Stream Bank/Stream Channel Erosion Study – Shady Creek, Harrison Creek, Walnut River and Cole Creek

Summary Report
April 28, 2017

Upper Walnut/El Dorado Lake Watershed Restoration and Protection Strategy (WRAPS)

Project Number: 2015-W071

Year 3 SFY 16 FFY 15
Project Start/End Dates: 10/01/2015 – 3/31/17
KS Grant #: 2015-W071 – Project ID# 756
EPA Grant #C9007405-21

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Background information:

A Feasibility Report was issued by the U S Army Corps of Engineers in 2007 *(Walnut River Basin, Kansas, Feasibility Report – El Dorado Lake, Kansas Watershed Management Plan, January 2007)* where stream bank restoration was mentioned (pages 58-61), but no real data or studies were available to show how much sediment was entering El Dorado Lake that might be coming from stream banks and/or stream channels. As part of our grant in 2010, (KS WRAPS Project No. 2009-0026; EPA C9007405 16 – 2959), a survey was conducted on 8 different stream banks above El Dorado Lake. The survey consisted of identifying areas where stream bank erosion was occurring, setting benchmarks at the survey sites on either side of the stream and then surveying a cross section at the set benchmarks. In addition to the cross sections, rebar (3 foot lengths) were driven into the stream bank flush with the bank at 3' intervals from the top of bank to the water line.

Harrison Creek - Sites #1 and #2 (2010 Photo)

As the streambank erodes, soil is washed away from the bank and the rebar is exposed. Then, after several rainfall/flood events, we would return to those same sites, resurvey the cross sections and measure the amount of exposed rebar to determine sediment loss from the stream bank and sediment loss from the stream channel.

Harrison Creek - Sites #1 and #2 (2017 Photo)
Note exposed rebar in the center of the picture.

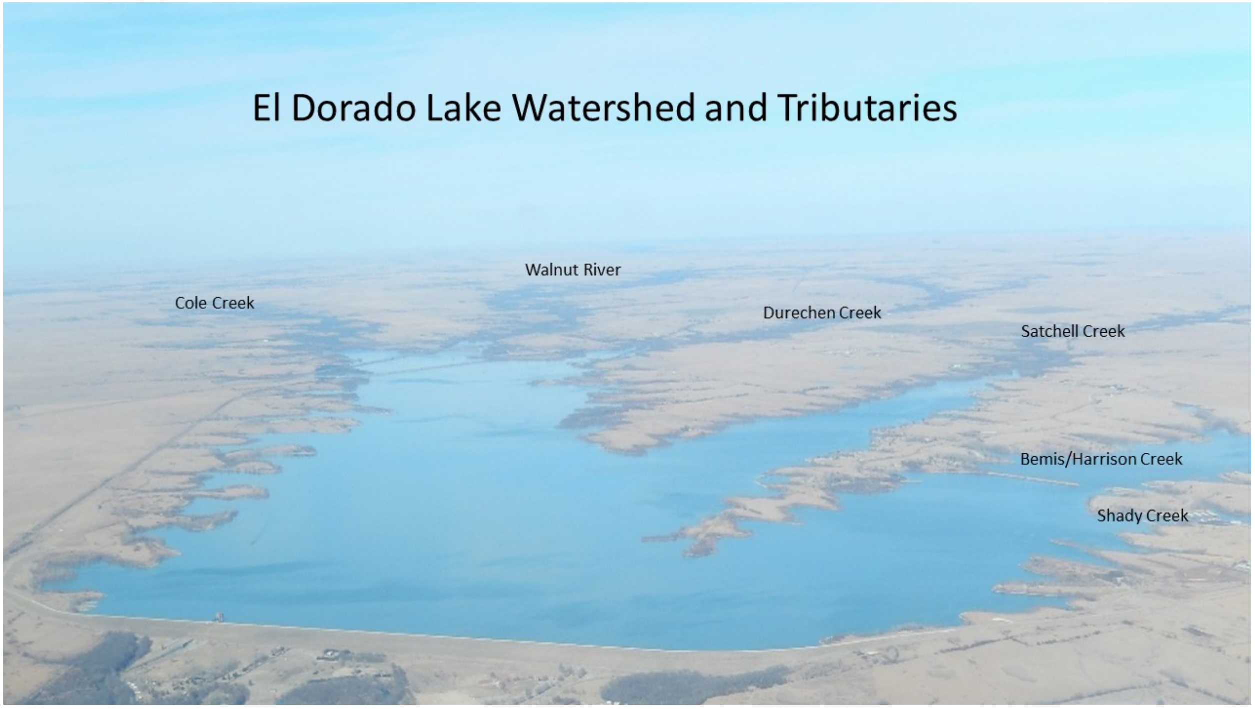
After the initial survey in October 2010, we experienced a two year drought followed by an above average rainfall year in 2013. With the ground being so dry, the rainfall that occurred in 2013 did not usually cause flooding or extremely high flows. The year 2013 was followed by another year of low rainfall. The years 2015 and especially 2016, we had significant rainfall, runoff events sufficient to warrant doing a re-survey on the sites surveyed in 2010. It would have been almost 6.5 years between surveys; however, in that time frame, only 3 years resulted in any significant flooding/rainfall events.

Year	Inches of Rain	Nat'l Weather Service Average from 1981 - 2010
2010	34.74	37.01
2011	24.45	37.01
2012	24.09	37.01
2013	44.53	37.01
2014	26.14	37.01
2015	40.34	37.01
2016	43.92	37.01

Our most recent grant provided the funding for the re-survey and engineering work.

