AERIAL ASSESSMENT OF DUTCHMAN CREEK
JOHNSON COUNTY, IL
December, 2004

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Illinois EPA has listed segment ADD02 of Dutchman Creek Watershed as impaired based on the 1998 303(d) list. This segment is approximately 14.8 miles long and contains Dutchman Lake; a 118 acre flood control structure located approximately 5 miles below the watershed divide. Dutchman Lake is a PL-566 flood control structure built by the USDA Soil Conservation Service in 1970 and is now owned by the US Forest Service as part of the Shawnee National Forest.

The Executive Summary for Dutchman Creek Watershed TMDL (Final Draft) lists Dissolved Oxygen (DO) as the TMDL criteria of concern with the major sources being phosphorus loading from agricultural land and internal cycling in Dutchman Lake, plus stagnant stream conditions and elevated instream temperatures in Dutchman Creek. “A correlation between DO and total phosphorus was established for Dutchman Lake, and modeling demonstrates a reduction of 53 percent total phosphorus necessary so that DO water quality standards can be achieved.

Primary sources of phosphorus loading to Dutchman Lake include internal cycling from the lake-bottom sediments and runoff from agricultural lands. Procedures outlined in the implementation plan to decrease phosphorus loading to the lake include in-lake measures as well as measures applied to the watershed to control nutrients in surface and eroded sediment.

In-lake mitigation practices include dredging the lake bottom and aerating the lake to eliminate internal cycling. Watershed controls include filter strips and wetlands to prevent phosphorus in surface runoff from reaching the lake, conservation tillage to decrease nutrient-rich soil erosion from agricultural fields, and development of nutrient management plans to ensure that excess phosphorus is not applied to agricultural fields.

“The TMDL analysis for DO in Dutchman Creek segment ADD02 was made through investigation of the relationship between DO, total organic carbon (TOC), 5-day biochemical oxygen demand (BOD5), and re-aeration in the creek. The likely source of DO impairments in the segment is primarily a lack of aeration caused by stagnant stream conditions and elevated instream temperatures. BOD loadings in runoff from nonpoint source loads may also contribute to DO impairments.

However, examination of BOD in the stream segment showed that the concentrations of BOD are low and likely represent ambient conditions in the stream; therefore, reductions in BOD concentrations are not recommended at this time. Due to data limitations and technical considerations of implementation difficulties, a load allocation cannot be developed for re-aeration or temperature, so allocations were not developed for segment ADD02.

Procedures to alleviate low DO caused by stagnant flows can be addressed with in-stream mitigation methods such as re-aeration. Additionally, riparian buffer strips aid in decreasing instream temperatures, which could help to alleviate the DO impairment. Excess nutrients can cause excessive algal growth that can also deplete DO in streams.

However, analytical tools were not used to assess nutrients, algae, and DO as no algal data was available for Dutchman Creek segment ADD02. Methods to control nutrients were still included in the implementation plan such as buffer strips along the stream banks, which are similar to filter strips in their ability to remove nutrients from surface runoff.

The potential contributions to BOD from nonpoint source loads are attributed to agricultural land uses requiring mitigation methods to control nutrients in sediment erosion and surface runoff from the land contributing to segment ADD02. These methods include filter strips, wetlands, conservation tillage, and nutrient management plans as discussed above." (1)

Assessment Procedure

Low level geo-referenced video was taken of Dutchman Creek in April, 2004. Video taping was completed by Fostaire Helicopters in Sauget, Illinois, using a camera mounted beneath a helicopter to record data from just above tree top level in DVD format for further evaluation and assessment. Video began below segment ADD02 at the confluence of Dutchman Creek and the Cache River and proceeded up the main channel until the stream size and vegetative cover prevented capture of useful video images. Aerial video of tributaries was not part of the project, regardless of the stream size or vegetation.

After videotaping the stream, the DVD tapes were processed by USGS to produce a geo-referenced DVD showing flight data and location. Next, USGS identified features from the video and created shapefiles containing the GPS location, type of feature identified, and the time on the DVD to allow cross referencing. The shape-files along with the DVD were used to identify and locate the points where ground investigations were needed to verify aerial assessment assumptions and gather additional data.

The ground investigation or "ground truthing" provides those viewing videos the opportunity to verify the interpretation and assumptions made by viewing the video. Furthermore, the investigation of specific segments of the stream is needed to collect field data for developing a good assessment of the stream.

Since survey data was not available, the slope data was calculated from USGS topo maps by measuring the channel length between contour lines. The report refers to this as “valley profile” although a true valley profile would use a straight-line distance down the floodplain rather than channel length.

This method is used because it incorporates sinuosity into the calculation and allows the channel slope to be assumed equal to “valley slope” in order to estimate channel capacity, velocity, etc. However, there are short segments near roads, logjams and knickpoints where the channel slope may differ significantly.

The DVD has been divided into “chapters” of approximately five minutes of video to enhance the ability to navigate within the flight video and provide a simple way to identify and discuss different stream segments. Although the report will begin with a broader, more general assessment of the entire study, it will also provide an assessment and treatment recommendations for each chapter.

The chapter divisions are clearly arbitrary and do not reflect “change points” in the stream characteristics or treatment recommendations. Conclusions and recommendations are presented for stream segments that are intended to assist in reaching the goal of reducing the phosphorus loads to Dutchman Lake and increasing the DO concentrations in the Dutchman Creek segment ADD02. The report will begin with a broader, more general assessment of the entire study reach.

General Observations from Assessment

There is a significant difference in the character of Dutchman Creek above Dutchman Lake as compared to Dutchman Creek below Dutchman Lake. First, the valley slope in Dutchman Creek reduces from 45 ft./mile immediately above Dutchman Lake to less than 5 ft./mile below the Lake. (Fig. 1)

Second, above Dutchman Lake the channel bed has multiple locations of bedrock exposure with small overfalls and a significant amount of cobble providing channel roughness and turbulence that should increase aeration. The reduction in slope below the lake contributes to the slow moving stagnant water in the creek that is low in dissolved oxygen. Outside of a couple of isolated points where cobble size material will create aeration, the channel roughness only increases around woody debris in the channel.

Figure 2 on the next page shows the location of the DVD Chapter Divisions along the valley profile. Each Chapter consists of five minutes of video.

