
Glen	Murray	Chapter Chair	Sierra Club, Nebraska Chapter
Duane	Hovorka		Nebraska Wildlife Federation
Wes	Sheets		Izaak Walton League
Nelli	Falzgraf	President	Audubon Society of Omaha
DeLynn	Hay	Program Leader Cooperative Extension Division	UNL, Biological Systems Engineering
Antoine A.	Provost	Executive Director	Omaha Tribe of Nebraska
Sandra	Powell	City Administrator	City of Springfield
Paul	Mullen	Director	Metropolitan Area Planning Agency
Bryan	Ralston	County Executive Director	U.S. Department of Agriculture
Steven	Oltmans	General Manager	Papio-Missouri Natural Resources District
Sharon	Skipton	Environmentalist	Douglas/Sarpy County Cooperative

First Name	Last Name	Title	Agency/Organization
			Extension Service
Elmer	Blackbird	Chairman	Omaha Tribal Council
Karen	Rock	Group Chair	Sierra Club, Missouri Valley Group
Ken	Tex	Sarpy County Planning Director	1210 Golden Gate Drive
Tim	Weander	Nebraska Department of Roads, District 2	4425 S 108th Street, PO Box 45461
Verlon	Barnes	District Conservationist	Natural Resources Conservation Service

During agency coordination, several agencies provided consultation letters. The following administrative record was documented by the NRCS and is included on the subsequent page for reference purposes:

- The Pawnee Nation of Oklahoma, dated September 30, 2005

Correspondence Log

Project: *W-2, TC-2, S-35* *Name:* *Richard Vaughn*

An "Administrative Record" must be kept and includes anything that relates to, or shows that NRCS considered the relevant factors and articulates a rational connection between the facts found and the choices made. This also applies to decisional information relative to how public review and overall NEPA and planning procedures are implemented. The "Administrative Record" must also include documentation of policy and decision making accomplished orally or electronically.

This sheet as an example of how to document oral conversations so as to have written documentation to satisfy the "Administrative Record" requirements.

Name	Date	Time (24hr)	Type of contact	Topic	Summary
Francis Morris	9/23/05		left message	Francis had left a message regarding his response to the agency participation mailing for rehab projects (W-3, TC-2, and S-35). Richard Vaughn contacted him directly. Mr. Morris stated that the Pawnee Nation of Oklahoma had "no objections" to any of the three rehabilitation projects. Also, to remember that there is always the possibility that previously unsuspected archeological remains may be discovered during the process of project construction and requested that his office be notified immediately under such circumstances so that an evaluation of remains may be made.	
	followup 9/30/05	15:00	telephone		
Acting Tribal Historic Preservation Officer The Pawnee Nation of Oklahoma 881 Little Dee Drive Pawnee OK 74058					

4.0 ALTERNATIVE EVALUATION

This section discusses the evaluation of rehabilitation alternatives for Structure 2.

4.1 Description of Alternative Plans

Four rehabilitation alternatives for Structure 2 were evaluated in detail. The following alternatives were considered:

- No-Action/Future Without Federal Project Alternative
- Federal Decommissioning Alternative
- Rehabilitation to High Hazard Class Alternative
- Rehabilitation to Grade Stabilization Structure Alternative

Cost estimates were computed for the alternatives studied in detail. The following procedure was used:

- Unit costs for specific items were obtained from "Nebraska Maximum Cost Share Rates, 2003 NRCS, NRD and State Programs" with an annual inflation adjustment of 3 percent per year. When no unit cost data were available, an estimated unit cost was based on past project experience.
- The cost estimates were based on February 2006 U.S. dollars.
- Dam rehabilitation and roadway rehabilitation costs account for estimated quantities.
- An allowance of 40 percent was included in the cost estimates for engineering, surveying, geotechnical investigation, and construction observation for Rehabilitation to High Hazard Alternative. An allowance of 35% was included for engineering, surveying and construction observation for the No-Action/Future Without Federal Project Alternative and Decommissioning Alternatives, since geotechnical evaluation and fulltime construction observation would not be required.
- Land rights costs were included as a separate component.
- Costs associated with operation and maintenance of the grade stabilization structure and mitigation of potential environmental and cultural/historical impacts were not included.
- The SLO historically has acquired flowage easements on properties at a cost of approximately half of the land value. This price was used for flowage easement on urbanized and unurbanized land for the portion of inundated area outside the existing channel. A rate of $100 per acre was used for the existing channel area to account for the use of the land to convey the breach flow.
- Land values were based on the recent land price for acquisitions for urbanizing lands. Table D4-1 lists the items considered in the land rights estimates.
- Temporary construction easements would be required for access to the construction site across private land, temporary storage of excavated materials, equipment and material staging, and stockpiling of construction materials.
- Disturbed areas within the construction easement would be restored to the original condition and seeded.

Table D4-1
Typical Land Rights Costs

Description	Estimated Land Cost ($/Acre)
Flowage Easement – Unurbanized Overbank Land	$20,000
Flowage Easement –Unurbanized Channel Land	$100
Flood Storage Easement	$10,000
Temporary Construction Easement	$2,000
Land Acquisition	$20,000
Excavation Waste (Clean Fill) Disposal Land	$2,000
Engineering and Administrative/Legal Services	20%

4.1.1 No-Action/Future Without Federal Project Alternative

The No-Action/Future Without Federal Project Alternative is the most likely course of action should the SLO receive a short-term legal mandate to fix or remove the dam and should no Federal funding be available for rehabilitation to current design standards. The SLO would likely breach the structure in a controlled manner. This sponsor or constructed breach would remove a portion of the earthen embankment and would excavate the embankment to remove the principal spillway riser and conduit.

Table D4-2
Structure 2– Opinion of Approximate Construction and Land Rights Costs for No-Action/Future Without Federal Project Alternative

Description	Subtotal Cost	Total Cost[1]
Construction		
Dam Construction Rehabilitation		
Mobilization	$4,000	
Clearing and Grubbing	$7,000	
Erosion and Sediment Control	$1,000	
Site Work	$6,000	
Removals[2]	$64,000	
Seeding	$17,000	
Subtotal, Dam Construction Rehabilitation		$99,000
Professional Services		
Engineering and Construction Observation (30% of Construction Cost)		$30,000
Total, Construction Cost		$129,000
Land Rights		
Easements[3]		$40,000
Professional Services		
Engineering, Administrative/Legal Services (20% of Land Rights Costs)		$9,000
Total, Land Rights Costs		$49,000
NRCS Construction Contract, Administration and Supervision Cost (10% of Construction Cost)		$10,000
Total, Opinion of Approximate Cost for No-Action/Future Without Federal Project Alternative		$188,000

Notes:
1 *Price base February 2006.*
2 *Removal of existing principal spillway.*
3 *Temporary construction easements (4 acres) and temporary waste area easement (0 acre).*

The constructed breach would eliminate the structure's ability to store runoff, significantly reduce the hazard of an unexpected failure of the dam. The downstream flooding conditions would be similar to those that existed prior to the construction of the dam. The partial excavation would occur along the principal spillway alignment.

The corrugated metal pipe (CMP) riser, CMP principal spillway conduit, and pipe supports would be removed and disposed off-site, excavated embankment and sediment would be placed in a stockpile on a suitable upland on-site area, and salvaged topsoil from the embankment and stockpile areas would be redistributed on the exposed embankment and stockpile areas and seeded with an upland native seed mixture.

The SLO has easements on the structure, allowing access for and undertaking of operation and maintenance activities. No additional land rights costs are anticipated for easement areas.

The approximate costs estimated for the No-Action/Future Without Federal Project Alternative total $326,000. Table D4-2 summarizes the approximate construction and land rights costs to construct for the No-Action/Future Without Federal Project Alternative.

4.1.2 Federal Decommissioning Alternative

The Federal Decommissioning Alternative would result in the complete removal of the structure, the reconnection and restoration of the stream and floodplain, the construction of concrete drop spillway structures and a drainage channel, and seeding.

Embankment material removed from the dam and deposited sediment would be placed in the existing auxiliary spillway, the surface would be graded to approximate original ground lines as shown on the as-constructed drawings. Excess material would be applied to suitable upland areas at a depth of 3 to 12 feet for use in land grading activities associated with future urbanization. Salvaged topsoil from the embankment and auxiliary spillway would be redistributed on the disturbed areas and reseeded with upland native seed mixture.

Standard drop spillway structures are used to control drops up to 10 feet. Two individual drop spillway structures would be required to control the 16-foot drop at the site. The concrete drop spillway structures of Structure 2 must pass the 100-year flow. Figure D-1 shows standard drop spillway structures.

The channel through the sediment would have similar cross-sectional area, depth, and slope as the original channel and would extend to the existing north subbasin channel.

The CMP riser, CMP principal spillway conduit, and pipe supports would be removed and disposed off-site and salvaged topsoil would be redistributed on embankment footprint and stockpile areas and reseeded with upland native seed mixture.

The SLO has easements on the structure, allowing access for and undertaking of operation and maintenance activities. Portions of the existing easement may be released back to the land owner but no additional cost would be associated with relinquishment of easement area. Additional land rights costs are anticipated for easement for storage of stockpiled material.

Roadway improvement would be required on South 156th Street and on Pflug Road to pass the 100-year, 24-hour storm event. Improvements on South 156th Street would consist of removing the 36-foot wood bridge and constructing a triple 6-foot span by 6-foot rise reinforced concrete box culvert (6x6 RCB). The roadway profile would not be changed. Improvement on Pflug Road would consist of removing the existing 16-foot span RCB culvert and constructing a triple 8x8 RCB culvert and increasing the roadway profile by 0.5 feet at the culvert.

The approximate dam and roadway rehabilitation costs and land rights costs estimated for the Federal Decommissioning Alternative total $1,204,000. Table D4-3 summarizes the approximate construction and land rights costs of Structure 2 for the Federal Decommissioning Alternative.

Table D4-3
Structure 2– Opinion of Approximate Construction and Land Rights Costs for Federal Decommissioning Alternative

Description	Subtotal Cost	Total Cost[1]
Construction		
Dam Construction Rehabilitation		
Mobilization	$18,000	
Clearing and Grubbing	$57,000	
Erosion and Sediment Control	$4,000	
Site Work	$6,000	
Removals[2]	$33,000	
Earthwork[3]	$396,000	
Drop Spillway Structure	$32,000	
Seeding	$19,000	
Subtotal, Dam Construction Rehabilitation		$581,000
Downstream Road Improvements		
156th Street RCB Culvert	$103,000	
Pflug Road RCB Culvert	$100,000	
Subtotal, Downstream Roadway Improvements		$203,000
Professional Services		
Engineering, Surveying, Geotechnical Investigation, and Construction Observation (35% of Construction Cost)		$275,000
Total, Construction Cost		$1,059,000
Land Rights		
Easements[4]		$72,000
Professional Services		
Engineering, Administrative/Legal Services (20% of Land Rights Costs)		$15,000
Total, Land Rights Costs		$87,000
NRCS Construction Contract, Administration and Supervision Cost (10% of Construction Cost)		$58,000
Total, Opinion of Approximate Cost for Federal Decommissioning Alternative		$1,204,000

Notes:
1. *Price base February 2006.*
2. *Removal of existing principal spillway.*
3. *Excavation above weir elevation and removal or sediment to drop structure crest elevation.*
4. *Temporary construction easements (4 acres) and temporary waste area easement (2 acre).*

4.1.3 Rehabilitation to High Hazard Class Alternative

The Rehabilitation to High Hazard Class Alternative is a plan to rehabilitate the structure to current high hazard class requirements and extend its life for 100 years. The existing CMP principal spillway would be removed and replaced with a standard D by 3D (NRCS Standard Drawing ES-169) cast-in-place concrete covered-top ported riser and an RCPP conduit which would discharge into a rock-lined plunge pool.

The proposed 36-inch RCPP conduit was selected so that hydraulic capacity of the proposed conduit would be nearly equivalent to that of the existing 42-inch CMP, using the nearest standard diameter, thereby maintaining the current level of incidental flood protection provided by the existing principal spillway.

The auxiliary spillway would be widened, and the top of dam would be raised approximately 10 feet to provide a combination of storage capacity and auxiliary spillway conveyance to pass the design storm without overtopping the dam. Figure D-1 shows a typical principal and auxiliary spillway section to rehabilitate the structures to high hazard class requirements. Table D4-4 summarizes the spillway parameters to rehabilitate Structure 2 to High Hazard Class requirements.

Table D4-4
Structure 2 – Spillway Parameters for Rehabilitation to High Hazard Class Alternative

Description	Existing Conditions	Proposed Rehabilitation
Hazard Class	Low[1]	High
Principal Spillway (PS) Data: Single-Stage Inlet, Circular Conduit		
PS Crest Elevation (feet)	1080.2	1082.4
Length of Conduit (feet)	114	210
Diameter of Conduit (inches)	42 CMP	36 RCCP
Surface Area (acres)	6.8	13.7
Storage (acre-feet)	17	39.7
Auxiliary Spillway (AS) Data		
AS Crest Elevation (feet)	1087.3[2]	1092.6
Side Slope Ratio (_H:1)	3	3
Bottom Width (feet)	70	150
Top of Embankment Elevation (feet)	1092.3[2]	1101.1
Surface Area (acres)	29.6	46.5
Storage (acre-feet)	143	345.1
Floodwater Retarding Storage (acre-feet)	126	280.3[3]
Maximum Water Surface Elevations (24-Hour Storm Event)		
Principal Spillway Hydrograph	1088.5	1092.6
Stability Design Hydrograph	1089.2	1096.1
Freeboard Hydrograph	1091.1	1101.1

Notes:

1 *Structure 2 was designed as a low hazard (A2) structure with the product of the height and storage volume less than 30,000.*

2 *Based on topographic survey conducted by HWS in 2005.*

3 *Floodwater retarding storage is the storage between auxiliary spillway crest (345.1 acre-feet) and the principal spillway crest (39.7 acre-feet) less aerated sediment storage (25.1 acre-feet) or 280.3 acre-feet).*

Excavation from widening the auxiliary spillway does not provide sufficient material to complete the embankment, a secondary borrow will be required. The borrow area is assumed to be in the floodwater retarding pool; however, the available storage volume was not adjusted since the material at that location may not be suitable.