Keep in mind the following: *(gleaned from pages 58-61 of the Feasibility Study and Kansas River & Stream Corridor Management Guide)*

1. Visual signs of an eroding stream bank do not inherently imply man made stream impacts.
2. In many cases, land use changes in the watershed (such as urbanization or agriculture practices) will increase runoff rates and upland erosion.
3. Due to item #2, upland changes will tend to result in accelerated stream bank erosion.
4. Stream bank erosion is only a symptom of the greater runoff rate.
5. The most appropriate and effective response to control stream bank erosion would be the application of BMP's at the site of the land use changes or between the land use changes and the nearest waterway.
6. When land use changes cause a higher rate of runoff, the collector streams will gain a higher level of power. Attempts to stabilize a stream bank at one location will shift the stream power (and erosion) to another location.
7. Stream bank stabilization is not rebuilding a stream channel, but only slowing or stopping the erosion along a stream bank. *(From the Kansas River & Stream Corridor Management Guide)*
8. Properly designed and installed rock vanes and bendway weirs work by slowing water velocities near the bank and redirecting flows away from the stream bank. *(From the Kansas River & Stream Corridor Management Guide)*

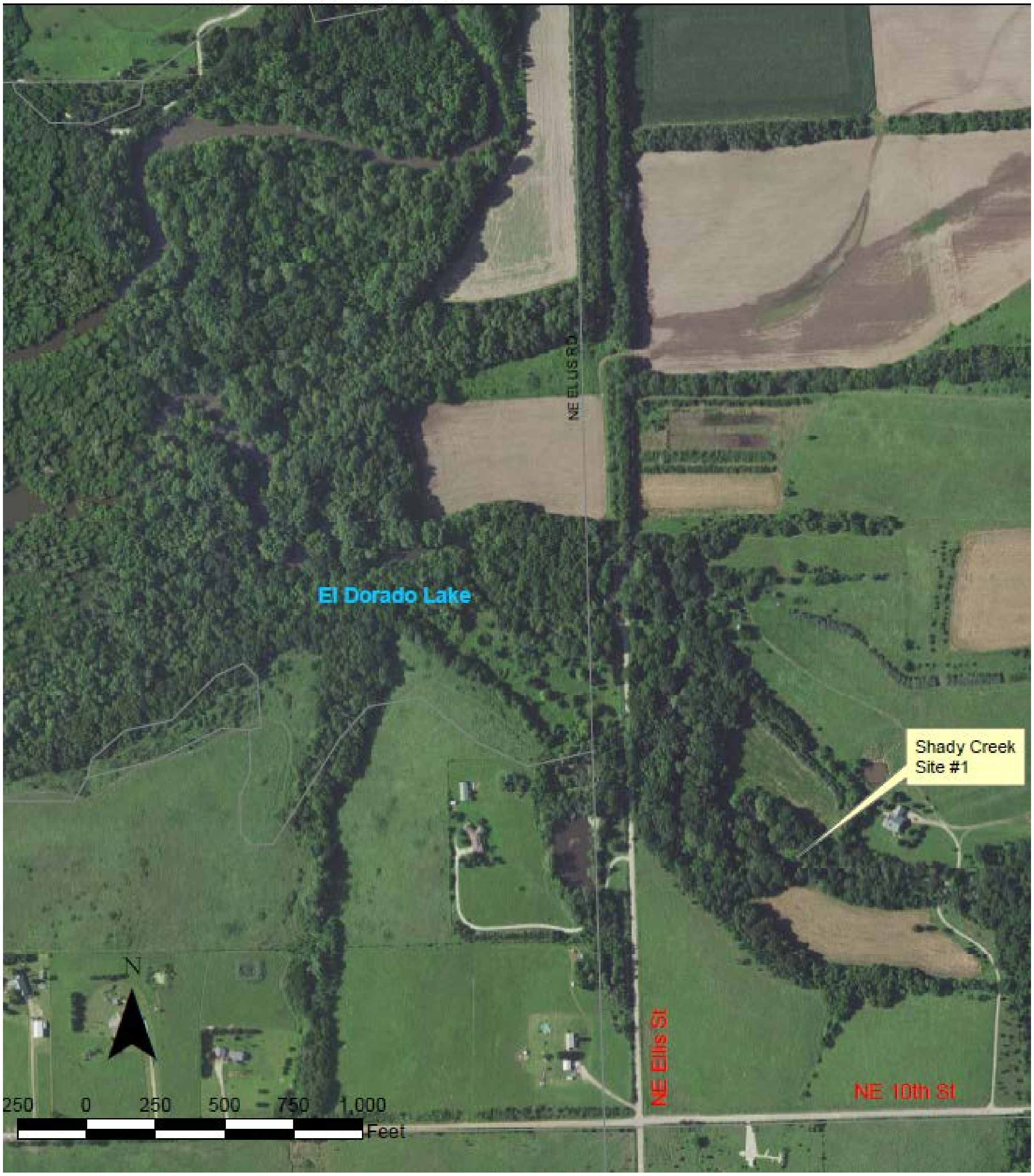


Shady Creek sub-basin is located in the southernmost part of the watershed. Its entire reach is in a high priority area according to the Soil and Water Assessment Tool (SWAT) model developed by the City of El Dorado, Kansas Water Office and the US Army Corps of Engineers, (report issued January 2007). It is also the shortest in length as far as stream miles (around 6 total miles in length). No part of the stream reach is considered a high priority stream. The site surveyed was roughly ¼ to ½ mile from the upper reaches of El Dorado Lake. Adjacent land use on the site of the eroding stream bank is farmed. The soil type is Verdigris soils, frequently flooded. The riparian buffer is 50-60 feet wide. The stream bank on the eroding side is 5.5 feet in height. A low water crossing was installed over 15 years ago about 500 feet upstream of the site so that the landowner could get to his home.