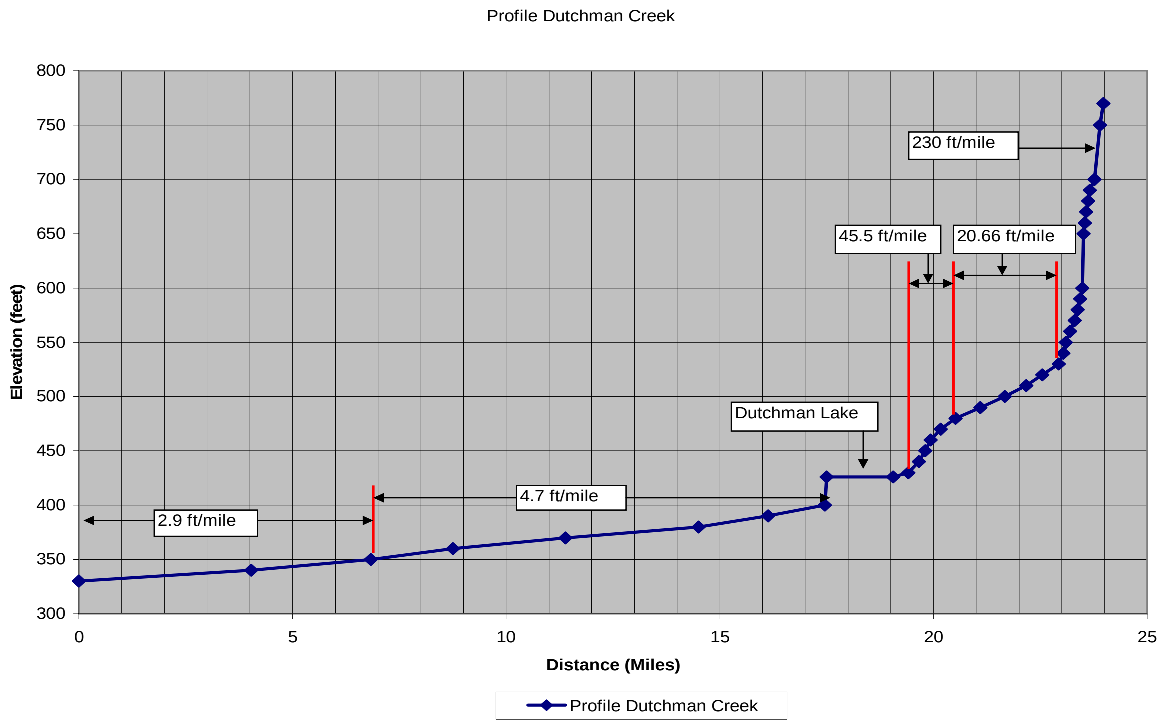


Figure 1. Valley Slope along Dutchman Creek from USGS Topographic Maps

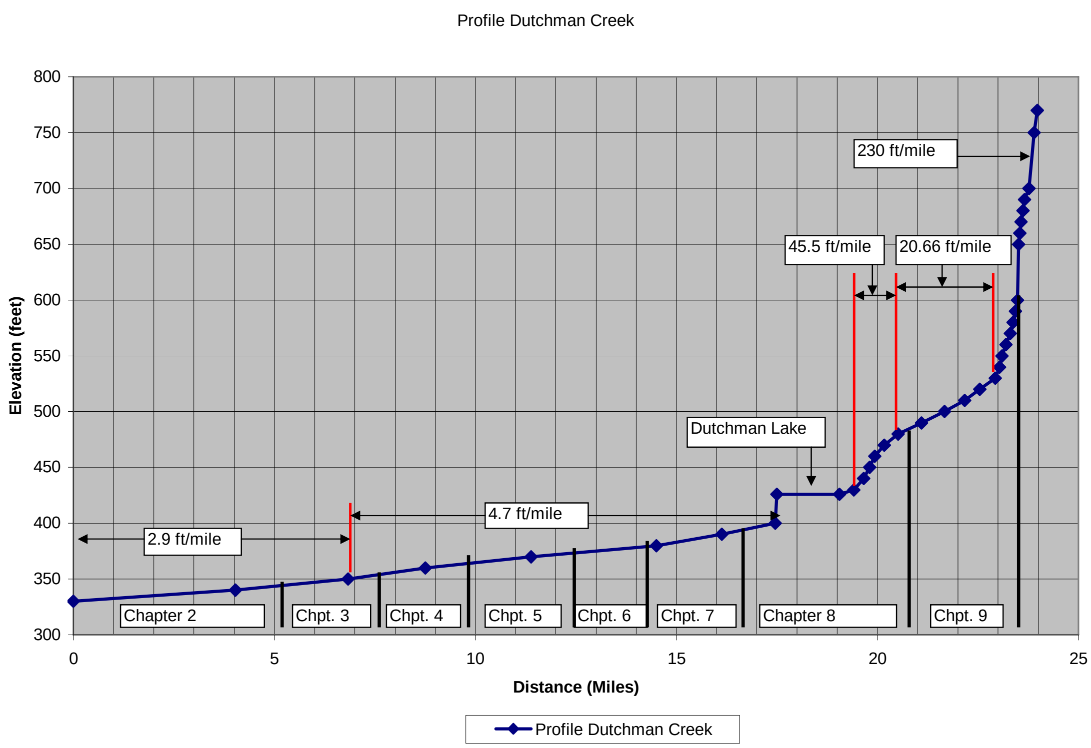


Figure 2. DVD Chapter Divisions along Valley Profile

Using the video to select appropriate locations to gather cross sections that would best represent Dutchman Creek, a total of nine cross section locations have been completed and analyzed. The locations are shown in Figure 3.