The existing sediment storage volume below the riser crest is not sufficient for 100 years based on projected land use development. Additional sediment storage volume could be achieved either 1) by raising the riser crest 2) by excavating above and below the riser crest, or 3) a combination of raising the riser and excavation above and below the riser crest.

Option 1 would raise the riser crest 2.2 feet to provide an additional 24.2 AF of sediment storage. This would increase the water surface elevation of the normal pool requiring the purchase of 6.9 acres of additional normal pool easement, raise the water surface elevation of the 100-year storm, and raise the auxiliary spillway crest elevation requiring the purchase of 17.3 acres of additional floodwater retarding pool easement.

Table D4-5
Structure 2 – Opinion of Approximate Construction and Land Rights Costs for Rehabilitation to High Hazard Class Alternative

Description	Subtotal Cost	Total Cost[1]
Construction		
Dam Construction Rehabilitation		
Mobilization	$15,000	
Clearing and Grubbing	$30,000	
Erosion and Sediment Control	$11,000	
Site Work	$6,000	
Removals[2]	$64,000	
Earthwork	$235,000	
Principal Spillway	$89,000	
Seeding	$19,000	
Subtotal, Dam Construction Rehabilitation		$469,000
Professional Services		
Engineering, Surveying, Geotechnical Investigation, and Construction Observation (40% of Construction Cost)		$188,000
Total, Opinion of Construction Cost		$657,000
Land Rights		
Purchase of Land Rights[3]	$315,000	
Temporary Easement[4]	$8,000	
Subtotal, Land Rights Costs		$323,000
Professional Services		
Engineering, Administrative/Legal Services (20% of Land Rights Costs)		$65,000
Total, Land Rights Costs		$388,000
NRCS Construction Contract, Administration and Supervision Cost (10% of Construction Cost)		$47,000
Total, Opinion of Approximate Cost for Rehabilitation to High Hazard Class Alternative		$1,092,000

Notes:
1 *Price base February 2006.*
2 *Removal of existing principal spillway.*
3 *Auxiliary spillway and embankment land purchase (7.0 acre) and purchase of floodwater retarding pool easement (17.3 acre).*
4 *Temporary construction easement (4 acres) and waste (clean fill) disposal easement (0 acre).*

Option 2 would excavate approximately 24.4 AF, or about 40,000 cubic yards, below the existing riser crest elevation, and would excavate approximately 19.0 AF or about 30,000 cubic yards above the riser crest elevation. The excavated sediment would be deposited on suitable areas within the Project area, plus the cost of obtaining an easement to store it until used for mass grading developments. The cost of providing 100-year sediment storage by raising the riser crest and acquiring additional easement at $20,000/acre is less than the cost to provide sediment storage at the riser crest by excavating above and below the riser. Option 3 is to be considered during final design, to optimize the cost of excavation and raising the dam. Option 1 was selected to prepare opinions of approximate costs for this alternative.

Approximately 35,000 cubic yards of embankment would be required to raise the top of dam elevation. Most of the material would be obtained from the auxiliary spillway widening, with about 15,000 CY from secondary borrow. The entire disturbed area would be seeded with a native seed mixture suitable for upland conditions.

Land rights acquisition will be required for the revised footprint, permanent pool, and floodwater retarding pool. The approximate dam rehabilitation costs and land right costs estimated for the Rehabilitation to High Hazard Class Alternative total $1,092,000. Table D4-5 summarizes the opinion of the approximate construction and land rights costs to rehabilitate Structure 2 to High Hazard Class requirements.

4.1.4 Rehabilitation to Grade Stabilization Structure Alternative

The Rehabilitation to Grade Stabilization Structure Alternative is a plan to rehabilitate the structure to full-flow grade stabilization structure requirements and extend its life for 100 years. The grade stabilization structure would not retard or store floodwaters as the floodwaters would pass through the structure to the downstream reach. The auxiliary spillway would be abandoned, the top of the dam would be lowered to remove storage capacity and the existing CMP principal spillway would be removed and replaced with a broad-crested weir chute spillway sized to convey the 25-year design storm and to pass the 100-year design storm without overtopping the embankment. The chute spillway would be lined with articulated concrete blocks to resist erosive forces. Embankment removed from the structure would be placed in the auxiliary spillway.

The auxiliary spillway would be abandoned, the top of dam would be lowered approximately 7.3 feet; thereby eliminating the storage capacity. Figure D-3 shows a typical principal section to rehabilitate the structure to grade stabilization structure requirements. Table D4-6 summarizes the spillway parameters to rehabilitate Structure 2 to grade stabilization structure requirements.

Table D4-6
Structure 2 – Spillway Parameters for
Rehabilitation to Grade Stabilization Structure Alternative

Description	Existing Conditions	Proposed Rehabilitation
Hazard Class	Low[1]	NA
Principal Spillway (PS) Data: Single-Stage Inlet, Circular Conduit		
PS Crest Elevation (feet)	1080.2	NA
Length of Conduit (feet)	114	NA
Diameter of Conduit (inches)	42 CMP	NA
Surface Area (acres)	6.8	NA
Storage (acre-feet)	17	NA
Auxiliary Spillway (AS) Data		
AS Crest Elevation (feet)	1087.3[2]	NA
Broad-Crested Concrete Weir Elevation (feet)	NA	1080
Side Slope Ratio (_H:1)	3	3
Bottom Width (feet)	70	80
Top of Embankment Elevation (feet)	1092.3[2]	1085.0
Surface Area (acres)	29.6	NA
Storage (acre-feet)	143	NA
Floodwater Retarding Storage (acre-feet)	126	NA
Maximum Water Surface Elevations (24-Hour Storm Event)		
Principal Spillway Hydrograph	1088.5	NA

Description	Existing Conditions	Proposed Rehabilitation
Stability Design Hydrograph	1089.2	NA
Freeboard Hydrograph	1091.1	NA

Notes:

[1] *Structure 2 was designed as a low hazard (A2) structure with the product of the height and storage volume less than 30,000.*

[2] *Based on topographic survey conducted by HWS in 2005.*

Providing for 100-year sediment storage volume is not necessary, as the sediment will pass through the structure.

Approximately 13,800 cubic yards of embankment would be required to be removed to lower the top of dam elevation. The removed embankment material would be placed in the existing auxiliary spillway. The entire disturbed area would be seeded with a native seed mixture suitable for upland conditions.

Floodwater would pass through the structure via the chute spillway, thereby eliminating the current level of incidental flood protection provided by the structure. Since the floodwater retarding pool is eliminated, the peak discharges downstream of Turtle 2 will change. For example, comparing the existing operational outflow conditions to the rehabilitation to grade stabilization structure outflow conditions, the 100-year peak discharge increases from 780 cfs to 2,300 cfs while the 25-year peak discharge increases from 340 cfs to 1,620 cfs.

The breach peak flow rate is greatly reduced from 3,700 cfs (existing Low Hazard Class structure) to 1,300 cfs (proposed full-flow grade stabilization structure) measured at the higher of the auxiliary spillway crest or the 100-year water surface elevation. This flow rate is less than the 100-year peak flow rate so would not need to be routed nor easement acquired for the breach.

No land rights acquisition will be required, since the structure would not be classified as a dam. The approximate dam rehabilitation costs and land right costs estimated for the Rehabilitation to Grade Stabilization Structure Alternative total $552,000. Table D4-7 summarizes the opinion of the approximate construction and land rights costs to rehabilitate Structure 2 to grade stabilization structure requirements.

Table D4-7
Structure 2 – Opinion of Approximate Construction and Land Rights Costs for Rehabilitation to Grade Stabilization Structure Alternative

Description	Subtotal Cost	Total Cost[1]
Construction		
Dam Construction Rehabilitation		
Mobilization	$12,000	
Clearing and Grubbing	$25,000	
Erosion and Sediment Control	$4.000	
Site Work	$3,000	
Removals[2]	$30,000	
Earthwork[2]	$30,000	
Principal Spillway	$264,000	
Seeding	$6,000	
Subtotal, Dam Construction Rehabilitation		$374,000
Professional Services		
Engineering, Surveying, and Construction Observation (35% of Construction Cost)		$131,000
Total, Opinion of Construction Cost		$505,000
Land Rights		
Purchase of Land Rights		
Temporary Easement[3]	$8,000	
Subtotal, Land Rights Costs		$8,000
Professional Services		
Engineering, Administrative/Legal Services (20% of Land Rights Costs)		$2,000
Total, Land Rights Costs		$10,000
NRCS Construction Contract, Administration and Supervision Cost (10% of Construction Cost)		$37,000
Total, Opinion of Approximate Cost for Rehabilitation to Grade Stabilization Structure Alternative		$552,000

Notes:
1 *Price base February 2006.*
2 *Removal of existing principal spillway and embankment accounted for under Removals and Earthwork.*
3 *Temporary construction easement (4 acres) and waste (clean fill) disposal easement (0 acre).*

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 ECONOMIC EVALUATION

5.1 Economic Benefits

Economic benefits and impacts associated with Structure 2 were calculated based on the grade stabilization benefits the site was intended to provide. The grade stabilization of the drainage area upstream of the structure provides a quantifiable benefit in the form of reduced damages to cropland and greenway property value gains. All economic benefits calculated assumed that Structure 2 is expected to be fully developed by 2030.

Gully erosion is the source of most potential economic damages in the Turtle Creek Watershed. The 1959 Watershed Work Plan (1959 Plan) reported that grade stabilization structures in the watershed (Structures 1 and 2) would prevent approximately 246 cropland acres from being depreciated and 41 acres from being voided, indicating moderate and extreme adverse potential impact to the land's productivity, respectively, if erosion was unchecked. For cropland, these impacts reduce yields and initiate changes in the cropping patterns from row crop to less profitable cover crops and pasture. In the case of voided land, its agricultural value goes to zero. This reduced profitability is capitalized into land values, with corresponding decreases in cropland values. The grade stabilization structures were also credited with reducing potential flood damage at downstream roadway crossings. Adverse impacts due to sedimentation were not considered detrimental to crop production due to the deep nature of the loess soils in the area, and were not estimated.

The grade stabilization provided by the structure allows for the availability of greenways around which to build residential properties on lots with higher values than lots not adjacent to greenways. The lot value increases from maintaining the grade stabilization are one-time gains.

Currently, the majority of the watershed remains in cropland, but urban development is approaching and land values have responded in a dramatic fashion. Near Nebraska Highway 50 (Hwy. 50) and Pflug Road, mixed use land uses are anticipated. Lands on the east side of Highway 50 are platted and developing. Residential development is planned, but not platted, for current cropland upstream from the Hwy. 50 corridor. Cropland in the Sarpy County is currently valued at approximately $2,300 per acre in this area, however cropland in the watershed is converting to developable land worth $20,000 to $40,000 per acre in its current state[1]. These most recent land values are approximately 9 to 17 times those of the agricultural land uses originally used to justify the existing grade stabilization improvements.

This analysis tests the feasibility of rehabilitation of the grade stabilization structure using a similar approach as that used for the 1959 Plan economic analysis. Both studies focus upon the impact to land values associated with a No-Action/Future Without Federal Project condition. However, the 1959 Plan uses changes in crop profitability as a proxy for changed land values, while the current study uses the land values associated with developable property.

The main differences between this analysis and the 1959 Plan analysis are that:

- The period of analysis has been extended from 50 years to 100 years

[1] Cropland prices in this area were obtained from the University of Nebraska, Department of Agricultural Economics, at the following link: http://agecon.unl.edu/pub/cornhusker/3-23-05.pdf. This range of land values for developable lands are based on land values used in the alternatives' cost estimates ($20,000 per acre) and anecdotal evidence from area developers and resource agencies ($40,000+ per acre).

- The relevant discount rate has increased from 2.5 percent to 5.125 percent
- The current analysis will assume that land uses change during the analysis period and the rate of gully erosion is subsequently reduced.

5.1.1 Grade Stabilization Benefits

Grade stabilization benefits are in the form of avoided economic damages resulting from the formation of gullies. These benefits would not be realized under the No Action/Future Without Federal Project Alternative because the gully formation the original structure was intended to stabilize would continue. These alternatives would result in land depreciation and voiding at some positive but uncertain rate in the future, depending on future land use and measures taken by landowners and other non-federal entities. The Rehabilitation to High Hazard Class, Rehabilitation to Grade Stabilization Structure, and Federal Decomissioning Alternatives would continue to protect the existing channel from gully formation.