Streambank/Channel Survey
2010 and 2017
Shady Creek Site #1

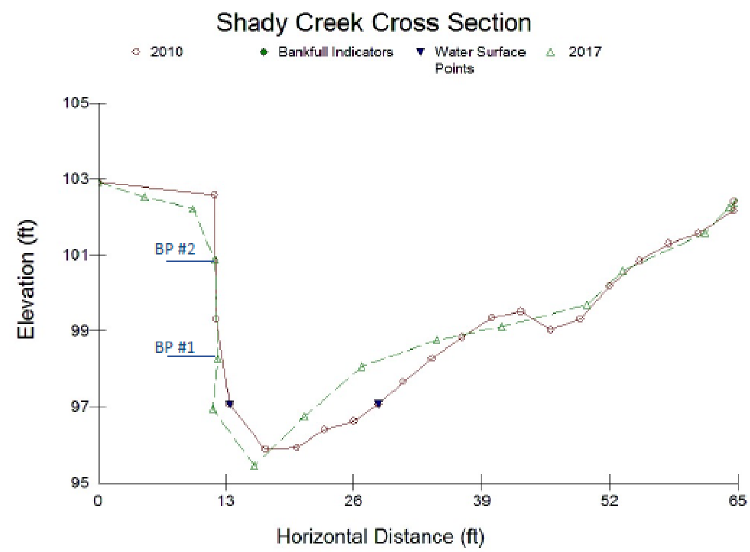
District: Butler County Conservation District
Section 25, Township 25, Range 6 East

Field Office:
El Dorado Service Center
Agency: USDA - NRCS
Assisted By: S Koontz
Date: 2015 Photo



Shady Creek (2010 Photo)

Shady Creek (2017 Photo)

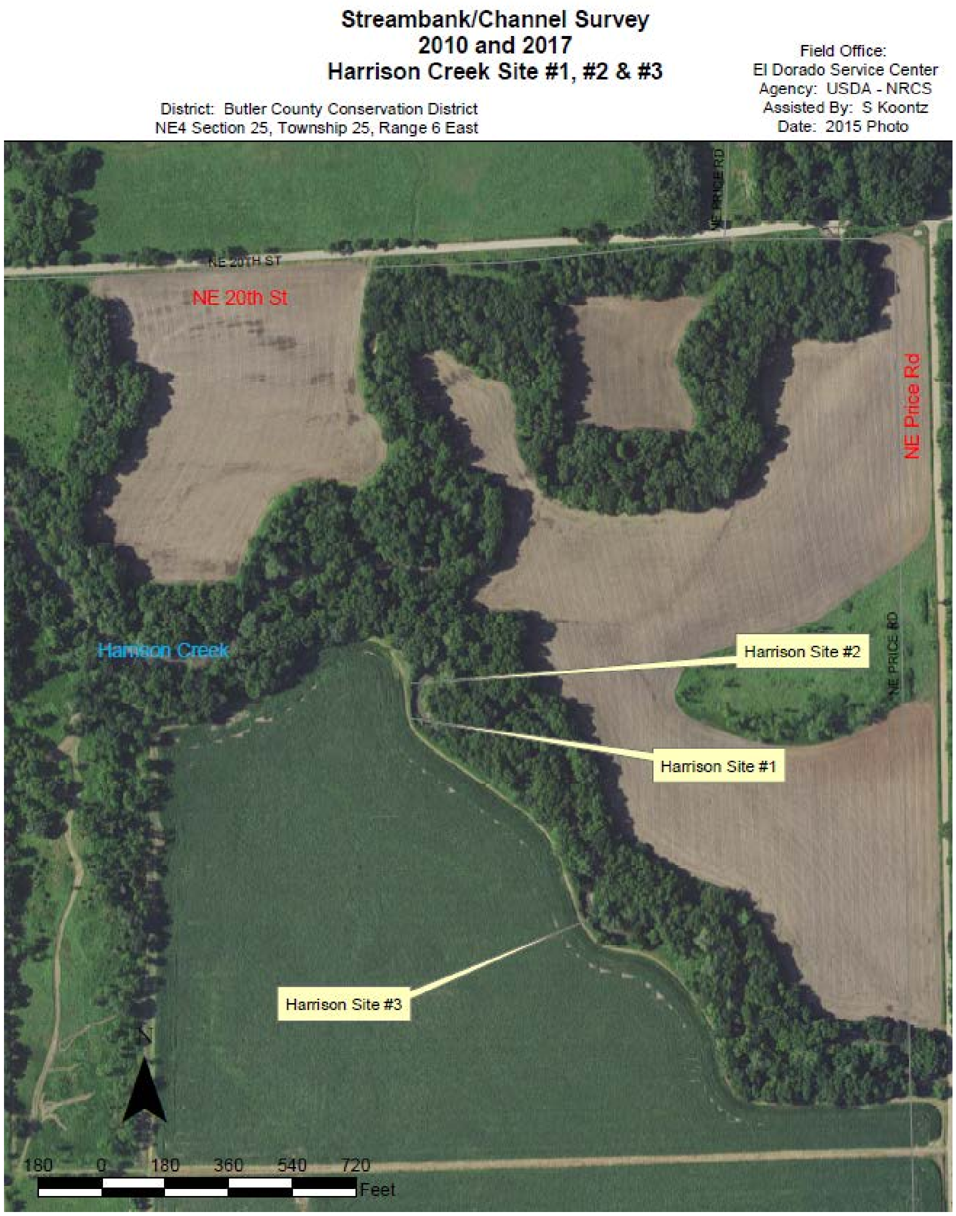


Change in Cross Sectional Area = -8.52 sq. ft. (deposition)
Bank Pin #1: 1.68' Exposed
BP #2: 2.25' Exposed