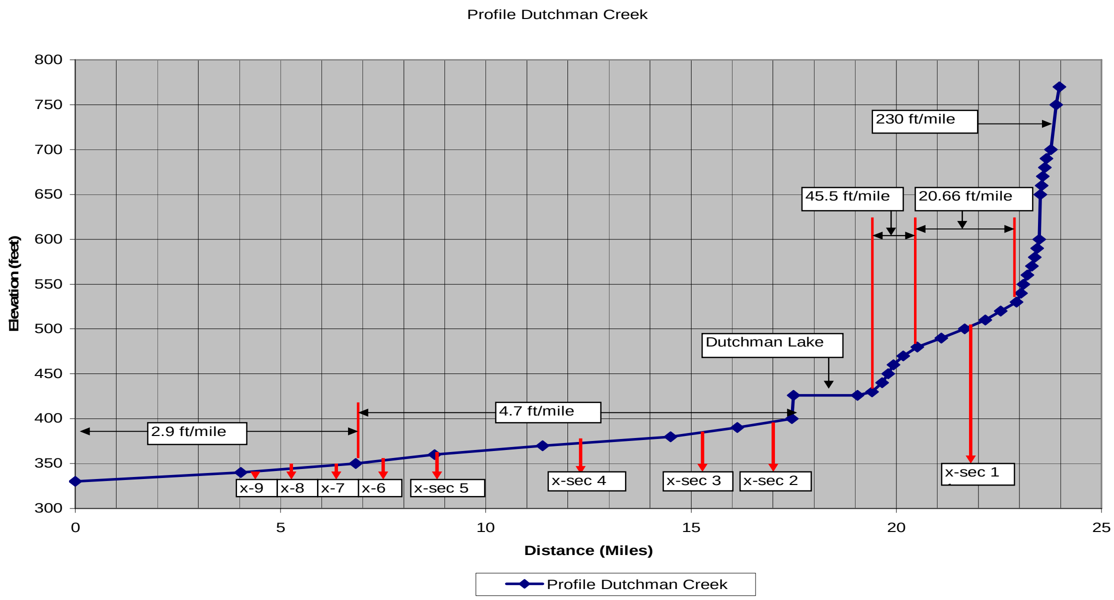


Figure3

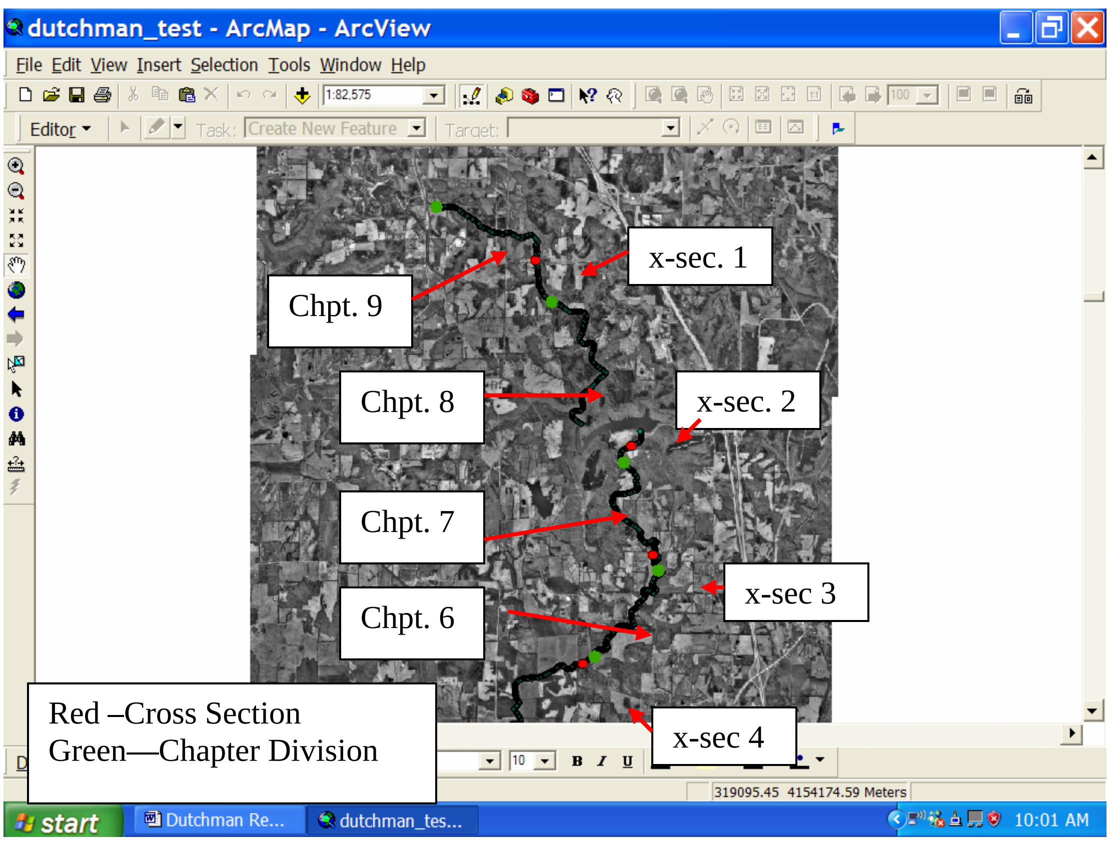


Fig. 4 Location of Cross Sections and Chapter Divisions (Upper Dutchman)

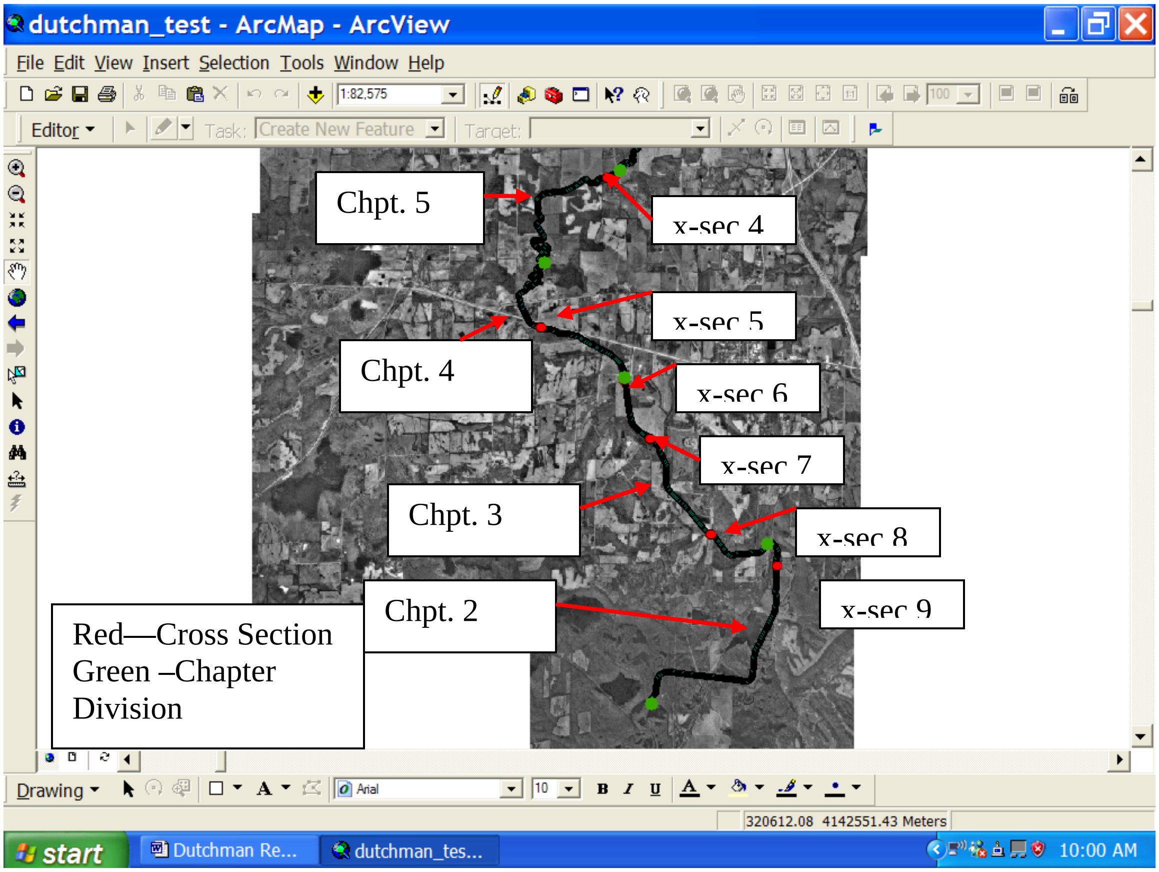


Fig. 5 Location of Cross Sections and Chapter Division (Lower Dutchman)

A summary of the data analysis is presented in Table 1 and the completed data sheets are included in Appendix A.

DUTCHMAN CREEK

Table 1. Cross Section Data from NRCS Streambank Inventory and Evaluation Procedures

X-Sec	Easting	Northing	ADA Sq. Mi.	Valley Slope ft./mi.	Q2 CFS	Bankfull CFS	Width (BKF) ft.	Mean Depth Ft.	W/D	Velocity Ft./sec.	Bedload In. Dia.	CEM (Simon)
1	328550	4154469	2.22	60	769	250	36	1.91	18.8	3.6	6	6
2	330502	4150698	10.87	23.5	929	227	44	2.51	17.73	2.1	2	4
3	330948	4148504	12.06	20.3	939	425	34	4.14	8.2	3	2	4
4	329509	4146292	15.62	17.4	1070	546	46	4.85	9.5	2.4	2	4
5	328210	4143386	26.39	10.8	1290	833	48	5.8	8.2	3	1	5
6	329826	4142354	28.82	10.8	1383	1012	43	6.35	6.8	3.7	1	3
7	330337	4141226	29.95	10.1	1378	1061	42	6.62	6.3	3.8	1	3
8	331506	4139358	69.07	9.8	2629	1711	61	6.84	8.9	4.1	1	4
9	332806	4138749	73.47	9.1	2662	1726	76	6.87	11.1	3.3	4	4

Table 1

Table 1. Summary of Cross Section Data from Dutchman Creek

In addition to the data collected for the NRCS Streambank Inventory & Evaluation (I&E), data was collected to compare the Total Depth at top bank (Td) and the Maximum Depth (Md) at bankfull discharge. (Fig. 6)