Based on continuation of agricultural land uses and existing farming practices at the time, the 1959 analysis estimated that grade stabilization structural measures would prevent impacts to approximately 288 acres, or approximately one-tenth of the total watershed. Specifically, it stated that at the end of 50 years, 247 acres would experience depreciation with resulting yield impacts, and 41 acres would become non-farmable. It is important to note that these acreage figures are net estimates, considering that some land depreciation and voiding will still occur even with the measures. Assuming that the damage occurs equally every year approximately 1 acre of crop land is converted to voided land and an additional 5 acres of depreciated land accompany the voided acres. This is true as long as land remains in cropland.

Since the watershed is still mostly in cropland production, at least in the near term, the rates of erosion were assumed to be the same as current in the future. However, since it appears nearly certain that this area will develop over the next 25 years, soil erosion rates and subsequent gully creation will likely decrease over time. Further, the area is expected to transition from cropland to mixed-use residential in the next 10 years. At the time the area begins to transition to residential use, it is reasonable to assume that premiums paid for lots adjacent to the greenway will capitalize the value of future reductions in land damages. The gains would be realized in 10 years when residential use begins and would occur one time only.

Therefore, for the initial 10 years of this analysis (2006-2015), it is assumed that the rate of transition of lands from undamaged to voided, and from voided to depreciated, are approximately the same as in the 1959 analysis. In year 2016, premiums paid on property values adjacent to the greenway are realized when development begins, and the value of future damages to zero. For the remaining years, property gains and benefits are zero, as premiums have already internalized the future benefits from reduction of damages to land.

The analysis assumes that undamaged land in the Turtle Creek Watershed has a current market value of $20,000 per acre, consistent with the land acquisition costs used in previous sections. Further, it is assumed that depreciated land has a value of $10,000 per acre, on the basis that it cannot be developed but has a buffer value for residential properties. Similarly, it is assumed that voided land has a value of $500 per acre, on the basis that it, too, has a buffer value for residential properties owners, but less so than depreciated land.

The assumed land values and gully creation rate assumptions are summarized in Table D5-1.

Table D5-1
Assumptions Used for Structure 2 Economic Analysis[1]

	Most Probable	Low	High
Value of "undamaged" land ($/acre)	$ 20,000	$ 15,000	$ 52,000
Value of depreciated land	$ 10,000	$ 5,000	$ 15,000
Value of voided land	$ 500	$ -	$ 1,000
Discount rate		5.125%	
Without Project			
Cropland Land Use (years 2006-2015)			
Rate that land converts to voided (acres/year)	1.00	0.50	1.20
Depreciated acres that accompany each voided acre, transition	5.00	3.00	7.00

Note:
1 Value of benefits based on a February 2006 price base.

5.1.2 Greenway Property Value Benefits

Property value gains were calculated by first calculating the approximate number of properties that could be located along each greenway for each structure and then the potential property value gain. The calculated property value gain for each structure was then discounted from the year of occurrence to 2006 values using a 5.125 percent discount rate. No inflation was included in this analysis.

Uncertainty in calculating the greenway property value gains was incorporated into the random variables: year the property gains are realized, length of lots adjacent to the greenways, average price of lots in the area, and the premium for greenway-adjacent lots. In attempts to bracket the uncertainty involved minimum expected values, maximum expected values, and most probable values were assigned to each of the random variables. Values used for prices per lot not against greenway were based on assessed land values of properties in the study area not adjacent to a greenway. Values used for premiums for properties adjacent to greenways are based on premiums observed in the study area when comparing assessed land values[2] of properties adjacent to greenways versus properties not adjacent to greenways.[3] The most probable values for the random variables are the values that were most often observed when analyzing actual assessor's property data. Table D5-2 shows the assumptions used for the random variables included in the calculations of greenway property value benefits.

Table D5-2
Greenway Property Benefits: Assumptions for Random Variables

Random Variable	Most Probable	Low	High
Price per lot not against greenway	$22,300	$19,000	$48,000
Premium for greenway-adjacent lot	25%	15%	30%
Lot lengths	75	60	100
Year property gains are realized	10	5	20

2 Assessed land values in Sarpy County represented 97 percent of market value in 2004.

3 Literature research showed that premiums for properties adjacent to greenways in various areas of the United States ranged from 8 percent to nearly 34 percent. The sources of the literature reviewed are including in the References Section of this Appendix.

The greenway reach length was measured from the principal spillway pool limits of Structure 2 to Platteview Road and included the main channel and tributary channels. Side channel lengths were measured from their confluence with the channel to the point of last channel confluence. Runoff from areas above the last confluence and from tributaries to the side channels are assumed to be contained within storm drain conduit. Greenway reaches above Platteview Road are assumed to be protected by the road culvert and were not included in greenway length values.

The measured lengths were reduced to account for road right-of-way at channel crossings. It was assumed the main channel would be crossed by one roadway and the side channels would be crossed once every 400 feet by a 100-foot wide right-of-way. Residential lots would be developed along both sides of the greenway and lot width is expected to range from 60 feet to 100 feet, with the most probable width being 75 feet.

For example; a 500-foot long greenway would be crossed by one right-of-way and have an effective length of 400 feet and for 75-foot wide lots would have 10 adjacent residential lots.

Table D5-3 shows the most probable property value benefits. As shown in the table below, total property value benefits in the most probable scenario is nearly $1,278,500. Amortizing this present value over 100 years at the federal discount rate results in an annual equivalent benefit of $40,000.

Table D5-3
Total Greenway Property Value Benefits

Parameter	Structure 2
Length of greenway[1] (feet)	8,600
Length of adjacent lot (feet)	75
Number of greenway adjacent lots	229
Average price of lot	$22,300
Premium for greenway adjacent lots	25%
Per property gain for greenway	$5,575
Total property value gain for greenway	**$1,278,500**
PV Factor (@ 5.125% discount)	0.607
PV of Greenway Property Value Gain	**$775,600**

Note:
[1] Length of upstream greenway is equal to the effective length of drainage way measured from the watershed stream diagram in the as-built drawings for Structure 2.

5.1.3 Grade Stabilization and Greenway Property Value Benefits Summary

Damage reduction benefits associated with the No-Action/Future Without Federal Project and Federal Decommissioning Alternatives, or equivalently stated, the avoided damages associated with the Rehabilitation to High Hazard Class and Rehabilitation to Grade Stabilization Structure were calculated on a year-by-year basis and are provided in Table D5-4. Based on the most likely estimates of the assumptions shown in Tables D5-1 and D5-2, the sum of the discounted economic benefits equal $1,731,400, expressed in 2005 dollars. Amortizing this present value over 100 years at the federal discount rate results in an annual equivalent benefit for grade stabilization benefits is $29,000 and for greenway property value benefits is $40,000 for a total of $69,000 in combined benefits.

Table D5-4
Economic Analysis of Grade Stabilization and Greenway Property Values Benefits
No-Action/Future Without Project and Federal Decommissioning Alternatives

Year	Acres Becoming Voided	Running Total Acres Voided	Acres Becoming Depreciated	Running Total Acres Depreciated	Reduction in land values, depreciated to voided	Reduction in Land Values, Undamaged to Depreciated	Total Reduction in Land Values	Total Value of Realized Property Gains from Greenway	Discounted
2006	1.00	1.00	5.00	5.00	$19,500	$50,000	$69,500	$ 0	$ 69,500
2007	1.00	2.00	5.00	10.00	$19,500	$50,000	$69,500	$ 0	$ 66,100
2008	1.00	3.00	5.00	15.00	$19,500	$50,000	$69,500	$ 0	$ 62,900
2009	1.00	4.00	5.00	20.00	$19,500	$50,000	$69,500	$ 0	$ 59,800
.									
.									
2015	1.00	10.00	5.00	50.00	$19,500	$50,000	$69,500	$ 0	$ 44,300
2016	0	0	0	0	$ 0	$ 0	$ 0	$1,279,000	$775,600
2017	0	0	0	0	$ 0	$ 0	$ 0	$ 0	$ 0
2036	0	0	0	0	$ 0	$ 0	$ 0	$ 0	$ 0
2037	0	0	0	0	$ 0	$ 0	$ 0	$ 0	$ 0
.									
.									
2104	0	0	0	0	$ 0	$ 0	$ 0	$ 0	$ 0
2105	0	0	0	0	$ 0	$ 0	$ 0	$ 0	$ 0
								Totals	$1,731,400

5.2 Benefit-Cost Ratio of Alternatives

The Rehabilitation to Grade Stabilization Structure Alternative provides a benefit-cost ratio of 2.20, the result of approximately $69,000 in annual benefits and $31,300 in annualized cost.

5.3 Risk and Uncertainty in Economics

The economic benefits contain a degree of uncertainty. This was explicitly recognized throughout the analysis and prompted the development of most likely, low, and high estimates of critical assumptions, as shown in Table D5-1. To address these uncertainties, a Monte Carlo simulation was utilized to evaluate the statistical properties of a very large number of possible combinations of the low, most likely, and maximum variables (20,000 combinations).

Table D5-1 establishes the parameters for triangular statistical distributions that are assumed to underlie these variables:

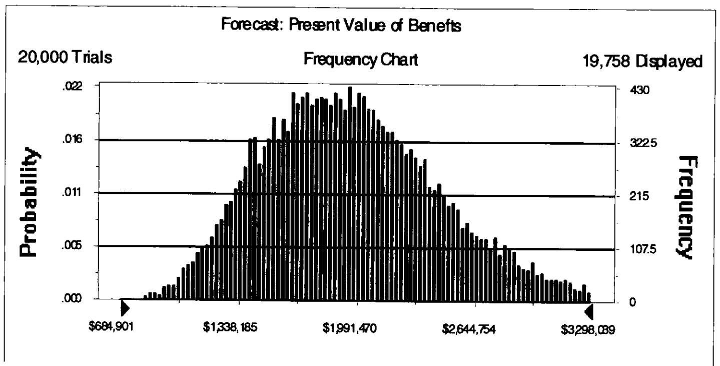
- The most likely value assumed for undamaged land cost is assumed to be $20,000 per acre, the same as assumed for land acquisition costs in the engineering analysis. This is the single most critical variable in the analysis with respect to influencing the feasibility of the project. The low estimate is assumed to consist of a mixture of developed land and cropland under a scenario that the watershed does not develop as rapidly over time as anticipated. The high estimate is based on anecdotal discussions with agency representatives discussing the purchase cost of similar, nearby lands.
- The low estimate of depreciated land value is based on a mixture of developed and undeveloped lands. The high estimate of depreciated land value is somewhat subjective but is based on what a future homeowner might pay to "put some distance" between

himself and his neighbors. Similar reasoning was used to assign ranges to the value of voided land.

- Estimated low and high values for the soil-related variables are also somewhat subjective and relatively wide bands of uncertainty are assigned to them in response. Under developed conditions, it should be noted that soil transition rates are more likely to be on the low end of the assumed range rather than the high end.

Based on these distributions, Exhibit D5-1 shows the underlying joint frequency distribution and the percentiles associated with the present value of project benefits.

Exhibit D5-1. Frequency Distribution and Percentiles of Federal Rehabilitation Benefits



Percentile	Value ($'s)
0%	$684,901
10%	$1,363,525
20%	$1,534,102
30%	$1,674,534
40%	$1,803,496
50%	$1,932,164
60%	$2,059,504
70%	$2,206,172
80%	$2,382,535
90%	$2,653,400
100%	$4,176,120

It should be noted that in 90 percent of the 20,000 combinations examined, present value benefits exceeded $1.36 million per year. This indicates that there is a 90 percent probability that benefit-cost ratio of the Rehabilitation to Grade Stabilization Structure Alternative is 1.0 or greater. At the 50th percentile, benefits are approximately $1.9 million, indicating a benefit-cost ratio of 1.8 or greater.

6.0 REFERENCES

7 CFR 658. Farmland Protection Policy Act of 1981.

33 CFR 328. Definition of Waters of the United States.

40 CFR 230. Section 404(b)(1) Guidelines for Specification of Disposal Structures for Dredged or Fill Material.

40 CFR 1508.7. Cumulative Impact.

42 FR 26961. May 24, 1977. Executive Order 11990, Protection of Wetlands.

16 USC 703-712. Migratory Bird Treaty Act of 1918, as amended.

16 USC 1531 et seq. Endangered Species Act of 1973, as amended.

33 USC 1251 et seq. Water Pollution Prevention and Control.

42 USC 4321-4347. National Environmental Policy Act of 1969, as amended.

About Greenways and Trails, Office of Greenways & Trails, FDEP. http://www.geoplan.ufl.edu/projects/greenways/whatisagreenway.html. Accessed December 10, 2004.

CEQ. January 1997. Considering Cumulative Effects Under the National Environmental Policy Act. http://ceq.eh.doe.gov/nepa/ccenepa/ccenepa.htm.

Chow, Ven-Te, Ph.D. 1959. *Open Channel Hydraulics*. McGraw-Hill Civil Engineering Series.

Cowardin, Lewis M., Virginia Carter, and Edward T. LaRoe. December 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U.S. Department of the Interior, Washington D.C.

Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors. www.nps.gov/pwro/rtca/econ_index.htm. Accessed December 10, 2004

Effects of Greenspace Proximity on Property Values in Lincoln, Nebraska. http://www.lincoln.ne.gov/city/pworks/watrshed/flood/mfp2003/pdf/nrdgecvr.pdf. Accessed December 10, 2004.

EPA. National Water Quality Inventory, 2000 Report. 2000. http://www.epa.gov/305b/.