Wildhorse Riverworks Inc.	Shady Creek Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-11-17 Checked by: PGB Date: 4-11-17

In general, at Shady Creek's cross section, the survey showed 8.52 square feet (2,360 pounds or 1.2 Ton) of deposition (sediment gained) from 2010 to 2017; the lower bank pin was exposed by 1.68 feet and the upper bank pin was exposed 2.25 feet. Deposition is a naturally occurring process and is to be expected during high flows. Visual observation from 2010 and 2017 showed gravel shifting from one part of the stream to the other and depositing in different places. The stream channel was much wider in 2010 than it was in 2017 (narrower stream channel = more velocity). A deeper channel indicates channel incision and stream bed erosion. More gravel and gravel piled higher on the non-eroding side of the stream bank was observed. The gravel bar deposition or lateral increase normally follows bank erosion. Once the lateral migration (bank erosion) slows, the bar may increase in height. The increase in gravel bar height may be due to excess sediment from upstream, loss of stream power (velocity) in this area due to wider stream channel, or other factors.

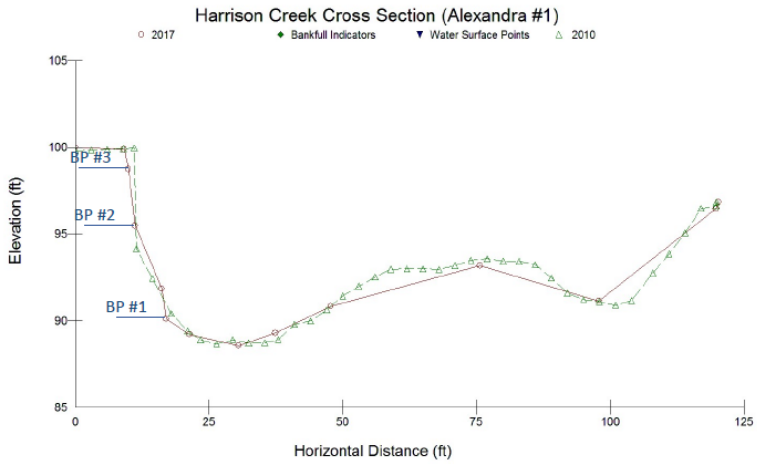
Harrison Creek (Simpson) sub-basin is located north of Shady Creek. According to the SWAT model, the lower part is high priority with a high priority stream reach on the lower 5 miles to El Dorado Lake. Three different sites were surveyed on the lower reach of Harrison Creek. The land use around the 3 sites located in the lower part of the sub-basin is row crop farming. The riparian area is 30 feet or less at the survey sites and the trees have been lost in the area where the surveys were done. The riparian area in general is wider than 30 feet in most areas on this landowner's property. The soil type is Verdigris silt loam, 0-1% slope, occasionally flooded. The stream banks on these sites are 12 feet to 18 feet in height.



Harrison Creek Simpson Site (2017 Photo)
Notice conventional tilled land adjacent to the buffer along the stream.

Harrison Creek (Simpson) Sites #1 and #2 (2010 Photo)


Harrison Creek (Simpson) Sites #1 and #2 (2017 Photo)



<u>Change in Cross Sectional Area</u> = 17.74 sq. ft. (erosion)
<u>Bank Pin #1</u>: 3.50’ Exposed
<u>BP #2</u>: 0.35’ Exposed
<u>BP #3</u>: 1.55’ Exposed

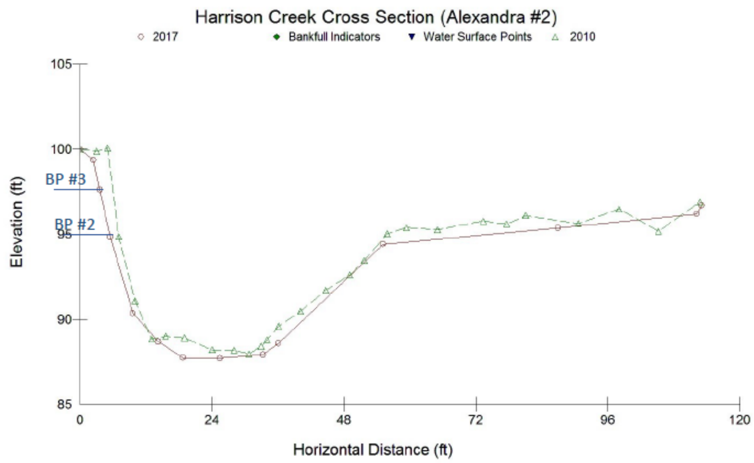
Wildhorse Riverworks Inc.	Harrison Creek (Alexandra #1) Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-24-17 Checked by: PGB Date: 4-24-17

The Harrison Creek (Simpson) Sites #1 and #2 were adjacent to each other on the same eroding stream bank; Site #1 was upstream of Site #2 but within 50 feet of each other. On Site #1, rebar was all exposed to some extent while on Site #2 the bottom rebar was buried. Visual observation showed further upstream the bank had sloughed off but vegetation was growing on the bank that had collapsed.

Harrison Creek (White/Simpson) #1 and #2 (2017 Photo)

Compared to 2010, the stream bank had more slope to it in 2017; in 2010, ladders had to be used to get down to the water. The cross section at Site #1 reveals sediment loss and deposition from the stream bank as well as the stream channel. Soil lost at this cross section = 17.74 square feet (7,098 pounds or 3.5 tons) of sediment lost at this site. The width of the channel changed very little from 2010 to 2017.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (84 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 294 tons or 0.5 tons/ft. of bank/year.