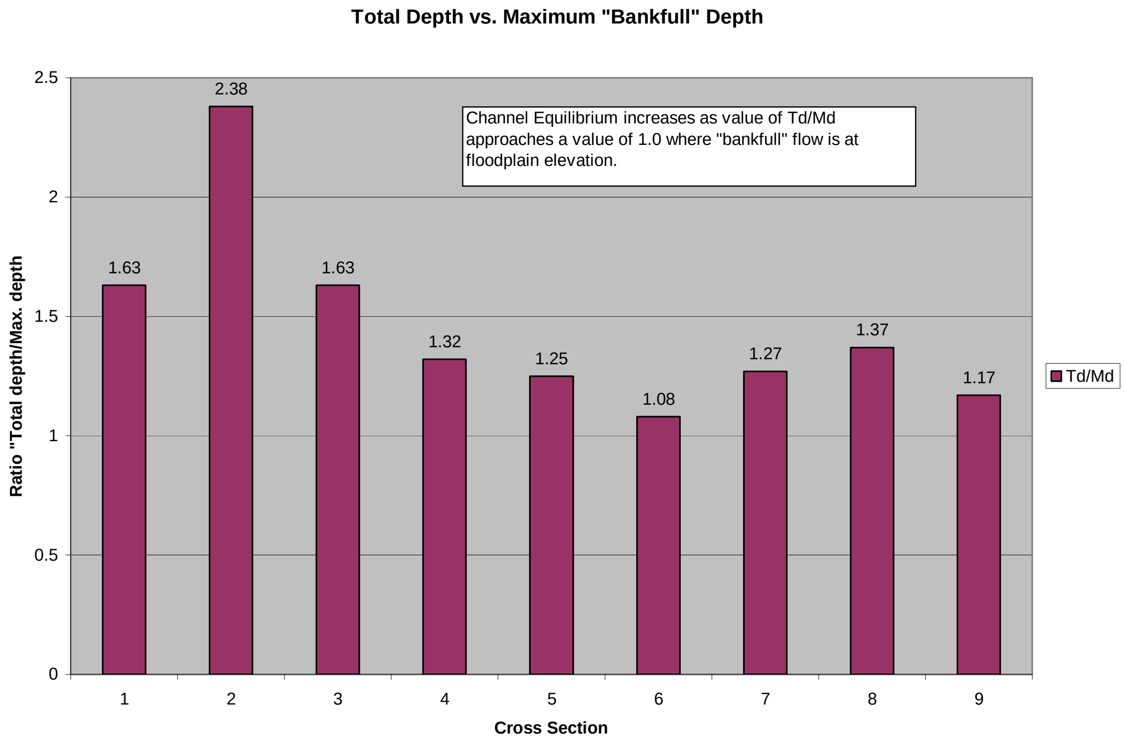


Figure 6. Total Depth at Top Bank compared to Maximum “Bankfull” Depth

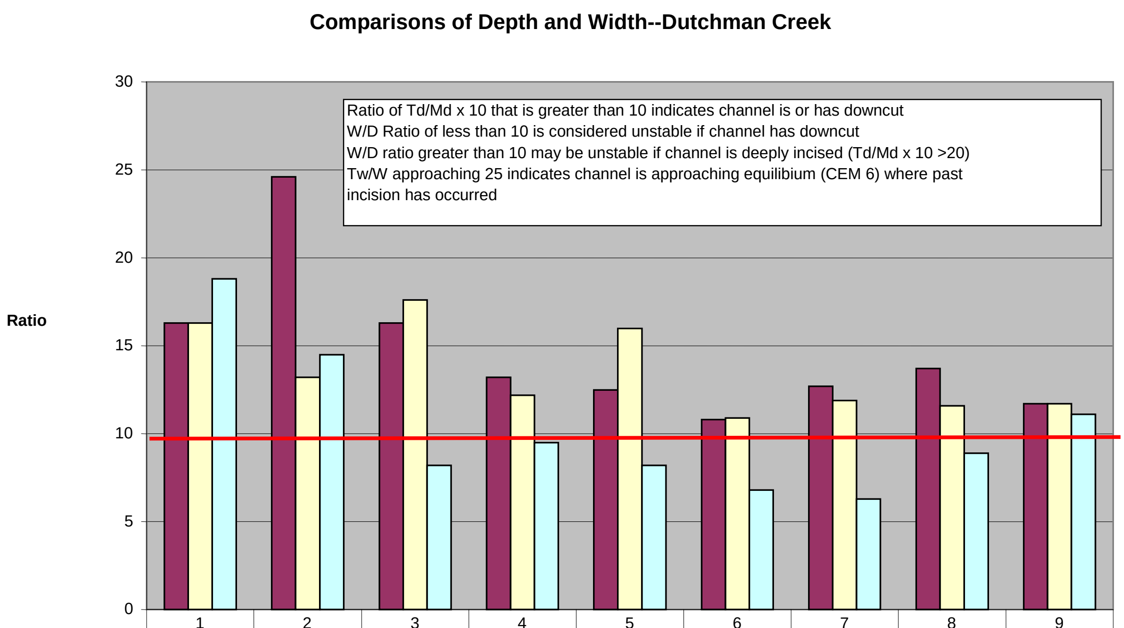
This comparison estimates past incision and the degree of separation from the floodplain and therefore is a good indicator in incised streams of the total amount of channel adjustment needed before reaching a new state of quasi-equilibrium (CEM 6). This comparison has an advantage over the Entrenchment Ratio used by Rosgen, Wildlands Hydrology, and adopted by NRCS since it estimates actual past incision where the floodplain is found at less than two times the Maximum Bankfull depth. This recognition is important, as degradation and channel incision are major problems long before reaching the threshold for measurement under the Entrenchment Ratio calculation.

Figure 6 shows the greatest incision, at 2.38 times bankfull depth occurs at Cross Section 2. It reduces at subsequent sections downstream to a value of 1.08 times bankfull until reaching Sections 7 and 8 where the incision increases somewhat to 1.27 and 1.37 respectively, before it reduces to 1.17 at Section 9.

Figure 7 shows a comparison of three channel dimension measurements. First is the Total Depth (Td)/Maximum Bankfull Depth (Md) using a multiplier of ten to make the graph more readable. Second is a measurement of Top Width(Tw) at Total Depth compared to Width at bankfull depth(W), again using a multiplier of ten. Third is a ratio of Width at bankfull depth to the "mean" Depth at bankfull flow(D). These three measurements taken together can be used to gain a clearer understanding of where each cross section is in relation to the Channel Evolution Model (CEM).

Although there is insufficient data analysis to assign a CEM stage to this combination of measurements, the following observations can be made. First, values of Td/Md greater than 10 indicate the channel has downcut, with higher values indicating more downcutting and increased separation from the floodplain.

Second, W/D ratios of less than 10 indicates the channel should be considered unstable and widening if the value of Td/Md indicates downcutting has occurred. W/D ratios of more than 10 may also be widening if Td/Md indicates that downcutting has been severe (W/D ratio greater than 20). Third, the Tw/W value indicates the amount of "floodplain" development that has occurred as the channel adjusts to past downcutting. A value of 25, meaning the active floodplain is 2.5 times the bankfull width has been suggested as approaching equilibrium (CEM stage 6).



	1	2	3	4	5	6	7	8	9
Td/Md x 10	16.3	24.6	16.3	13.2	12.5	10.8	12.7	13.7	11.7
Tw/W (x10)	16.3	13.2	17.6	12.2	16	10.9	11.9	11.6	11.7
W/D	18.8	14.5	8.2	9.5	8.2	6.8	6.3	8.9	11.1

Cross Section

Figure 7. Comparisons of Depth and Width Computations on Dutchman Creek at Cross Section Locations

The threshold value of incision measured by Td/Md x 10 has been increased by 20% to a value of 12 to compensate for the difficulty in locating "bankfull indicators" in degraded channels and the imprecision of the flow data and bankfull flow frequency. The following analysis of bank stability (Table 2) can be used as a guide to determine the need for bank stability. This analysis does not indicate whether there is active downcutting occurring.

Dutchman Creek Stability Analysis Table

X-Sec.	Td/Md x 10 > 12	W/D Ratio <10 and Td/Md> 12	W/D Ratio > 10 and Td/Md>20	Tw/W < 25	Channel Stability
1	x			x	possibly --large W/D
2	x		X	x	severely incised & widening
3	x	x		x	incised & widening
4	x	x		x	incised & widening
5	x	x		x	incised & widening
6				x	Near stability
7	x	x		x	incised & widening
8	x	x		x	incised & widening
9	x			x	Near stability

Table 2. Channel Stability Analysis from Channel Dimension Data

By combining the data in Table 2 with the location of bank failure on the DVD it becomes apparent that there is little channel instability above Dutchman Lake. However, beginning approximately 1.6 miles below the lake there is an abundance of "geotech" failures with the notable exception being the reach just below Illinois Route 146. This is also the reach where Cross Section 6 is located and the bank stability analysis indicates a near stable channel dimension.