Greenspace and Local Economies. http://aec.army.mil/usaec/natural/pli-economics.pdf. Accessed December 10, 2004.

Hansen, E.M., L.C. Schreiner, and J.F. Miller. August 1982. NOAA Hydrometeorological Report No. 52 (HMR 52), Application of Probable Maximum Precipitation Estimates, United States East of 105th Meridian. Prepared by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce and the U.S. Department of the Army, Corps of Engineers.

Hershfield, David M. May 1961. Technical Paper No. 40 (TP-40), Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. Prepared by the U.S. Weather Bureau for the Engineering Division, Soil and Water Conservation Service, U.S. Department of Agriculture, Department of Commerce.

Miller, John F. 1964. Technical Paper No. 49 (TP-49), Two- to Ten-day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. Prepared by the U.S. Weather

Bureau for the Engineering Division, Soil and Water Conservation Service, U.S. Department of Agriculture, Department of Commerce.

Nebraska Unmarked Human Skeletal Remains and Burial Goods Protection Act. Nebraska Statute Chapter 12-1201 through 12-1212.

NDEQ. December 31, 2002. Title 117 – Nebraska Surface Water Quality Standards. http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC.

NDEQ, Water Quality Division. March 2004. 2004 Surface Water Quality Integrated Report. http://www.deq.state.ne.us/Publica.nsf/23e5e39594c064ee852564ae004fa010/9b20b5698c99413106256ac7007266c9/$FILE/2004%20Integrated%20Report-final.pdf.

Public Value of Nature: Economics of Urban Trees, Parks, and Open Space. http://www.cfr.washington.edu/research.envmind/CityBiz/Public_Value.pdf. Accessed December 10, 2004.

Sarpy County, Nebraska. Study Report on Water Quality Issues Related to Water and Wastewater Systems, Final Report, April 2006. Prepared by HDR Engineering, Inc., Omaha, NE.

Sarpy County, Nebraska. The Sarpy County Plan, A Comprehensive Development for Sarpy County, Nebraska, December 2005. Prepared by RDG, Omaha, NE.

Schreiner, Louis C., and John T. Riedel. June 1978. Hydrometeorological Report No. 51 (HMR 51), Probable Maximum Precipitation Estimates, United States East of 105th Meridian. Prepared by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce and the U.S. Department of the Army, Corps of Engineers.

Springfield, Nebraska. The Springfield Plan, A Comprehensive Development Plan for Springfield, Nebraska, October 2001. Prepared by RDG, Omaha, NE.

U.S. Census Bureau. 2000. 2000 Census Lookup. http://factfinder.census.gov.

U.S. Department of Commerce, Environmental Science Administration. June 1968. Climatic Atlas of United States.

USACE. Hydrologic Engineering Centers River Analysis System (HEC-RAS) computer program, Version 3.1.1.

USACE. Hydrologic Engineering Centers River Analysis System (HEC-RAS) User's Guide.

USDA NRCS. National Engineering Manual. Part 520, Soil and Water Resource Development. http://www.info.usda.gov/CED/ftp/CED/NEM.html.

USDA NRCS. Water Resources Site Analysis Program (SITES) computer program, Version 2000.5. http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-sites.html.

USDA NRCS. 2001. Conservation Programs Manual. Chapter VI, Sec. 657.5, Identification of Important Farmlands. http://policy.nrcs.usda.gov/scripts/lpsiis.dll/M/M_440_523_F_Title7.htm.

USDA NRCS. May 2001. Water Resources Site Analysis Program (SITES) computer program User's Guide, Version 2000.

USDA, NRCS, National Engineering Handbook, Section 3, (NEH-3) Sedimentation (Second Edition), 210-VI, December 12, 1983.

USDA NRCS, Conservation Engineering Division. June 1986. Technical Release 55 (TR-55), Urban Hydrology for Small Watershed.

USDA NRCS. Conservation Engineering Division. July 2005. Technical Release 60 (TR-60), Earth Dams and Reservoirs.

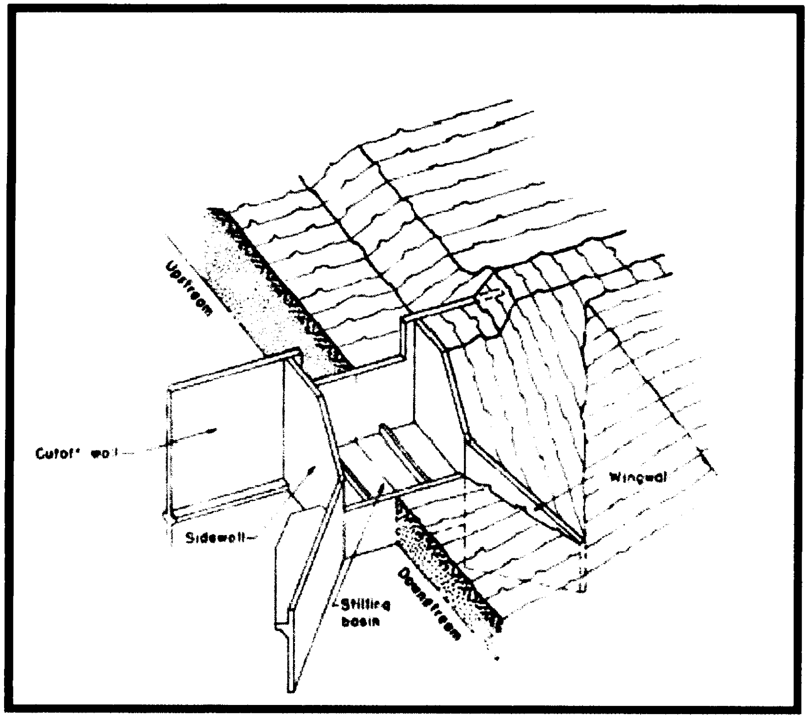
USDA NRCS, Nebraska Natural Resources District, Nebraska Maximum Cost Share Rates, 2003, NRCS, NRD and State Programs, 2004.

USDA NRCS. Site Assessment Report, Turtle Creek Watershed Site: 2, Sarpy County, Nebraska, Lincoln, NE, December 2003.

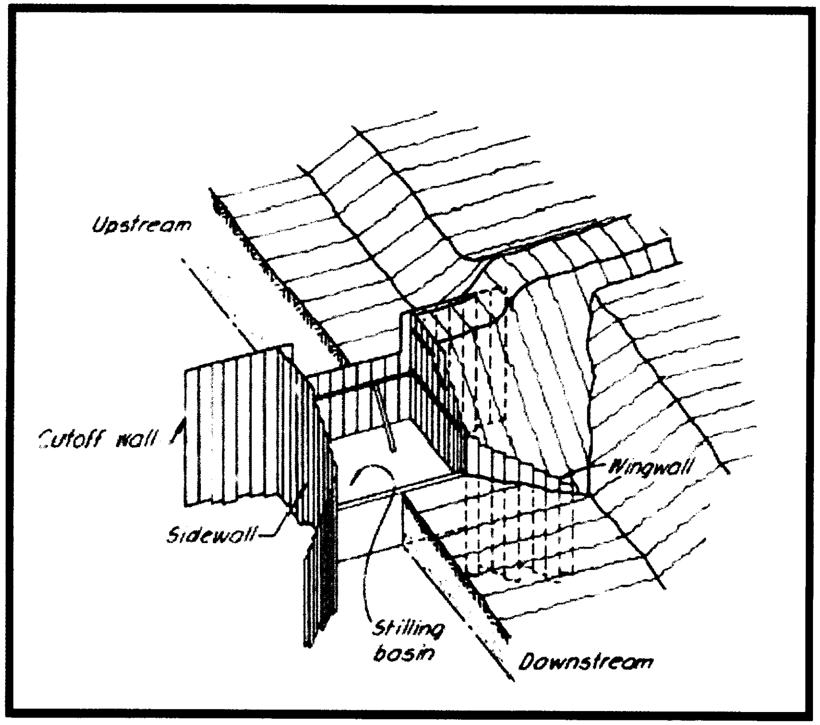
USDA SCS. December 1975. Soil Survey of Douglas and Sarpy County, Nebraska.

USDA SCS. September 20, 1985. Technical Release 66 (TR-66), Simplified Dam-Breach Routing Procedure, Third Edition.

USDA SCS, Sarpy Soil and Water Conservation District, Turtle Creek Watershed Conservancy District, Watershed Work Plan for Watershed Protection and Flood Prevention,: Turtle Creek Watershed, Sarpy County, Nebraska, December 1959.



CONCRETE DROP SPILLWAY



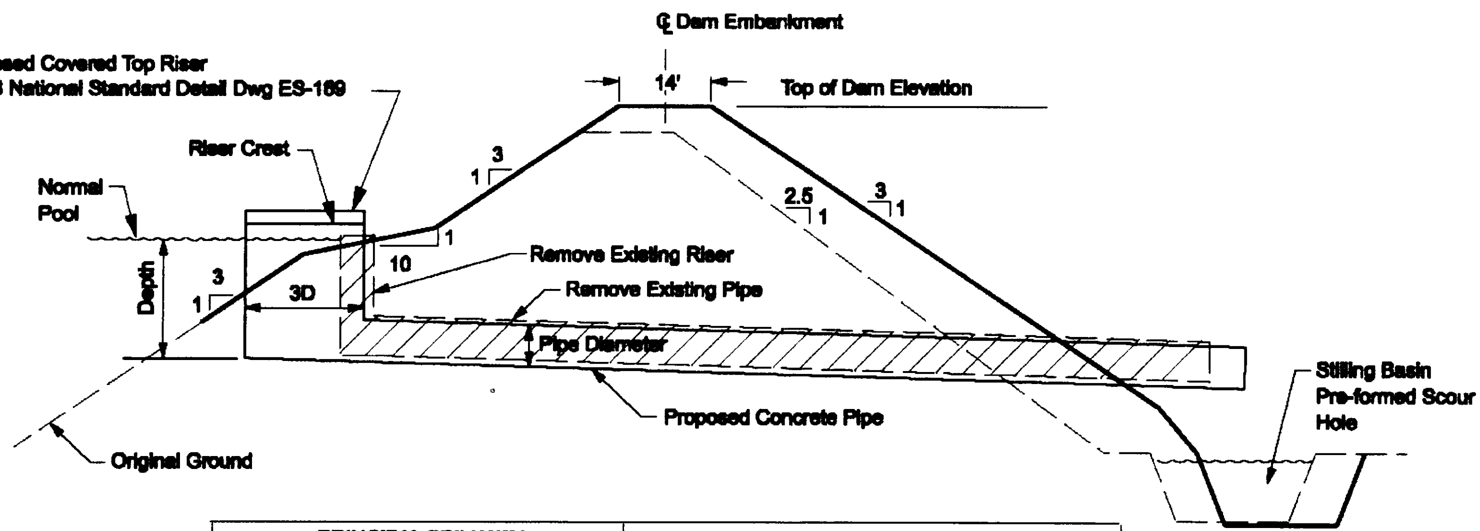
SHEET PILING DROP SPILLWAY

HDR

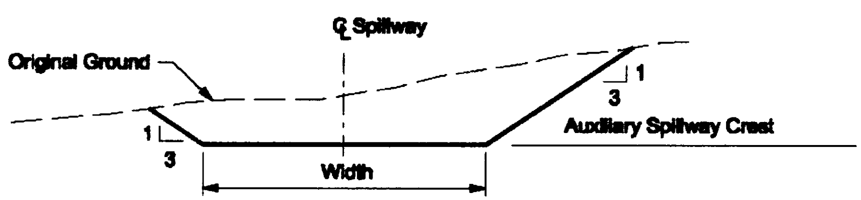
Typical Drop Spillway Structure

Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE	JUN 2006
FIGURE	D-1



PRINCIPAL SPILLWAY			AUXILIARY SPILLWAY		
RISER		PIPE DIAMETER	CREST EL.	WIDTH	TOP OF DAM CREST EL.
CREST EL.	DEPTH				
1082.4	15	36"	1092.6	150	1101.1

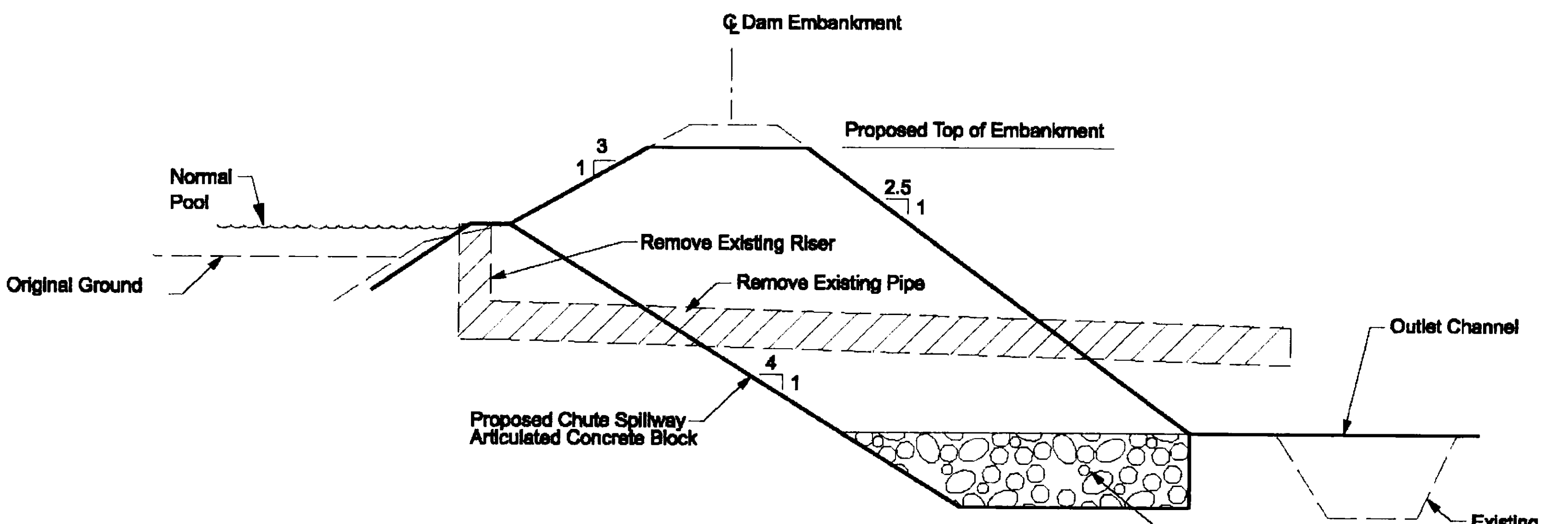


Typical Principal and Auxillary Spillway Sections Rehabilitation to High Hazard Class