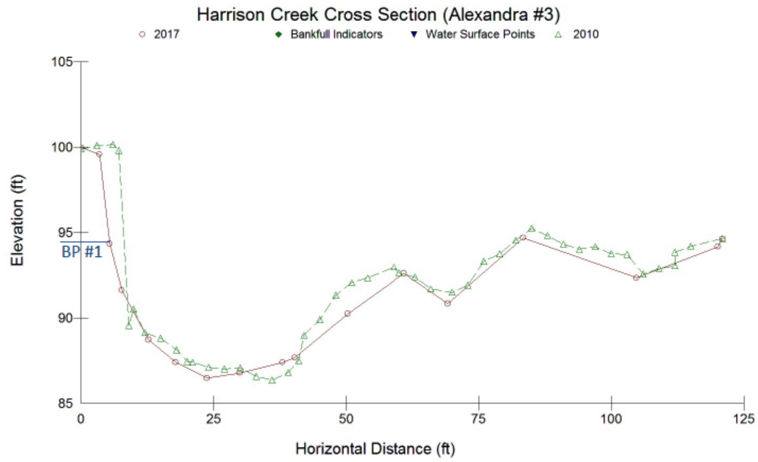


Change in Cross Sectional Area = 59.95 sq. ft. (erosion)
Bank Pin #1: 2.05’ Exposed
BP #2: 1.25’ Exposed
BP #3: Buried

Wildhorse Riverworks Inc.	Harrison Creek (Alexandra #2) Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-24-17 Checked by: PGB Date: 4-24-17

The Harrison Creek (Simpson) Site #2 was adjacent and downstream of Site #1 on the same eroding stream bank. On Site #2, the bottom rebar was buried but the top two rebar pins were exposed. In 2010 the bank was vertical; in 2017, there was more of a slope to the bank; however not as much slope as at Site #1. The cross section at Site #2 reveals sediment loss and deposition from the stream bank as well as the stream channel. Soil lost at this cross section = 59.95 square feet (44,097 pounds or 22 tons) of sediment lost at this site. The width of the channel changed very little from 2010 to 2017.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (119 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 2,618 tons or 3.1 tons/ft. of bank/year.



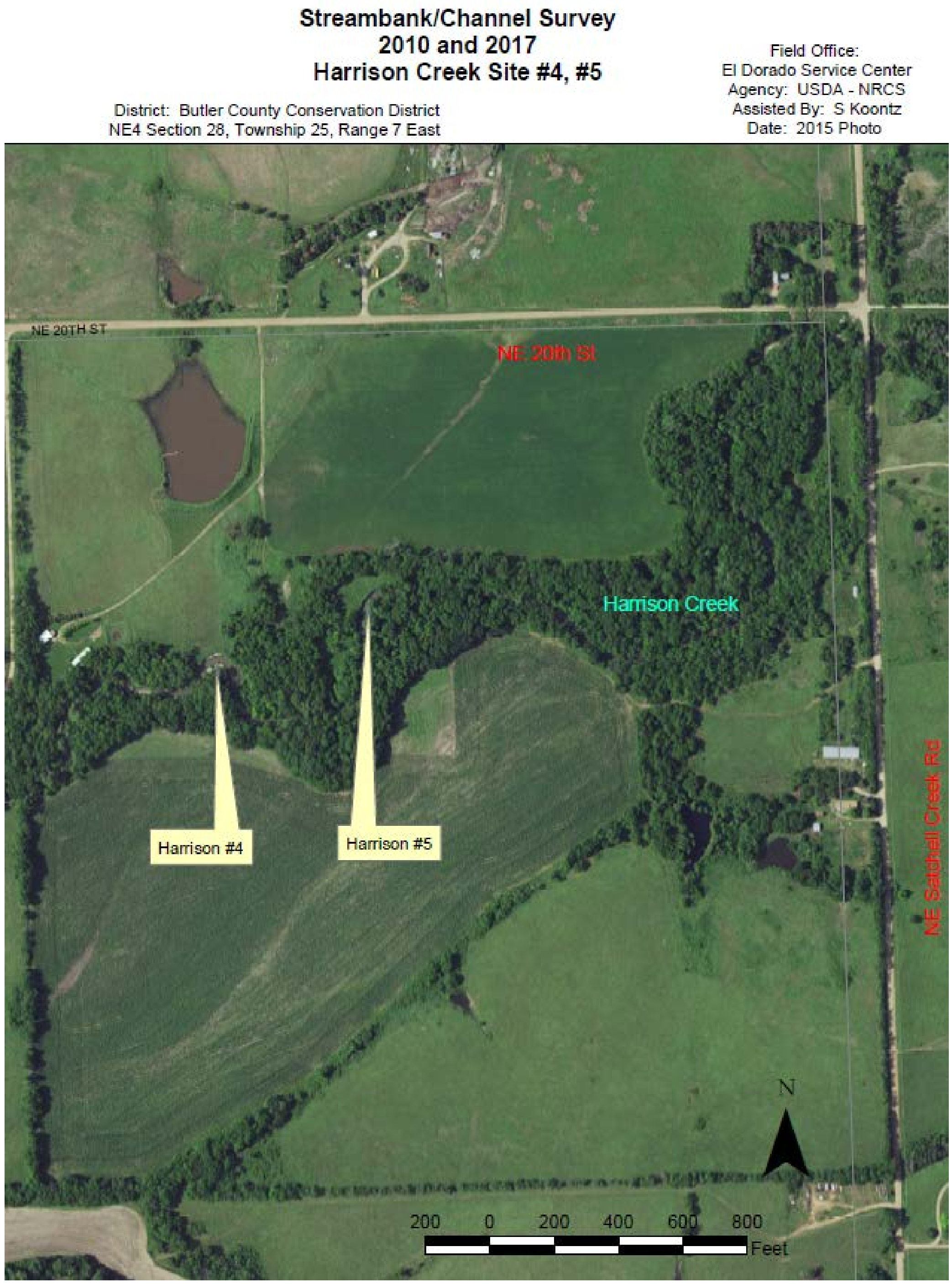
Change in Cross Sectional Area = 75.99 sq. ft. (erosion)
Bank Pin #1: 2.10' Exposed
BP #2: Buried
BP #3: Buried