Although Cross Section 9 was also determined to be stable by analysis, it does not agree with the USGS review of the DVD. This discrepancy is probably due to the fact that Section 9 was taken at the only "riffle" location in the lower portion of Dutchman and the field investigation found that this site has been channelized by excavating through a ridge that contained enough large stone and cobble to armor the bed. See Figures 8 and 9.

The large bank failures and numerous logjams below Dutchman Lake are presumed to be due to the geotech failures that caused large trees to fall into the channel. See Figures 10 and 11.

Conclusions:

The following conclusions have been formulated from the cross section data collected in the field and the aerial assessment.

1. Dutchman Creek is a flow driven channel with very few depositional areas and very little bedload being deposited within the channel.
2. The gradient below Dutchman Lake is less than 5 ft./mile and velocities even at high flow are less than 4 ft./sec. with some cross sections as low as 2.4 ft./sec.
3. There has been extensive channelization of Dutchman Creek below Dutchman Lake. The gradient, even though relatively low, must be higher than occurred naturally before the channelization took place. Therefore, channelization is likely the largest factor contributing to the past downcutting that has occurred.
4. Downcutting has created excessive bank heights. Channel widening has occurred due to the channel adjustment predicted by the CEM model. As a result, near vertical banks have developed in almost all reaches causing massive bank failures identified by USGS as “geotech” failures.
5. Install instream structures, which were recommended by the TMDL draft plan to increase aeration without causing an increase in local flooding. Inspection of a grade control below Old Route 146 indicates that the spacing between structures can be spread out beyond the normal 6 bankfull widths and still pass the bedload. Therefore, grade control structures can be taller to achieve better re-aeration.
6. Addition of instream grade control structures would not only increase aeration, but also increase bank stability by reducing effective bank heights and preventing additional downcutting. Properly designed and constructed structures should provide as much roughness as possible and narrow the flow width at the structure locations to increase turbulence in an attempt to increase the DO.
7. By increasing stability of the banks there will also be a preservation of the existing riparian area and a reduction in the amount of woody debris that creates logjams.