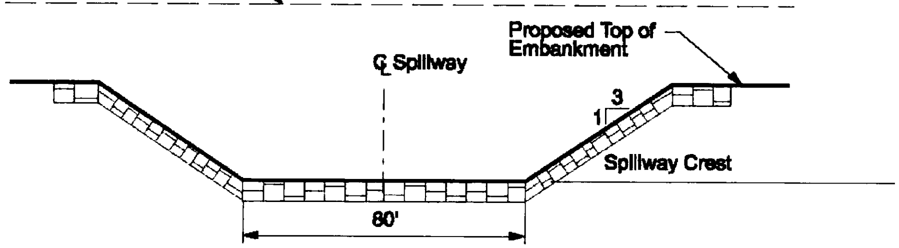
Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE
JUN 2006

FIGURE
D-2



CHUTE SPILLWAY		
CREST EL.	WIDTH	TOP OF EMBANKMENT EL.
1080.0	80	1085.0



HDR

Typical Chute Spillway Sections
Rehabilitation to Grade Stabilization Structure

Turtle Creek Watershed Structure 2
NRCS Watershed Rehabilitation Program

DATE
June 2006

FIGURE
D-3

APPENDIX E

SUPPORTING INFORMATION

ACRONYMS, ABBREVIATIONS, AND SHORT FORMS

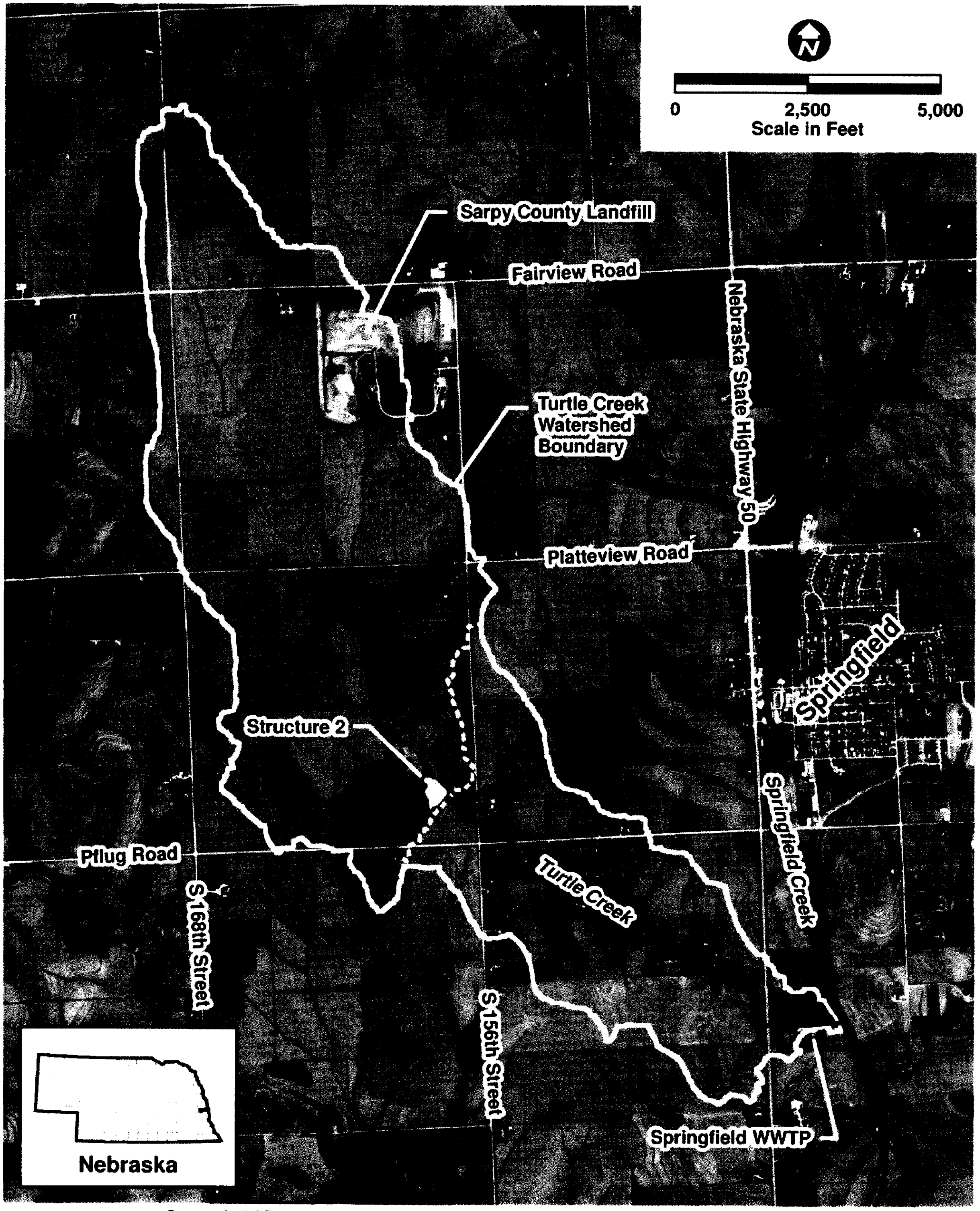
1959 Report	Watershed Work Plan, Turtle Creek Watershed, December 1959
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	corrugated metal pipe
CRP	Conservation Reserve Program
E&T	Endangered or threatened
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
et seq.	*et sequentia* (and the following)
FEMA	Federal Emergency Management Agency
FPPA	Farmland Protection Policy Act
FR	Federal Register
GSS	grade stabilization structure
HEC-RAS	Hydrologic Engineering Centers River Analysis System
MLRA	Major Land Resource Area
NAVD88	North American Vertical Datum of 1988
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NED	National Economic Development
NEPA	National Environmental Policy Act of 1969
NGPC	Nebraska Game and Parks Commission
NGVD29	National Geodetic Vertical Datum of 1929
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRD	Natural Resources District
NWM	National Watershed Manual
O&M	operation and maintenance
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (NRCS, March 10, 1983)

the Project	The intent of this study is to evaluate the "Project" alternatives to rehabilitate Structure 2 for the SLO. The purpose of the Project is to continue to provide grade stabilization protection in a manner that minimizes the risk of loss of human life and is both cost efficient and environmentally acceptable.
RCB	reinforced concrete box
RCP	reinforced concrete pipe
RCPP	reinforced concrete pressure pipe
SCS	Soil Conservation Service
SHPO	State Historic Preservation Office
SID	Sanitary Improvement District
SLO	Sponsoring Local Organization
Sponsoring Local Organization	Papio-Missouri River Natural Resources District
the State	the State of Nebraska
TMDLs	Total Maximum Daily Loads
TR	Technical Release
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
WSEL	water surface elevation

APPENDIX F

PROJECT MAP

THIS PAGE INTENTIONALLY LEFT BLANK



Source: Aerial Photography, Metropolitan Area Planning Agency, flown by Horizons Inc. in April 2004.

Project Location Map
Turtle Creek Watershed Structure 2

NRCS Watershed Rehabilitation Program

DATE
JUN 2006

FIGURE
1

Z:\NRCS\28686_Dam_Rehab_Task_Order_2\map_docs\arcmap\Turtle_Creek_Project_Location_Map.mxd

THIS PAGE INTENTIONALLY LEFT BLANK

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION
AND
FLOOD PREVENTION

TURTLE CREEK WATERSHED

SARPY COUNTY, NEBRASKA

DECEMBER, 1959

USDA-SCS LINCOLN, NEBR. 1959

WATERSHED WORK PLAN

TURTLE CREEK WATERSHED

Sarpy County, Nebraska

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act. (Public Law 566, 83d Congress, 68 Stat. 666) as amended.

Prepared by: Sarpy Soil and Water Conservation District
Turtle Creek Watershed Conservancy District

With Assistance by:

United States Department of Agriculture

Soil Conservation Service

December 1959

TABLE OF CONTENTS

Table of Contents, continued

SECTION 2 - INVESTIGATIONS, ANALYSES, SUPPORTING TABLES AND MAPS

SECTION 1

WATERSHED WORK PLAN

TURTLE CREEK WATERSHED

Sarpy County, Nebraska

December 1959

SUMMARY OF PLAN

The Turtle Creek Watershed work plan outlines a two-year project for watershed protection and flood prevention. The project is sponsored by the Sarpy Soil and Water Conservation District and the Turtle Creek Watershed Conservancy District. Endorsing agencies include the Sarpy County Board of Commissioners and the village of Springfield. Technical assistance in preparing the plan was provided by the United States Department of Agriculture, Soil Conservation Service.

The watershed contains an area of 3.1 square miles (2,000 acres) in Sarpy County, Nebraska. Approximately 86 percent of the area is cropland, nine percent is grassland and five percent is in miscellaneous uses including farmsteads and roads.

Gully erosion is the major problem in this watershed. Two areas of erosive grades are progressing up Turtle Creek. The vertical increments needing structural control are 5 and 16 feet respectively. Flooding is not a serious problem, although a storm occurred on August 5, 1958, which caused $3,000 damage. This storm is estimated to have been a 50-year frequency event.

This project will be installed at a cost of $57,600. Of this, $44,800 will be furnished from Public Law 566 funds, and $12,800 from other sources, including A.C.P. cost-sharing and technical assistance available under other Federal programs. Local interests will bear the cost of operation and maintenance of the structural measures at an estimated cost of $300 anually.

The cost of applying the land treatment measures is $13,200. The Public Law 566 share, consisting entirely of technical assistance for acceleration of the needed land treatment during the project period, is $2,400.

Two structures are planned, one in each land stabilization problem area. The total cost of these measures is $44,400. This includes $42,400 of Public Law 566 funds and $2,000 of other funds.

The estimated average annual damage from land voiding and depreciation in the watershed is $4,200. Land treatment measures for watershed protection are expected to reduce these damages $400

and the structural measures an additional $2,500. The land stabilization measures, as planned, will provide some water-flow control benefits, estimated at $150 annually.

A watershed conservancy district has been formed under the laws of Nebraska. This governmental subdivision has all the legal authorities necessary to install, operate, and maintain the project, including the powers of taxation and eminent domain. The directors of the district will use the necessary powers to accomplish their objectives.

The land treatment measures will be installed and maintained by the landowners and operators of the farms on which the measures are installed under agreements with the Sarpy Soil and Water Conservation District. The structures will be operated and maintained by the Turtle Creek Watershed Conservancy District.

DESCRIPTION OF WATERSHED

Physical Data

Turtle Creek Watershed, encompassing the entire drainage area of Turtle Creek, contains about 2,000 acres and is approximately four miles long and one mile wide. It flows southeasterly and enters Springfield Creek about one mile south of the village of Springfield, Sarpy County, Nebraska. Springfield Creek is a tributary of the Platte River.

The topography of Turtle Creek is rolling with most of the upland slopes ranging from 4 to 12 percent. The natural surface drainage is good. The over-all channel gradient of the watershed is approximately 25 feet per mile. The total relief is 190 feet.

The soils are derived from silty loess parent material. Bedrock is not encountered at or near the surface anywhere in the watershed. For the most part, the soils on the more nearly level areas have deep surface soils with moderately permeable subsoils. Soils on the steeper slopes are immature, thin surfaced, and light colored. The bottomland consists of deep medium textured soils subject to frequent overflow.

The present land use of the soils in acres is as follows:

Soils	Cropland (acre)	Pasture (acre)	Miscellaneous (acre)
Silty alluvial	86	99	6
Friable Upland	1,641	80	88
Total	1,727	179	94

The climate is subject to wide seasonal extremes. The average frost free season is from May 4, to October 7, a season of 150 days. Killing frosts have been recorded as late as May 26, and as early as September 13. Records show an extreme of 112 degrees above and 31 degrees below zero.

The average annual precipitation is approximately 30 inches. About 83 percent of this precipitation occurs during the growing season, April to October.

Economic Data

According to the 1950 census, the average sized farm in the watershed is 146 acres with an average total valuation of $26,749. There are 23 farms in the watershed, 10 are operated by owners, nine by tenants, and four by part-owners.