Wildhorse Riverworks Inc.	Harrison Creek (Alexandra #3) Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-24-17 Checked by: PGB Date: 4-24-17

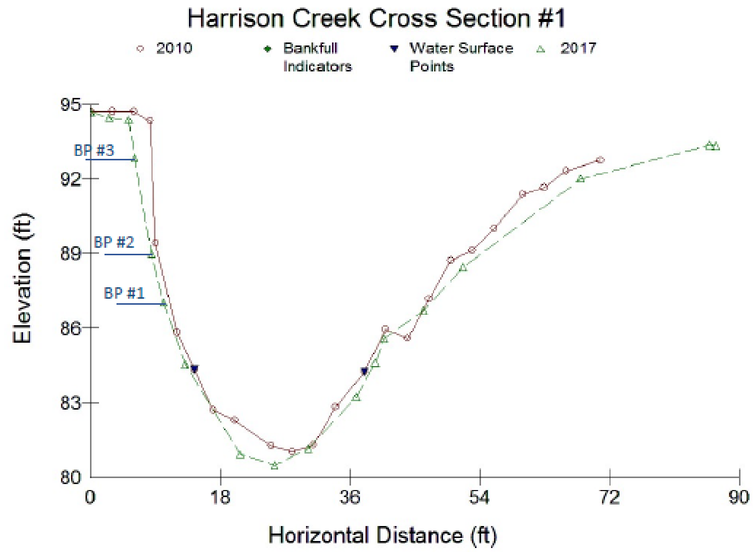
The Harrison Creek (Simpson) Site #3 showed similar erosion as compared to Simpson Sites #1 and #2 as well as the Moore Sites #1 and #2 (discussed later in this report). On this site, the top of the bank sloughed off and buried the rebar closest to the water line. The cross section reveals sediment loss from the stream bank as well as the stream channel. Soil lost at this cross section = 75.99 square feet (62,930 pounds or 31.5 tons) of sediment lost at this site. The width of the channel changed very little from 2010 to 2017.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (253 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 7,970 tons or 4.5 tons/ft. of bank/year.

Harrison Creek (Moore) sub-basin is located north of Shady Creek sub-basin. According to the SWAT model, the upper part of this sub-basin is part low priority and part no priority. Two sites were surveyed in the low priority area. In the upper reach, the soil type is Verdigris, frequently flooded. Land use adjacent to these two sites is brome but directly upstream of the sites the land use is row crop. The trees have been lost in the area where the surveys were done. The riparian area is generally 80-100 feet wide in areas on this landowner's property except for the two survey sites. The stream banks on these sites are 12 feet to 15 feet in height.



Harrison Creek (Moore) Upstream Site #5 (2010 Photo)



Change in Cross Sectional Area = +65.07 sq. ft. (erosion)
Bank Pin #1: 1.80' Exposed
BP #2: 0.95' Exposed
BP #3: 1.60' Exposed

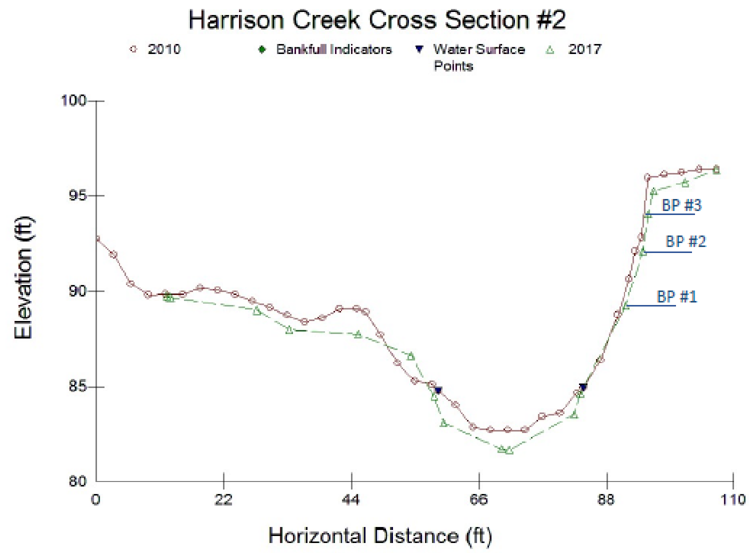
Wildhorse Riverworks Inc.	Harrison Creek Cross Section #1 Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-11-17 Checked by: PGB Date: 4-11-17

Harrison Creek Site #5 Upstream Site

The Harrison Creek (Moore) upstream site had a lot of deposition occur on the left bank or inside bend, based on visual observation. The stream bank pins (rebar) showed that the brome grass was holding the top of the bank; however, the bottom pin was exposed more so than the top pin which indicates as rainfall saturates the top of the bank and as additional flooding occurs, the top of the bank will eventually fall into the creek and be lost as sediment. This is evidenced by the jagged look of the top of bank as clumps of brome and soil give way. The cross section reveals sediment loss from the stream bank as well as the stream channel. Soil lost at this cross section = 65.07 square feet (49,864 pounds or 25 tons) of sediment lost at this site. The width of the channel changed very little from 2010 to 2017.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (185.1 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 4,628 tons or 3.57 tons/ft. of bank/year.