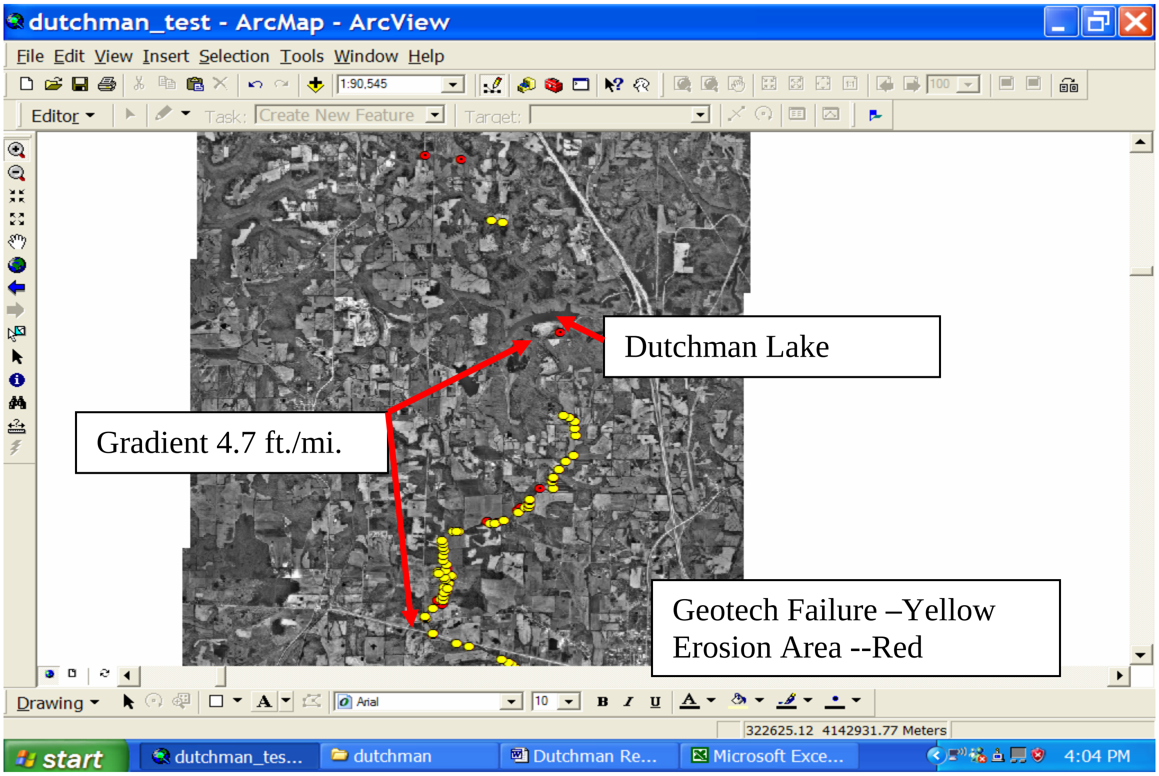


Fig. 8 Upper Dutchman Creek, above Illinois Route 146

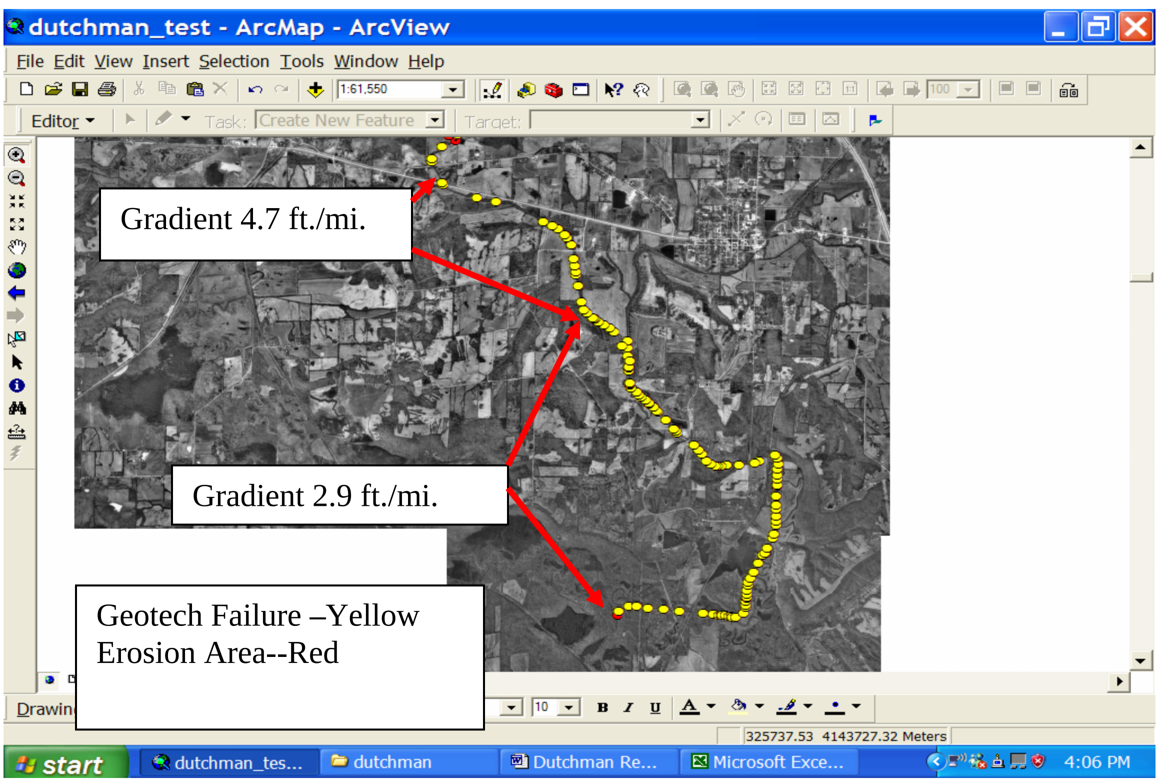


Fig. 9 Lower Dutchman Creek, below Illinois Route 146

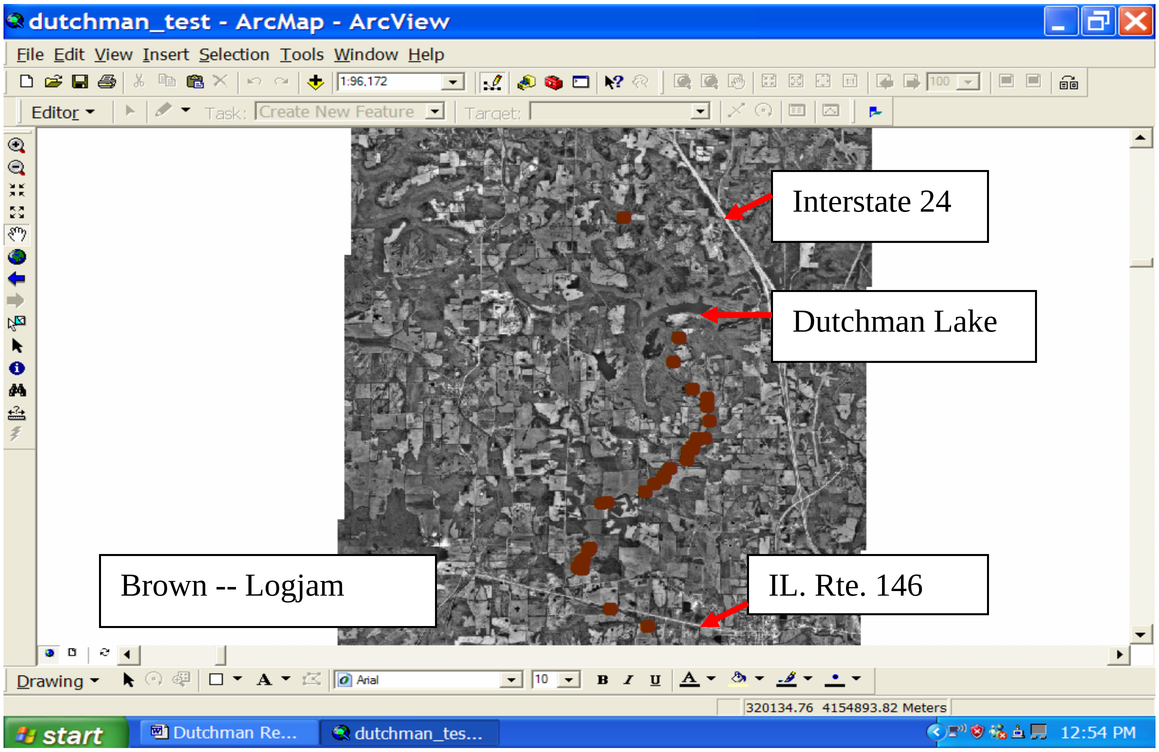


Fig. 10 Dutchman Creek Logjams, above Illinois Route 146

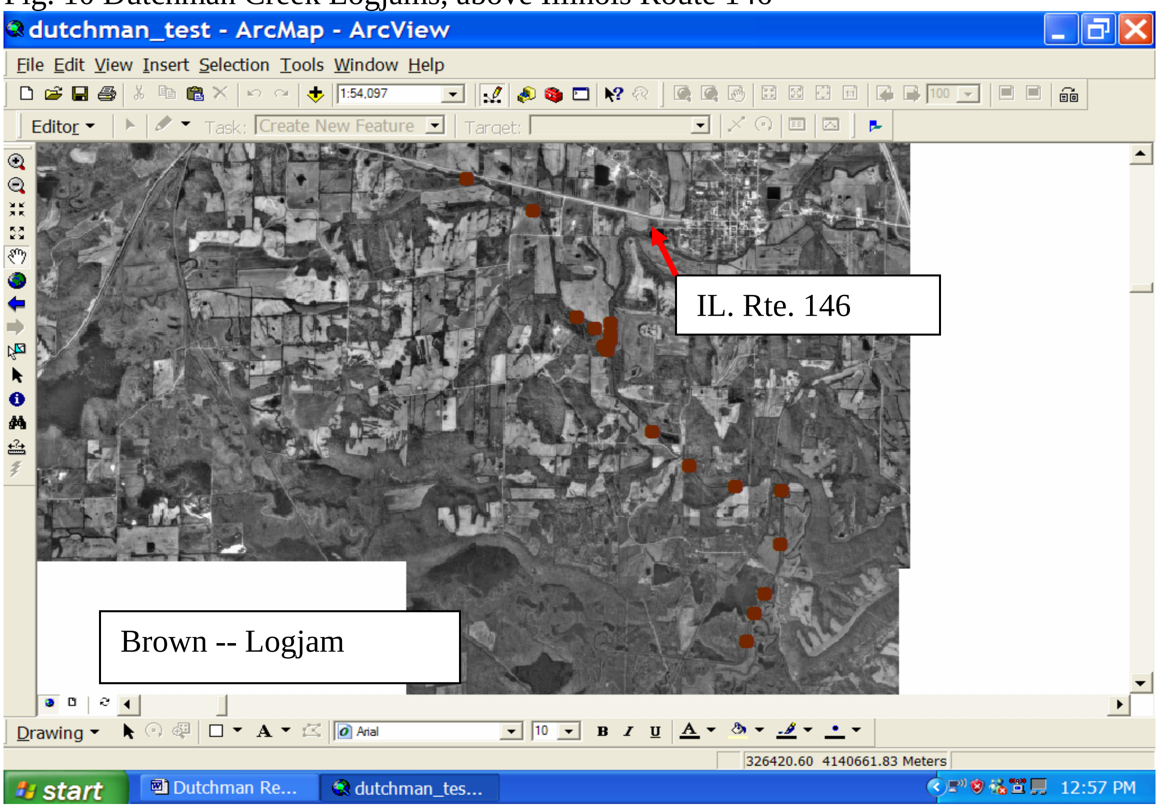


Fig. 11 Dutchman Creek Logjams, below Illinois. Route 146

Treatment Recommendations

The DVD has been divided into "Chapters" 2 thru 9 as shown in Fig. 4 and 5. As stated previously, each chapter consists of five minutes of video. The report provides a separate assessment and set of recommendations for each Chapter.

Treatment Recommendations for Chapter 2

This section of Dutchman Creek begins at the confluence with the Cache River and continues upstream to a point above the U.S. Route 45 bridge and ends just below cross Section 9. The entire reach has been channelized and has a gradient of about 2.9 ft./mile. There are over 30 geotech failures identified in this reach. They are located all along the channel with no specific area of concentration. There are no grade breaks or riffles in this reach as it is one long slow moving pool about 2.4 miles long.

The bank failures appear to be the result of oversteepened banks, possible due to downcutting, although the pool depth in this reach prevented an accurate cross section from being collected. Downcutting has been identified in the Cache River immediately downstream and Newberry type Rock Riffle Grade Controls have been installed.