The principal crop grown is corn. Oats and alfalfa are used in the rotation. The farm cash receipts are divided as follows: grain 43 percent, cattle 48 percent, and other livestock 9 percent. Several large cattle feeding enterprises are located in this area.

The area is served by the villages of Springfield, (population 377), Louisville (population 1014), and Papillion (population 1034), all lying outside the watershed. The watershed is within the trade area served from Omaha, a principal livestock market, and Lincoln. The farmers possess modern farm machinery. Their homes are equipped with electricity, telephones, and other modern conveniences.

WATERSHED PROBLEMS

The principal problem in the watershed is destruction of land by gully erosion. Two areas of degradation are progressing up the main channel of Turtle Creek. Floodwater damage and other water management problems are not serious.

Erosion Damage

Prior to 1936 a large gully had developed in the land stabilization problem area in Section 22 (Figure 1). Farmers in the watershed reported the gully approximately one-half mile in length and in places as much as 20 feet deep and 100 feet in width.

An erosion control structure was installed at the lower end of the gully in 1936 with Works Progress Administration assistance. Sediment accumulation by 1945 reduced the storage capacity of the reservoir causing frequent use of the spillway and consequent erosion. Although maintenance was attempted, the spillway was completely washed out by 1950. An excellent stand of brome grass was maintained in the watercourse above the old structure site. During the past nine years the gully has advanced approximately a quarter of a mile, and 200 feet of this distance in the past season.

A similar land stabilization problem area exists in Section 26 above a new bridge on U.S. Highway No. 50. The stream channel makes a sharp bend above the bridge. Channel flows are undercutting the streambank in a sand substratum and destroying fertile cropland. The stream channel has an overfall immediately above the bridge which has also advanced approximately 200 feet in one season. The soil materials underlying the channels are erosive requiring low water velocities to establish stable channels.

The unstable channel conditions will proceed upstream and adversely affect the existing conservation practices. The application of land treatment measures is being delayed in the areas immediately adjacent to the land stabilization problem areas because stable outlets are not available for terraces and grassed waterways.

Sediment Damage

The loess hills have the potential for an exceedingly high sediment production rate. This is shown by the accumulation of sediment deposits in the reservoir which failed and in farm ponds and erosion control structures surveyed in adjacent watersheds. The application of land treatment measures in this watershed has materially reduced sediment production. Soil productivity of the bottomlands has not been materially reduced because the sediment deposits have been fertile.

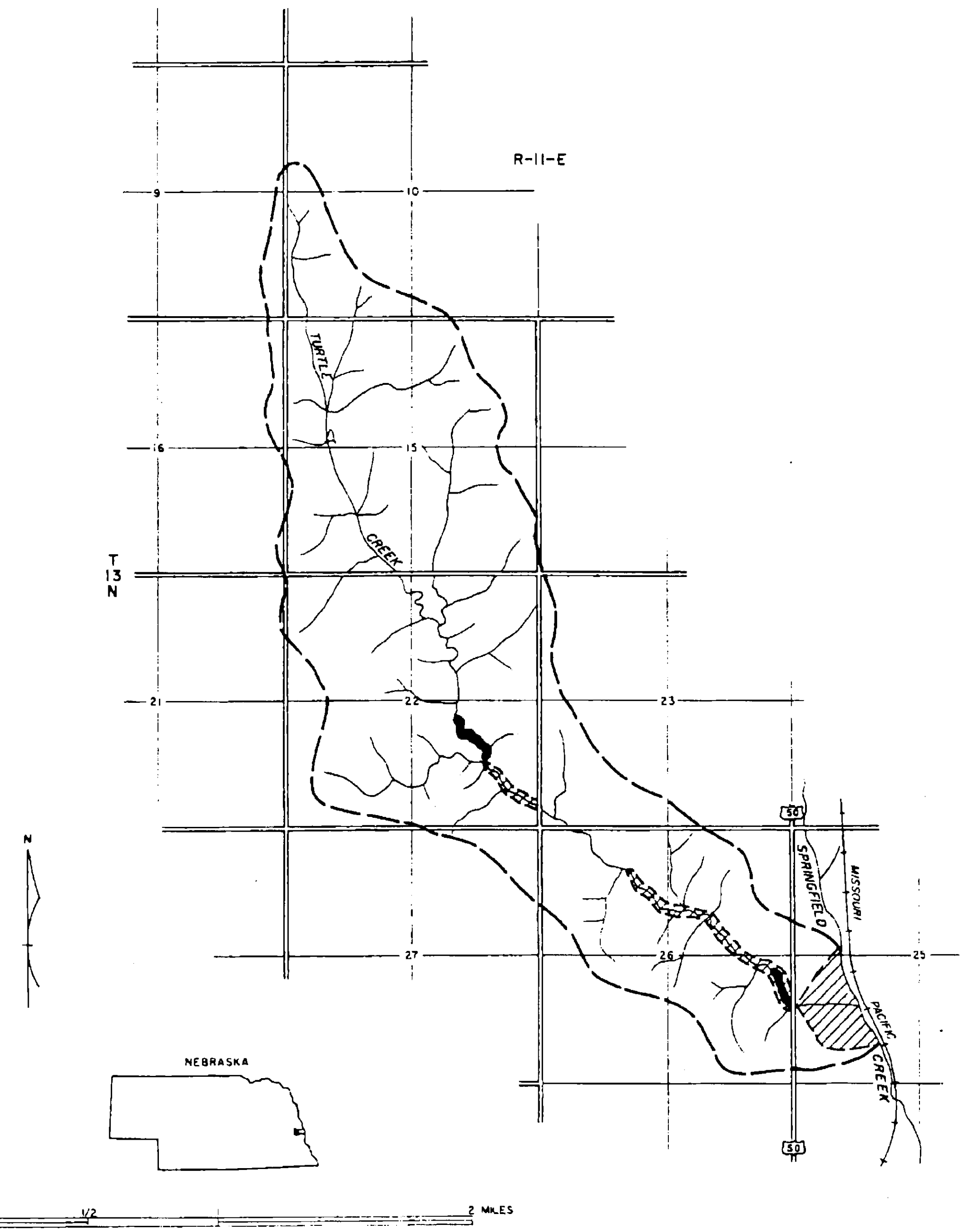
Floodwater Damage

Some floodwater damage occurs in the watershed every year, however, it is not a serious watershed problem. Local people made a damage survey of the storm which occurred August 5, 1958. Their survey shows damage to 60 acres of cropland, 32 acres of pasture, one farmstead, one culvert, and 850 feet of fence. They estimated the value of this damage to be $3,000. Most of the crop damage area lies below the highway on the common floodplain with Springfield Creek. This flood approaches a 50-year frequency event.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Installation of soil and water conservation measures have been and are being carried out through going programs of the Sarpy Soil and Water Conservation District. Technical assistance is furnished by the Soil Conservation Service under authority of Public Law 46 and with financial assistance from the Agricultural Conservation Program.

No existing or proposed works of improvement will be adversely affected by the measures proposed in this plan.



LEGEND

LAND STABILIZATION PROBLEM

MINOR FLOODWATER DAMAGE AREA

REV. 3-3-60

FIGURE 1

PROBLEM LOCATION

TURTLE CREEK WATERSHED

SARPY COUNTY NEBRASKA

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

COMPILED	CHECKED	DATE	DRAWING NO.
J.R.C		11-30-59	5,0-16,262-A

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

Installation of land treatment measures are an essential part of an effective watershed protection and flood prevention program. Land treatment for watershed protection is based upon the use of each acre of agricultural land within its capabilities and treatment in accordance with its need. Emphasis will be on accelerating the application of those land treatment measures which have a direct and measurable off-site effect on runoff and seiment production. Land treatment measures will be planned, applied, and maintained under cooperative agreements with the Sarpy Soil and Water Conservation District. Financial assistance for the installation of these measures is currently available through the Agricultural Conservation and Conservation Reserve (Soil Bank) programs.

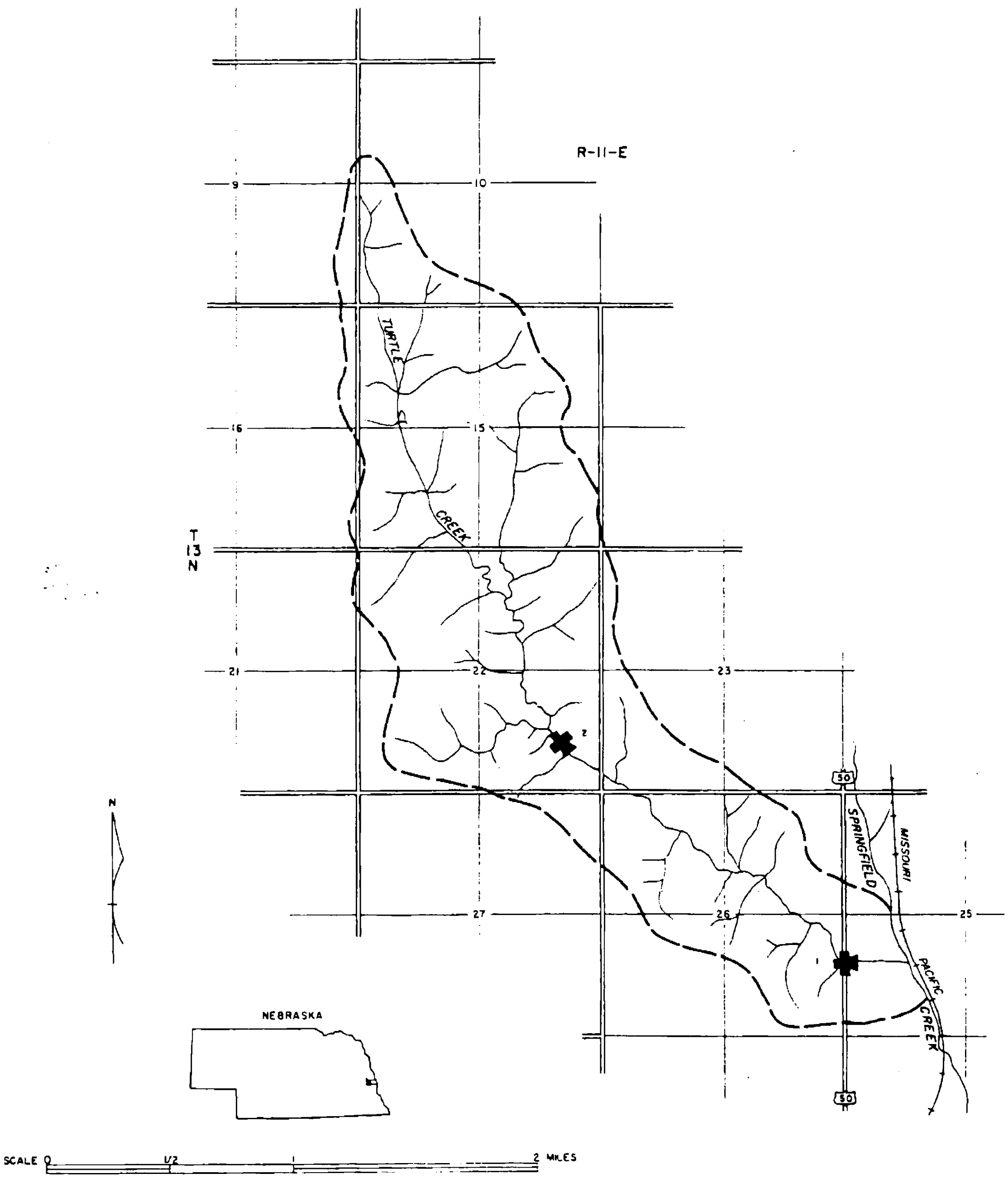
The measures will be installed during the project period by landowners and farm operators. The estimated total cost of planning and installing these measures is $13,200. Of this amount $2,400 will be provided from Public Law 566 funds and $10,800 from other sources (Table 1).

The main purpose of the agronomic measures is to increase infiltration and decrease erosion by improving cover conditions and physical characteristics of the soil. Land best suited for permanent vegetation, but now under cultivation, will be seeded to adapted species of native grasses for forage production and soil protection. Proper pasture use will improve the forage stand and increase soil protection. Conservation cropping systems provide maximum protection from erosion hazards and maintain favorable soil conditions. Roadsides will be shaped and vegetated to adapted species of perennial grasses to reduce damage from water erosion. A structure will be installed by the highway department to provide a non-erosive outlet from the road ditch into the main channel.

Mechanical measures for protection of cultivated land include gradient terraces to retard surface runoff and reduce erosion. Diversions will be constructed to intercept runoff, minimize erosion, and to reduce overflow of lower areas. Waterways will be shaped and vegetated with perennial grasses and legumes to dispose of excess surface runoff from terraces at safe velocities. Two grade stabilization structures will be constructed to stabilize watercourses.