Harrison Creek (Moore) Downstream Site #4 (2010 Photo)



<u>Change in Cross Sectional Area</u> = +41.68 sq. ft. (erosion)
<u>Bank Pin #1</u>: 1.55' Exposed
<u>BP #2</u>: 1.75' Exposed
<u>BP #3</u>: 1.70' Exposed

Wildhorse Riverworks Inc.	Harrison Creek Cross Section #2 Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-11-17 Checked by: PGB Date: 4-11-17

Harrison Creek Downstream Site #4

The Harrison Creek (Moore) downstream site also showed a lot of deposition through the reach of the cross section on the inside bend similar to the upstream site. From visual observation, it didn't appear the site had lost as much of the stream bank as the upstream site. There was more gravel in the bank below the rebar; gravel may have helped protect the bank from erosion. The change in the cross section was 41.68 square feet (25,573 pounds or 12.8 ton) of sediment lost at this site. This was also verified by the rebar; less rebar exposed. The stream in 2017 appeared much as it had in 2010.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (129 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 1,651 tons or 1.83 tons/ft. of bank/year.

The **Walnut River** is the largest of the sub-basins above El Dorado Lake. We surveyed a site that was roughly 3 miles from the upper reaches of the Lake. The site was in a medium priority area as based on the SWAT model as well as considered a high priority stream. The soil type is Verdigris silt loam, 0-1% slope, occasionally flooded. The land use above the survey site is farmed, mainly row crop. There are no trees remaining at the survey site but generally the riparian area throughout this landowner's property ranges from 45-100 feet wide. The stream bank on this site is 12 feet to 15 feet in height.

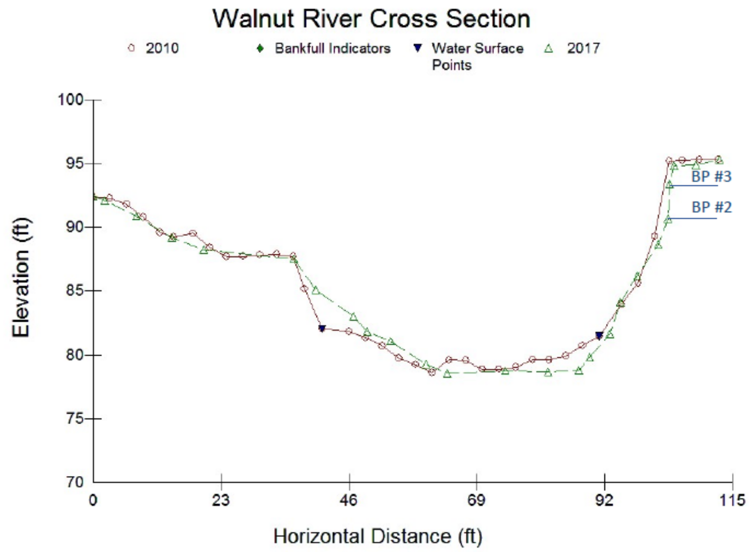
Streambank/Channel Survey
2010 and 2017
Walnut River Site #1

District: Butler County Conservation District
SE4 Section 2, Township 24, Range 6 East

Field Office:
El Dorado Service Center
Agency: USDA - NRCS
Assisted By: S Koontz
Date: 2015 Photo

Walnut River (2010 Photo)

Walnut River (2017 Photo)



Change in Cross Sectional Area = 10.85 sq. ft. (erosion)
Bank Pin #1: Buried
BP #2: 0.83' Exposed
BP #3: 1.54' Exposed

Note: 2010 elevation points from Sta. 0+41 to 1+01 were adjusted up by 3.99 feet due to "double-sticking" error.

Wildhorse Riverworks Inc.	Walnut River Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-27-17 Checked by: PGB Date: 4-27-17

At this site, the visual observation was that in 2010, there was a large log jam just upstream from the cross section; in 2017, the log jam had re-adjusted/moved. In 2010, one of the trees in the log jam had a lot of branches and was helping to protect the bank, in 2017 that large tree was gone but part of the log jam was still intact, it but (before) it wasn't as effective in protecting the stream bank. At the cross section, the top of the stream bank had a large overhang from the top of bank to the first pin. The bank sloughed off in a large chunk and landed about half way down the stream bank covering the bottom bank pin. It was also observed that the gravel bar on the far bank was bigger and longer upstream and downstream of the cross section in 2017. This is most likely also contributing to the change in flow of the stream-diverting the water during higher flows towards the eroding stream bank. The cross section shows that 10.85 square feet (3,395 pounds or 1.70 tons) of sediment was lost at this site.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the sediment loss along the entire length of eroding stream bank (218.1 feet in length) at this one site, based on 7 years of time elapsed from 2010 to 2017, the amount of soil lost would be 371 tons or 0.24 tons per foot per year.