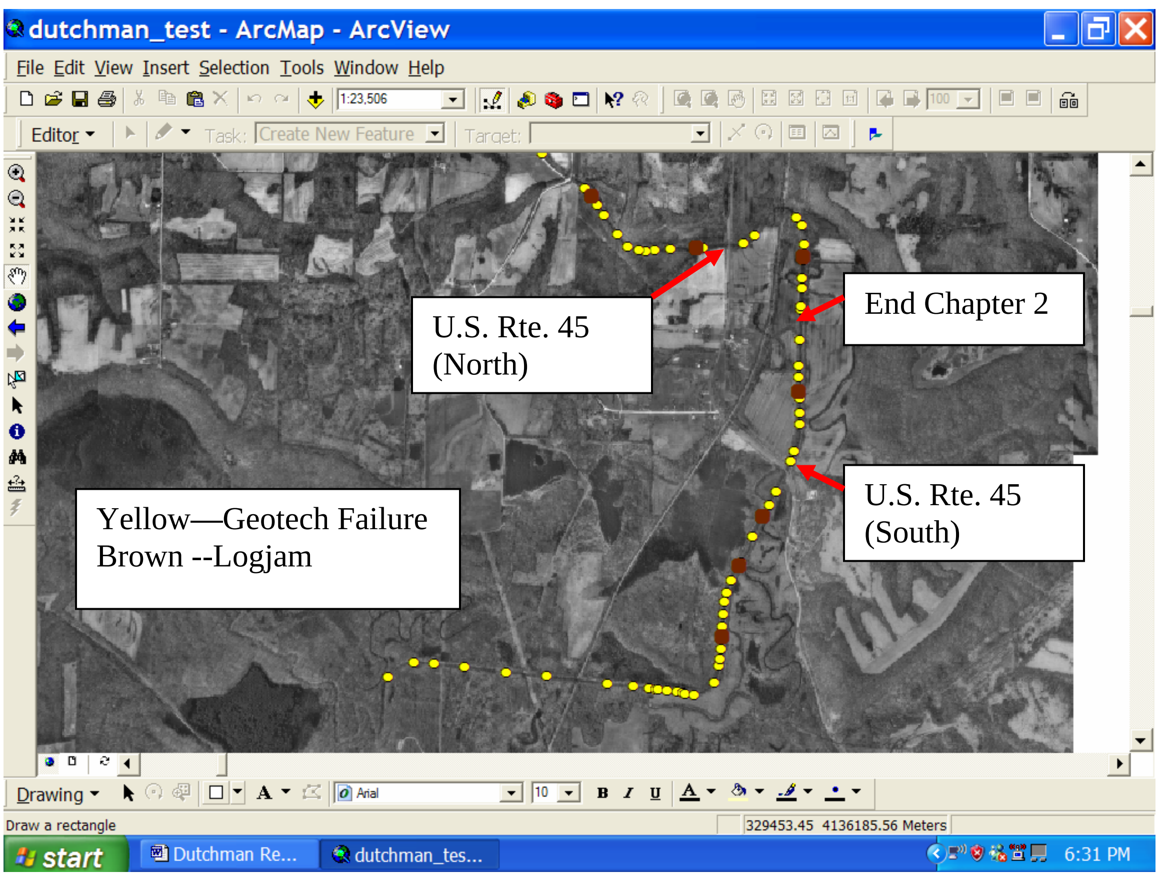


Figure 12. Chapter 2 Dutchman Creek

A series of Rock Riffle Grade Control Structures is recommended for treating this reach. The height and location of each structure will depend on a design survey and calculations that cannot be made at this time. However, there is only approximately 7 feet of fall in this entire reach, so for re-aeration purposes the structures cannot have a total drop of more than 7 feet plus any increase in water surface profile that can be achieved without causing flood damages.

For estimating purposes, assume 8 Newberry type structures three feet high with a net drop of 1 foot per structure. Each structure will require approximately 650 tons of stone at a cost of $40 per ton installed. Therefore, each structure is estimated to cost $26,000 for a total estimated cost of $208,000. Fig. 13 is an example of a Newberry style rock riffle near Bloomington, Illinois.

Instead of using the Newberry type structure, the use of Rock Cross Vanes may be more effective at re-aeration. Cross Vanes would more easily adapt to concentrating the low flow toward the center of the stream and therefore increase the effective height, create more turbulence and consequently result in more aeration. Cross Vanes may be more economical as they would require considerably less stone, however the difficulty in construction and the handling of larger stones may offset most of the potential cost savings.

Fig. 14 is an example of a Cross Vane Structure constructed on Lusk Creek near Eddyville, Illinois.