Structural Measures for Flood Prevention

There are two land stabilization problem areas in the watershed which require base grade stabilization by means of structures. These structures are needed to support the land treatment measures listed in Table 1. One drop inlet and one box drop appurtenance are planned to provide this stabilization. The proposed drop inlet structure at site 2 (Figure 2), will be designed with the inlet of



LEGEND

GRADE STABILIZATION STRUCTURE

REV. 3-3-60

FIGURE 2

PLANNED STRUCTURAL MEASURES			
TURTLE CREEK WATERSHED			
SARPY COUNTY			NEBRASKA
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE			
COMPILED	CHECKED	DATE	DRAWING NO
J.R.C		11-30-59	5,0-16,262-B

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Turtle Creek Watershed, Nebraska

Installation Cost Item	Unit	No. to be Applied	Estimated Cost (Dollars) 1/ P. L. 566	Other	Total
LAND TREATMENT FOR WATERSHED PROTECTION					
Soil Conservation Service					
Conservation Cropping Systems	acre	150		450	450
Proper Range Use	acre	10		20	20
Range Seeding	acre	1		30	30
Terracing (gradient)	mile	15		3,750	3,750
Diversion Construction	mile	0.10		50	50
Grassed Waterways	acre	16		3,650	3,650
Grade Stabilization Structures	each	2		2,000	2,000
Technical Assistance			2,400	850	3,250
TOTAL LAND TREATMENT			2,400	10,800	13,200
STRUCTURAL MEASURES					
Soil Conservation Service					
Grade Stabilization Structures	each	2	30,500		30,500
Subtotal - Construction			30,500		30,500
Installation Services					
Soil Conservation Service					
Engineering			8,600		8,600
Other			3,300		3,300
Subtotal - Installation Services			11,900		11,900
Other Costs					
Land, Easements & Rights-of-way				1,000	1,000
Administration of Contracts				1,000	1,000
Subtotal - Other				2,000	2,000
TOTAL STRUCTURAL MEASURES			42,400	2,000	44,400
TOTAL PROJECT			44,800	12,800	57,600
SUMMARY					
Subtotal SCS			44,800	12,800	57,600

1/ Price Base 1959

December 1959

the principal spillway at the 80 percent chance firm water surface elevation or the 25-year sediment accumulation whichever is the more desirable. The structure will be located so that the overfall is covered by the 80 percent chance firm water surface elevation or the channel will be graded to bring the critical point of erosion below the 80 percent chance elevation. The reinforced concrete box drop apprutenance will be constructed on the inlet end of the double box concrete culvert across the highway, site 1 (Figure 2). It will take up five feet of grade in the channel which is sufficient to cover the area of instability.

Some water-flow control will result by the installation of the drop inlet structure. Only partial control of the flood flows will be achieved, however, since the planned release rate is higher than normally included in floodwater retarding structures. The control would be provided for 2.1 square miles or 66 percent of the watershed. The total floodwater retarding capacity for this structure is 200 acre feet.

The total installation cost of these structures is estimated to be $44,400. A general plan and cross sectional view of a drop inlet structure is shown on Figure 3.

BENEFITS FROM WORKS OF IMPROVEMENT

During the 50-year evaluation period, an estimated 41 acres of land voiding (destruction) and 246 acres of land depreciation will be prevented by the structural measures.

These structural measures provide stable outlets for waterways and terraces. The land treatment needs in the land stabilization problem areas will be installed at a high rate initially, and then gradually over the evaluation period. All the land treatment measures that are installed during the evaluation period are not fully effective during the whole 50-year evaluation period. Neither is it estimated that all the conservation needs will be installed by the end of the 50-year evaluation period. Consequently, the potential damage estimated to develop without the project will not be fully prevented with the project. This is the explanation for the $1,300 remaining land damage with the project (Table 7).

The installation of the drop inlet structure will reduce the replacement cost of a 73-foot county bridge which has an expected life of about ten years. This would result in a saving in construction cost of $5,300, an average annual saving of $150.

The installation of the bridge appurtenance will reduce the cost of stabilizing a roadside erosion problem.

COMPARISON OF BENEFITS AND COSTS

The land stabilization measures with an average annual cost of $1,982 will provide average annual benefits of $2,650 for a benefit cost ratio of 1.3 to 1.

ACCOMPLISHING THE PLAN

The people of the watershed have formed a watershed conservancy district as provided in L.B. 358, 1957 Session of the State Legislature, now contained in Sections 2-1550 to 2-1565 R.S. Supplement, 1957. This is an Act relating to soil and water conservation districts; to authorize the establishment of a subdistrict within one or more soil and water conservation district(s) for the purpose of carrying out a watershed protection and flood prevention program within the subdistricts. Subject to the approval of the soil and water conservation district board of supervisors, the board of directors of the watershed conservancy district have the power to: (1) require the county governing board to levy an annual tax on the real and personal property within the conservancy district; (2) acquire by purchase, exchange, gift, lease, grant, bequest, devise, or through condemnation proceedings, such lands, or rights-of-way as are necessary for the execution of any authorized function of the watershed conservancy district; (3) construct, enlarge, improve, operate, and maintain such structures as may be necessary to the performance of any function authorized by the act; (4) sue and be sued in the name of the district; and (5) to purchase, lease, rent or otherwise acquire such equipment and labor as is necessary to carry out the operation and maintenace of works of improvement made under the authorities of this Act.

Federal assistance for carrying out the works of improvement described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended. Table 1 shows the estimated project installation cost. It is planned to install the project in two fiscal years. Estimated funds needed are $44,800 from the Federal Government under authority of Public Law 566 and $12,800 from other Federal and non-Federal sources.

The Extension Service will assist with the educational phase of the project by conducting general information and local farm meetings, tours, preparing radio and press releases, and using other methods of presenting information to landowners and operators. This activity will help to accelerate the land treatment program and the installation of structural measures for flood prevention.

The Farmers Home Administration furnished the following policy statement to be included in the plan:

"The loan authorities of the Farmers Home Administration for making improvements related to soil conservation; water development, conservation and use; permanent pasture, drainage of farm land; and related measures will be available to all eligible farmers in the watershed for the application of conservation measures which will have an appreciable effect upon the success of the project. At informational meeting to be held in cooperation with other agencies, the services available and eligibility requirements of the Farmers Home Administration will be explained. Present F.H.A. borrowers will be encouraged to cooperate in the project."

Land Treatment Measures

The conservation measures shown in Table 1 will be applied by individual farmers or small groups of farmers working together. The financial assistance available through the Agricultural Conservation and Conservation Reserve Programs will be fully utilized. Soil Conservation Service technicians working with the Sarpy Soil and Water Conservation District will assist in the planning and installation of these conservation measures. Additional technical assistance will be provided to accelerate the application of land treatment measures. Land treatment measures will be applied in accordance with conservation farm plans following technical standards of the Soil Conservation Service. To date, eight conservation plans have been developed in the watershed. An additional 14 will be planned during the project period. The sponsoring and endorsing agencies will conduct an educational program to accelerate land treatment.

Structural Measures for Flood Prevention

The watershed project will be considered as a single construction unit. The sponsors have agreed upon a two-year installation schedule. This is possible since about 70 percent of the needed land treatment measures above the planned structural measures have been applied.

The Turtle Creek Watershed Conservancy District will act as the local contracting organization. The directors of the Turtle Creek Watershed Conservancy District have agreed to use all powers granted to them by State Law to achieve project objectives. The watershed conservancy district will obtain the necessary easements and rights-of-way before Federal financial assistance is made available for construction of the works of improvement.

The Soil Conservation Service will provide for the following installation services as assistance to the local contracting organization; planning, designing, preparing of specifications, supervising construction, making final inspection, executing certificates of completion, and performing other related duties for the establishment of the planned structural measures for flood prevention.

PROVISIONS FOR OPERATIONS AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the owners or operators of the farms on which the measures are installed. A representative of the soil and water conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage owners and operators to perform the needed maintenance.

Structural Measures

Structural measures for flood prevention will be operated and maintained by the Turtle Creek Watershed Conservancy District. An annual inspection of all structures will be made each spring, jointly by representatives of the Soil Conservation Service, the Sarpy Soil and Water Conservation District, and the Turtle Creek Watershed Conservancy District. Representatives of the watershed conservancy district will also make an inspection after each major storm or upon the occurrence of any unusual condition that might adversely affect the proper functioning of the works of improvement. Reports will be prepared covering the inspections, stating maintenance and repairs needed, and an agreed date when such repairs will be completed.

Funds, materials, and labor for carrying out the operation and maintenance work will be furnished by the watershed conservancy district as provided for under Legislative Bill 358.

COST-SHARING

The total cost of installing the project is $57,600, of which, $13,200 is the cost of applying the land treatment measures for watershed protection, and $44,400 is the cost of installing the structural measures for flood prevention.

Local interests, using funds and services available from the Agricultural Conservation and Conservation Reserve programs will apply land treatment measures at an estimated cost of $9,950. The Soil Conservation Service, through the existing supplemental memorandum of understanding with the Sarpy Soil and Water Conservation District, will provide technical assistance at an annual cost of $425. Additional technical assistance will be provided from Federal sources under authority of Public Law 566 in the amount of $2,400 to accelerate the application of land treatment measures.

The Federal Government will bear the cost of construction, $30,500, and installation services, $11,900, of the structural measures for flood prevention. The sponsoring local organizations will provide the cost of administrating the contracts, $1,000, and will acquire easements and rights-of-way, $1,000; a total of $2,000.

The Federal Government will provide $44,800 from funds authorized by Public Law 566. This is 78 percent of the project installation cost. The balance, $12,800 will be provided from all other sources. In addition, the sponsoring local organizations will expend an estimated $300 anually during the 50-year life of the project to operate and maintain the structural works of improvement.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

This project plan conforms to all Federal Laws and Regulations. This plan will work harmoniously with other water resource development project being constructed or planned on the Platte River.

SECTION 2 - INVESTIGATIONS, ANALYSES, SUPPORTING TABLES AND MAPS

INVESTIGATIONS AND ANALYSES

Project Formulation

Formulation of the project was based upon the principle of accomplishing the objectives of the sponsoring groups in such a manner as to achieve maximum net benefits. The sponsors determined their objectives after the preparation of a floodwater and land damage inventory map, hereafter referred to as the "damage map". It summarises the damages resulting from the August 5, 1958, storm. The damage map was used by Soil Conservation Service technicians as a guide to the location and intensity of damage.

Land treatment was considered the first increment of project development and was allocated the first increment of project benefits. A soil survey had previously been made and was used to determine soil classification, slopes, land use, and erosion conditions of the entire watershed. Land capability classes and hydrologic characteristics were determined from this survey. This information, together with the technical guides (standards and specifications) for the Sarpy Soil and Water Conservation District, provided the basis for the land use and treatment needs as set forth in Table 1. Although the analyses indicate significant benefits are being received from a high percentage of land treatment already applied and additional benefits are expected from the application of the land treatment measures, it was apparent that other flood prevention measures would be required to attain and maintain the desired degree of watershed protection.

Maintaining the stability of the main channel was considered to be the most serious watershed problem. A field investigation was made of the two land stabilization problem areas to explore their physical limitations and to determine if the solutions of the problems were within the scope of P. L. 566. The tentative project proposal was developed and discussed with representatives of the sponsoring local organizations. The report included (1) a review of the watershed problems, (2) the suggested system of structural control, and (3) the probable degree of protection which would be achieved. After a thorough analysis of the proposed structural program, the sponsors requested that detailed investigations be continued to determine physical and economical feasibility of the recommended structural measures. These investigations resulted in two structures, one located in each land stabilization problem area.

Hydraulic and Hydrologic Investigations

These investigations follow procedures described in National Handbooks of the Soil Conservation Service. The investigations were made primarily for changes in runoff and other water-flow characteristics which are expected to take place after the conditions of this plan have been fulfilled. A high percentage of the land treatment measures has been applied, therefore, present and projected soil cover complex numbers, expressing the runoff characteristics of the watershed, will remain the same.

The source data for measurements in this watershed are the precipitation data published in the U.S. Westher Bureau's Technical Paper No. 25. Procedures in Section 3.7 through 3.10 of Supplement A to the Soil Conservation Service National Handbook for Hydrology, were employed to convert precipitation into surface runoff as influenced by the conditions of the watershed.

The present weighted watershed condition is expressed by a soil cover complex number of 75, and with the future as the same. The following tabulation gives the volume (inches depth) for six hours unadjusted for area, corresponding to the various current intervals:

	Recurrent Intervals			
	10 Years	25 Years	50 Years	100 Years
Precipitation	3.6	4.3	4.8	5.3
Surface runoff	1.37	1.89	2.28	2.69

The major effects of this project will be through stabilization of grade by land stabilization structures. The effect, which the detention storage in these structures might have on floodplain damage, was not evaluated since it would be minor in comparison to that for which the structures are primarily intended.

Sediment Investigations

Farm reservoirs in similar watersheds were surveyed to determine the average annual rate of sediment production. These surveys indicate the reservoirs are losing storage capacity at rates ranging from 0.92 to 4.9 acre feet per square mile of drainage area per year.

Gross erosion computations for present and future conditions were made for the drainage area above the planned drop inlet structure. These computations were based on the principles of a proportional expression developed by G. W. Musgrave. The future sheet erosion rate was estimated on the premise that 75 percent of the needed land treatment measures, the lack of which would adversely affect the design, operation and maintenance of structural works, will be installed prior to, or concurrent with, the installation of structural measures. Most of the needed land treatment measures above proposed structural sites have been applied. The sediment storage requirement under future conditions is determined to be 1.15 acre feet per square mile of drainage area per year.

Erosion Investigations

Gully erosion is serious in some places in the watershed. A field investigation was made of these problem areas to determine its potential for land voiding and deterioration. Engineering surveys were made to determine channel profiles. These were used in the physical determination of the rate and extent of land voiding and depreciation. The procedure outlined in Advisory Notice W-453, dated August 27, 1958, Part 1, "Guide to Determination of Rates of Land Damage, Land Depreciation and Sediment Production by Channel Erosion" (interim) was used as a guide for the physical determinations. These investigations showed 41 acres destroyed and 286 acres depreciated in productivity ranging from 40 to 80 percent during the 50-year evaluation period.