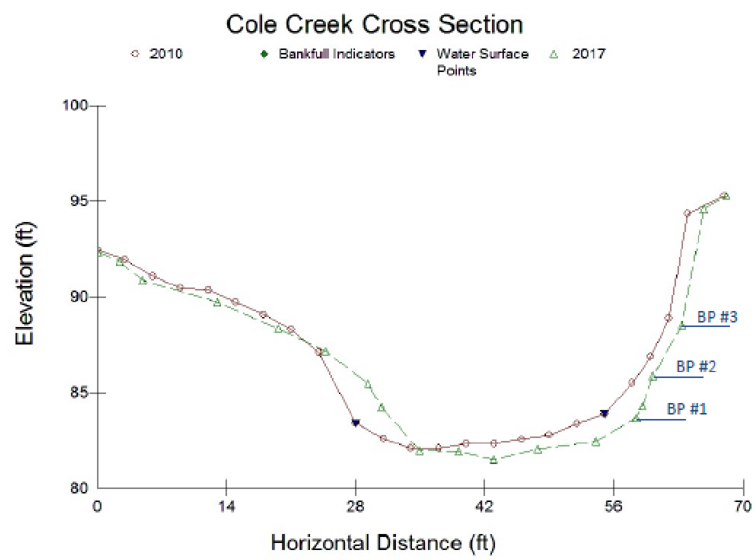
Walnut River (note log jam and gravel bar) (2017 Photo)

Cole Creek sub-basin is on the western-most side of the El Dorado Lake Watershed. The site used for the survey is located in a high priority area as per the SWAT model and is also considered a high priority stream in this area. The site is about 3.5 miles from the upper reaches of El Dorado Lake. The soil type is Verdigris silt loam, 0-1% slope, occasionally flooded. Land use surrounding this site is row crop; however, the landowner is an avid hunter/sportsman and has established grass buffers and food plots all along his property adjacent to the riparian areas. Riparian area widths range from 40 feet to over 140 feet in places. The survey site still has trees along the bank, but erosion is occurring and some trees have been lost. The site is on a sharp bend in the stream. The stream bank on this site is around 15 feet in height.

Streambank/Channel Survey
2010 and 2017
Cole CreekSite #1

District: Butler County Conservation District
NE4 Section 4, Township 24, Range 6 East

Field Office:
El Dorado Service Center
Agency: USDA - NRCS
Assisted By: S Koontz
Date: 2015 Photo



Change in Cross Sectional Area = +26.75 sq. ft. (erosion)
Bank Pin #1: 1.78' Exposed
BP #2: 0.84 Exposed
BP #3: 1.30' Exposed

Wildhorse Riverworks Inc.	Cole Creek Cross Section Butler County, Kansas 2010 – 2017	Drawn by: KAB Date: 4-11-17 Checked by: PGB Date: 4-11-17

While erosion is evident at the Cole Creek site, large trees and shrubs are still holding in place and preventing large losses of sediment. A gravel shelf is evident at the water line and may be the reason the bank pin at the water line was exposed by 1.78', undercutting this area first. Tree roots are helping to stabilize the upper part of the stream bank in the area upstream and downstream of this cross section. Deposition occurred on the inside bend but erosion was evident as seen by the cross section data and exposed rebar on the right stream bank. In all, 26.75 square feet (13,133 pounds or 6.6 tons) of sediment lost was calculated at this cross section.

The cross section survey is just a snapshot of what is occurring along the entire horizontal length of the stream where we see active stream bank erosion. If you were to calculate the soil lost for the entire length of eroding streambank (203.1 feet), the amount is equal to 1,340 tons or 0.94 tons per foot per year.

Summary

All sites showed signs of stream bank erosion between 2010 and 2017. Stream channel erosion was more variable as sediment and gravel are constantly moving and changing as they make their way down stream, depositing in some places and scouring in other places. Cross sections did show stream channel erosion on all or parts of each stream channel. The amount of sediment lost from stream banks/channels is significant in that where stream bank erosion is occurring, the length of the stream bank affected is usually 80 to 100 feet or more meaning tons of sediment can be lost in a large flood event or a series of flood events. With a recurring drought for over half the study period, it is not known whether the lack of soil moisture played a part in the amount of soil lost when flood events did occur; as the soil dried out along the streambanks, would that cause more soil to be lost due to the looseness of the soil and then as saturation occurred, additional soil would be lost?

Visual observation of these sites over the study period tends to show that log jams and gravel bars/deposits can impact the severity of the erosion on the stream bank due to water diversion (water flow redirected at the stream bank due to log jams, trees or brush collecting in an area and in some cases protecting the stream bank but in other cases causing additional stream bank erosion because water would get behind the logs or brush and erode away). Most of the sites were planted to brome along the erosion area. These areas tended to scour below the brome root zone undercutting the bank and then eventually clumps of brome and soil would fall in the stream as well. The two sites where trees were still prevalent (Shady Creek and Cole Creek) chunks of soil falling in were not observed unless a tree was washed out. Brome filters are beneficial in helping to protect the stream bank but trees and shrubs are most efficient and more able to provide the stabilization needed to protect the stream bank.

Maintenance is usually not discussed much when talking about streams; however, there would be some benefit to landowners to walk their streams on a regular basis, observe gravel bar movement, log jams and watch for signs of stream bank erosion. In areas where large trees leaning over the stream are in jeopardy of falling into the stream, roots and all, maybe cutting the tree down to take the pressure off the roots thereby allowing the root ball to stay intact might reduce the amount of sediment lost. Some of those leaning trees could be cabled to other trees to keep them along the bank when they fall. If maintenance such as this was done, some of these issues may be able to be controlled or slowed and would possibly lower the cost of expensive fixes such as rock vanes and other structural measures.

Special Thanks:

- Landowners who allowed us to survey in 2010 and 2017:
    - Tim Donges
    - Gail Vogelman
    - JCS Partnership
    - Dale and Marilyn Moore
    - Gene White
    - Alexandra Simpson
- Phil Balch and Kari Bigham, Wildhorse Riverworks
- Survey assistants/volunteers –
    - Isaac Broeckelman, WRAPS Coordinator, Grouse, Silver, Timber Creek WRAPS
    - Kim Austin
    - Steve Koontz, Hayley Koontz
    - Dr. Bill Langley
    - Friends University Master of Science Environmental Studies Program Students (2010)
    - Dane Baxa, Waterlink (2010)