Geologic Investigations

A reconnaissance geologic inspection was made of the proposed structure site in the upper problem area. Hand augered test holes were drilled on both abutments and in the channel. Both abutments are mantled with Peorian Loess to a depth of approximately nine feet. The loess varies in texture but in the main has sufficient clay content to be satisfactory as fill material. Underlying the loess is a heavy moderately firm clay which provides suitable dam foundation. This formation, Kansan Till, was also encountered at 13 feet below the present channel elevation.

An old breached dam is located near the proposed site. Detailed investigations of the accumulated sediment should be made during project design to determine its suitability for embankment material. Adequate borrow material is, however, available in the immediate vicinity of the proposed site.

A visual inspection of the lower site shows a thin mantle of Peorian Loess overlaying clean, uniformly sized fine sand. It is believed that this sand is of large areal extent. When encountered in other locations, it has been in excess of 30 feet deep.

Detailed geologic investigations for design purposes are warranted for both sites.

Economic Investigations

The monetary benefit attributable to land stabilization structures was determined in terms of prevention of land voiding and associated land depreciation. The extent of land voiding and depreciation for the evaluation period was based on a 50-year projection. This was reduced to an average annual rate and multiplied by the present worth of annual damage to obtain the average annual benefit per structure. Advisory Notice W-453, dated August 27, 1958, was followed in the evaluation of annual damage. The estimated average annual land stabilization benefit from this source is $2,500.

Detailed investigations were not made of floodwater damages. A recent storm, estimated at a 50-year frequency event, caused about \$3,000 damage. Most of this occurred on the common floodplain with Springfield Creek. Structural control on Turtle Creek will not materially reduce these damages without structural control on Springfield Creek.

The county official responsible for road maintenance estimates that the bridge immediately below structure site 2, will need replacing within ten years. The bridge can be replaced with a culvert after installation of the drop inlet structure. This would result in a saving of \$5,300 in the cost of the installation. The average annual saving is \$150, computed by amortizing the difference in cost at $2\frac{1}{2}$ percent interest rate and discounting for the usefulness of the present structure.

The cost of easements and rights-of-way, as shown in Tables 1 and 2, reflect the sponsors' estimate. However, the capitalized value of net production was used in the cost-benefit determination. The amortized difference between the sponsors' estimated cost and the cost based upon the capitalized value is shown in Table 6 as Other Economic Cost.

Engineering Investigations

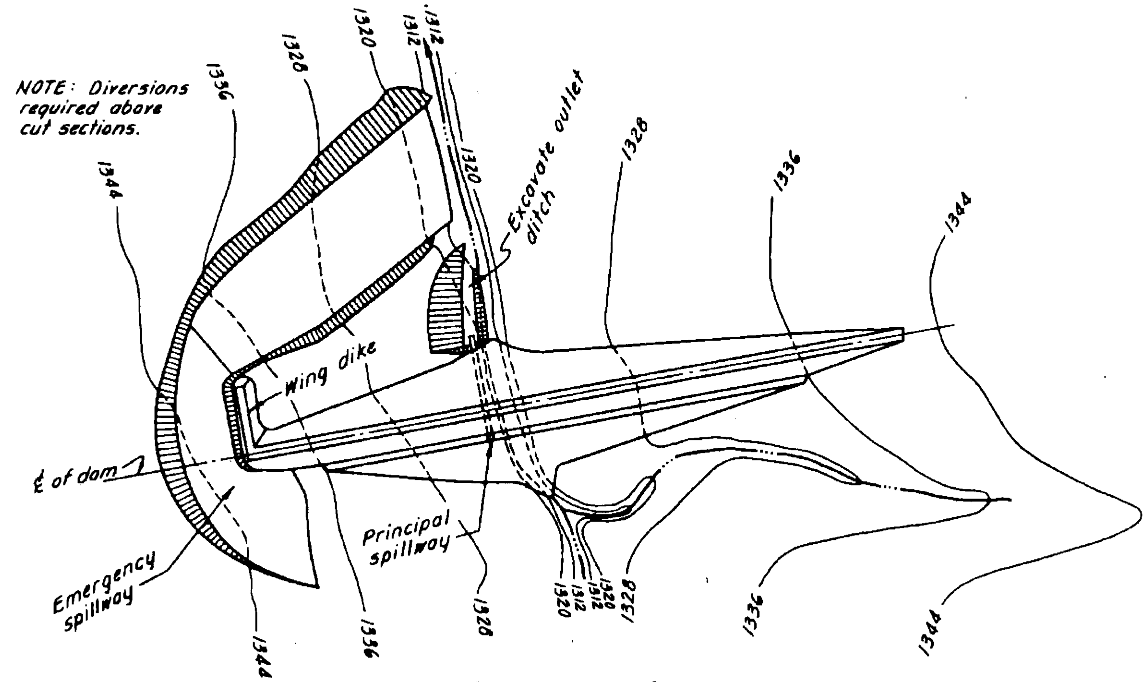
The land stabilization problem areas were investigated in detail. This included cross sections, profiles, and topographic surveys. Volumes, capacities, velocities, etc., were computed from these data.

A drop inlet, (Figure 3) and a concrete box drop appurtenance to the state highway bridge were selected to provide the necessary channel stabilization. Preliminary designs were based upon a 25-year frequency event, six-hour duration storm. The drop inlet structure is located in order that the reach of channel instability will be covered by the permanent pool with the crest of the principal spillway set at the 80 percent chance annual runoff yield.

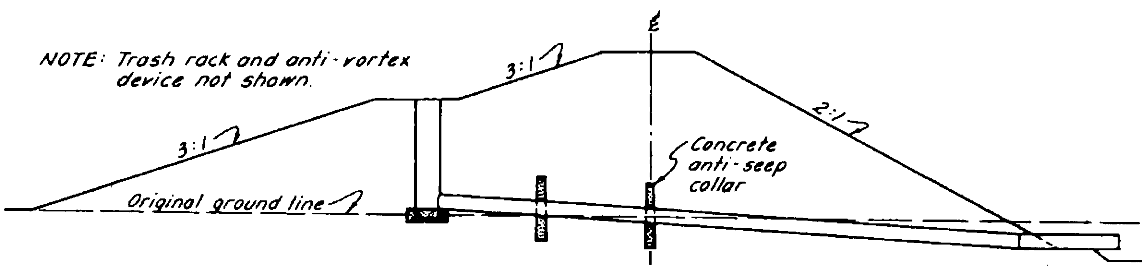
The appurtenance to the highway bridge is designed to maintain the present flow capacity of the bridge and provide streamflow directly through the bridge opening. Preliminary designs for the concrete drop appurtenance indicate that no additional outlet problems will be encountered by placing this appurtenance on the inlet end.

Contract cost estimates for the structural measures were based on installation of similar structures in Nebraska Pilot and Public Law 566 watersheds. The costs were adjusted to reflect individual site conditions.

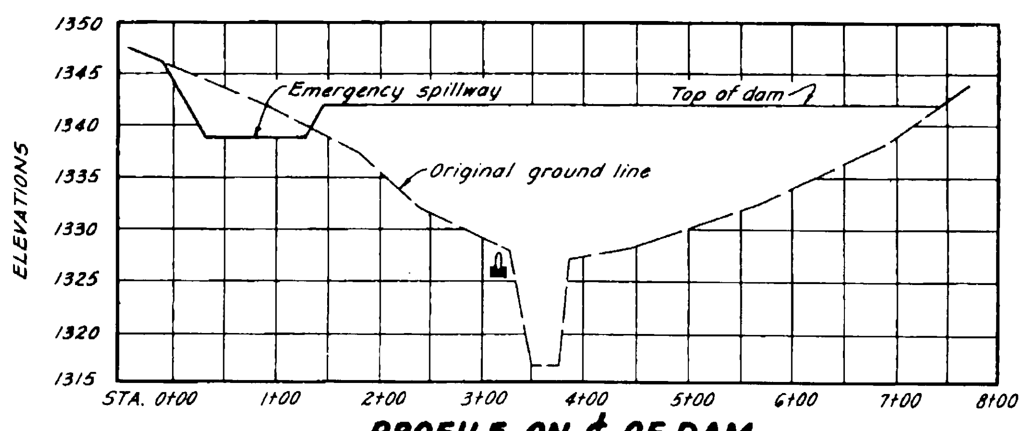
TYPICAL STABILIZING AND SEDIMENT CONTROL STRUCTURE



GENERAL PLAN



CROSS SECTION OF DAM ON CENTERLINE OF PRINCIPAL SPILLWAY



PROFILE ON ℄ OF DAM

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

Turtle Creek Watershed, Nebraska

Measures	Unit	Number Applied To Date	Total Cost
			(Dollars) 1/
LAND TREATMENT FOR WATERSHED PROTECTION			
Conservation Cropping System	acre	1,440	4,320
Terracing (gradient)	mile	73	18,250
Grassed Waterways	acre	73	16,880
Grade Stabilization Structure	each	2	2,000
TOTAL LAND TREATMENT			41,450

1/ Price Base 1959

December 1959

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Turtle Creek Watershed, Nebraska

(Dollars)1/

Struct. Site Number	Installation Cost - P. L. 566					Installation Cost-Other Funds			Total Inst. Cost
	Construction		Installation Serv.		Total P. L. 566		Other		
	Engr. Est.	Contin-gencies	Engineer-ing	Other		Admin. of Contracts	Easements & R/W	Total Other	
1	5,700	900	1,850	700	9,150	300	100	400	9,550
2	20,800	3,100	6,750	2,600	33,250	700	900	1,600	34,850
GRAND TOTAL	26,500	4,000	8,600	3,300	42,400	1,000	1,000	2,000	44,400

1/ Price Base 1959

December 1959

TABLE 3 - STRUCTURE DATA

LAND STABILIZATION MEASURES

Turtle Creek Watershed, Nebraska

Site (No.)	Drainage Area (Acres)	Drop (Feet)	Earth Fill (Cu.Yds.)	Concrete (Cu.Yds.)	Type Structure
1	1,900	5		56	Concrete Box Inlet Appurtenance
2	1,329	16.6	25,980		Drop Inlet

December 1959

TABLE 4 - SUMMARY OF PHYSICAL DATA

Turtle Creek Watershed, Nebraska

Item	Unit	Quantity Without Project	Quantity With Project
Watershed area	sq.mi.	3.1	xxx
Watershed area	acre	2,000	xxx
Land use			
Cropland	acre	1,727	1,720
Grassland	acre	179	174
Miscellaneous	acre	94	106
Average annual rate of erosion 1/			
Sheet	ton/yr.	300,000	250,000
Gully and channel	ton/yr.	60,000	12,000
Sediment production	ton/ac/yr.	18	13
Average annual rainfall	inch	30	xxx

1/ Gross erosion in watershed

December 1959

TABLE 5 - SUMMARY OF PLAN DATA

Turtle Creek Watershed, Nebraska

Item	Unit	Quantity
Years to complete project	year	2
Total installation cost		
Public Law 566 funds	dollar	44,800
Other	dollar	12,800
Annual O & M cost		
Non-Federal	dollar	300
Average annual monetary benefits 1/	dollar	2,650
Agricultural	percent	100
Structural Measures		
Grade stabilization structures	each	2
Area inundated by structures		
Floodplain		
Sediment pool	acre	5
Detention pool	acre	6
Upland		
Sediment pool	acre	5
Detention pool	acre	18
Watershed area above structures	acre	1,900
Reduction of erosion damage	dollar	2,900
By Land Treatment Measures -		
Watershed Protection	percent	14
By Structural Measures	percent	86

1/ From Structural Measures

December 1959

TABLE 6 - ANNUAL COSTS

Turtle Creek Watershed, Nebraska

(Dollars) 1/

Measures	Amortization of Installation Cost 2/	Operation and Maintenance Cost (Non-Federal)	Other Economic Costs 2/	Total
Land Stabilization	1,566	300	116	1,982

1/ Price Base 1959
2/ Amortization rate $2\frac{1}{2}$ percent interest

December 1959

TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES AND LAND TREATMENT MEASURES

Turtle Creek Watershed, Nebraska

(Dollars) 1/

Item	Est. Average Annual Damage			Average Annual Monetary Benefits 2/
	Without Project	After Land Treatment for W/S Protection	With Project	
Floodwater Damage				
Non-Agricultural				
Bridge	200	200	50	150
Subtotal	200	200	50	150
Erosion Damage				
Land Depreciation and Land Voiding	4,200	3,800	1,300	2,500
Subtotal	4,200	3,800	1,300	2,500
Total, All Damage	4,400	4,000	1,350	2,650
TOTAL FLOOD PREVENTION BENEFITS				2,650

1/ Price base long-term prices
2/ Benefits from structural measures

December 1959

TABLE 8 - BENEFIT COST ANALYSIS

Turtle Creek Watershed, Nebraska

(Dollars) 1/

Measures	AVERAGE ANNUAL BENEFITS Flood Prevention Floodwater	Erosion	Total	Average Annual Cost	Benefit Cost Ratio
Land Stabilization	150	2,500	2,650	1,982	1.3 to 1

1/ Installation cost - 1959 construction costs
Benefit - long-term projected prices

December 1959