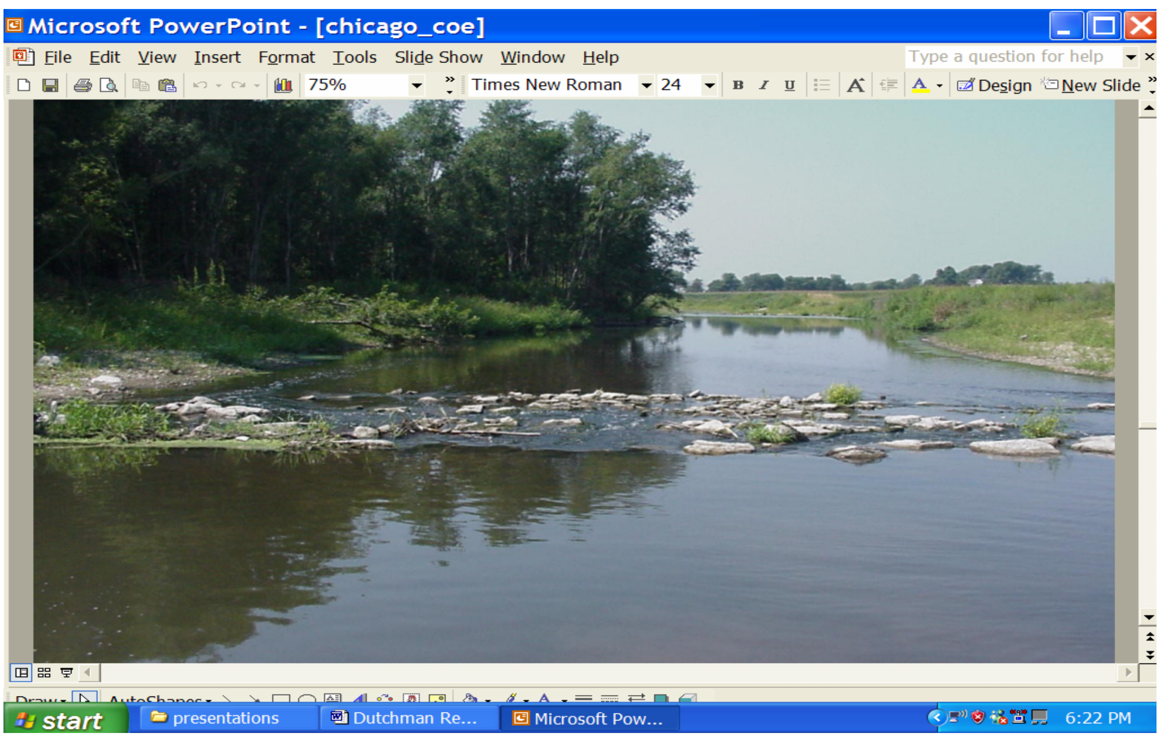


Fig. 13 Newberry Rock Riffle near Bloomington, Illinois

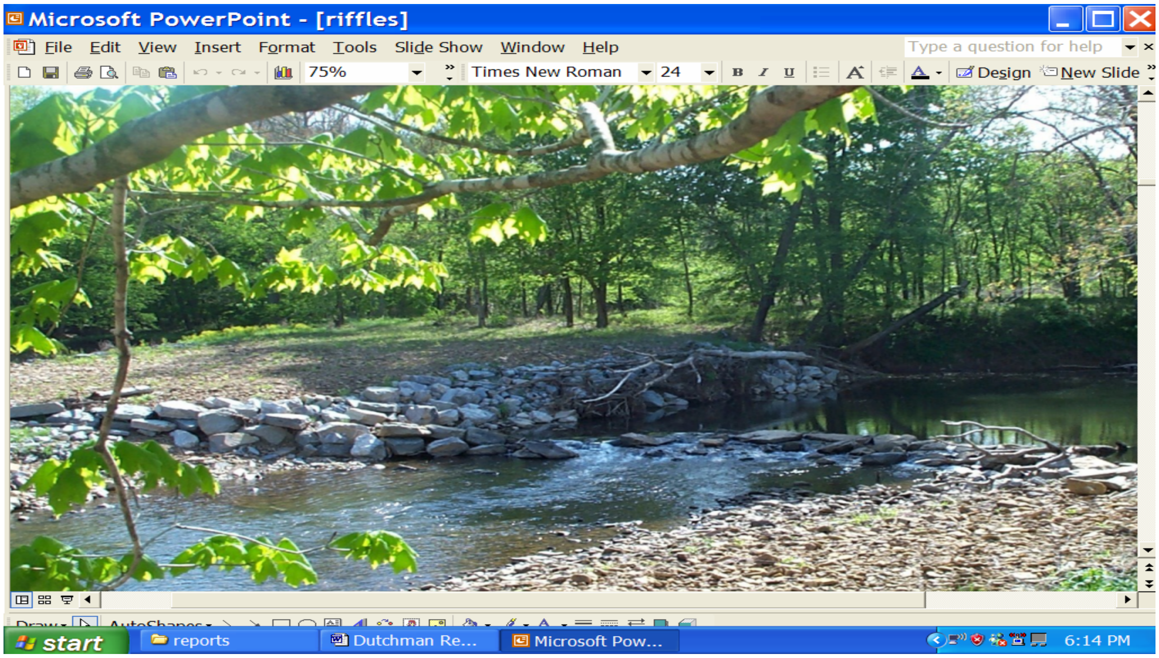


Fig. 14 Cross Vane Grade Control Structure near Eddyville, Illinois

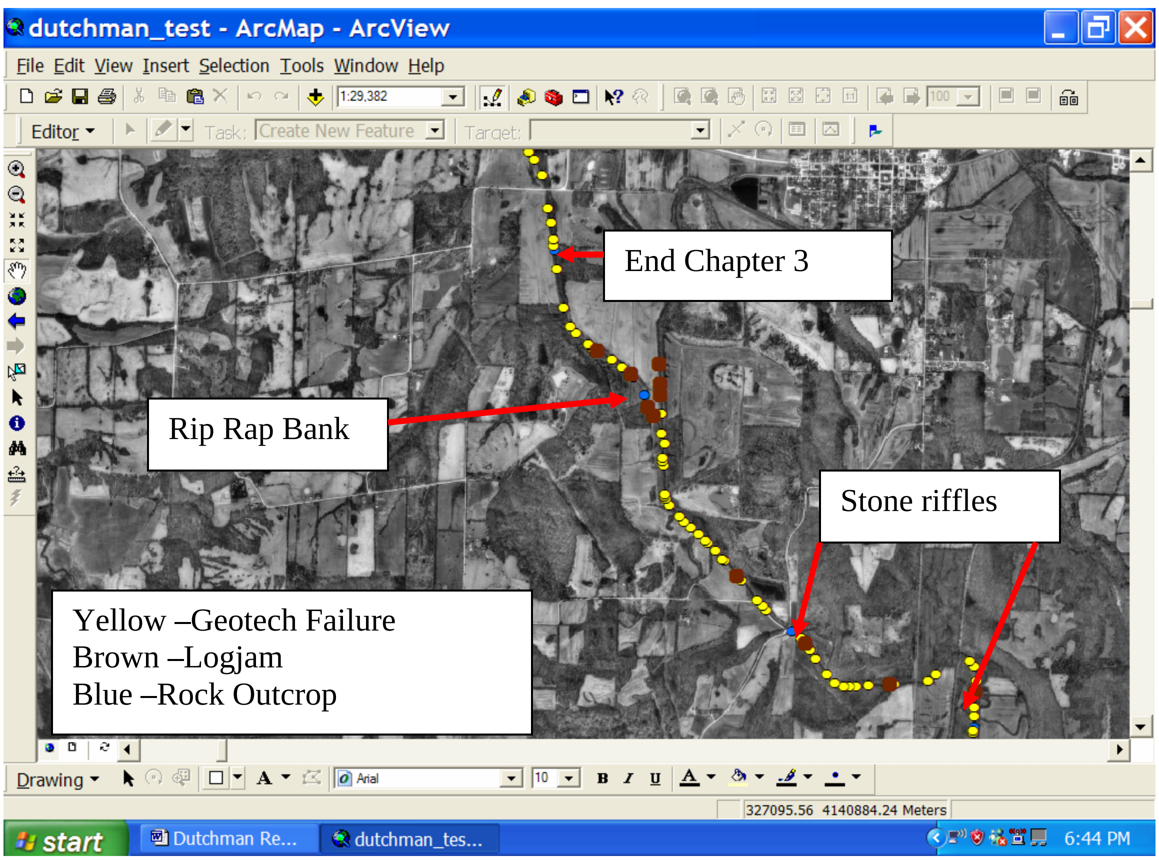


Fig. 15 Chapter 3, Dutchman Creek

Treatment Recommendations for Chapter 3

This section begins approximately halfway between the two U.S. Route 45 bridges and continues upstream to approximately 0.5 mile below Old Cypress Road. This reach is very similar to Chapter 2 with the addition of two existing riffles where there is some re-aeration occurring. Both of these sites are stone cobble riffles that appear to be stable. Figure 15 shows the location of Chapter 3 and the identified features of geotech failure, logjams and rock outcrops.

This reach has over 40 identified geotechnical failures and at least 8 logjams. The recommended treatment for this 3.25 mile reach is also to construct either Newberry Rock riffles or Rock Cross Vanes. This structure will increase the aeration, create a riffle pool sequence that will help stabilize the banks and reduce the volume of woody debris which is contributing to the logjams.

Unlike Chapter 2, this reach has cross sectional data that suggest the channel has degraded and is still downcutting. In the very upper reach of Chapter 3, the gradient increases from 2.9 to 4.7 ft./mile and the channel bed has exposed residual material that strongly suggest active downcutting. Using available cross section data, it is estimated that the riffles can be 3.0 feet above the existing channel bed without increasing flood elevations.

There is approximately 10 feet of gradient in this reach, therefore the estimate calls for the installation of 8 additional grade control structures around the two existing natural riffles. The channel begins to reduce in width in this reach, especially above the confluence with the Little Cache River, therefore the estimated stone requirements for each riffle in this reach is reduced to 375 tons at a cost of $15,000. The total estimated cost for riffles in this reach is $120,000.

There are two additional sites where the channel is migrating into adjacent cropland that can be treated with Stone Toe Protection (STP). Each site is approximately 600 feet long and will require about 750 tons of stone. The estimated cost of placing stone in this reach will be $25 per ton due to easier access and placement. Therefore, each of these sites has an estimated cost of about $18,750 for a total cost of $37,500.

The Little Cache River joins Dutchman Creek in this reach and it appears that a headcut has migrated up the Little Cache as well. However no planned treatment is recommended at this time for the Little Cache.

Recommended Treatment for Chapter 4

This reach begins below Old Cypress Road and continues upstream about 0.75 miles above Old Route 146. The entire reach has a gradient of 4.7 ft./mile. There is a section of this reach below Illinois Route 146 that appears to be near equilibrium. The features of geotechnical failures, logjams and rock outcrops are shown in Fig. 16.

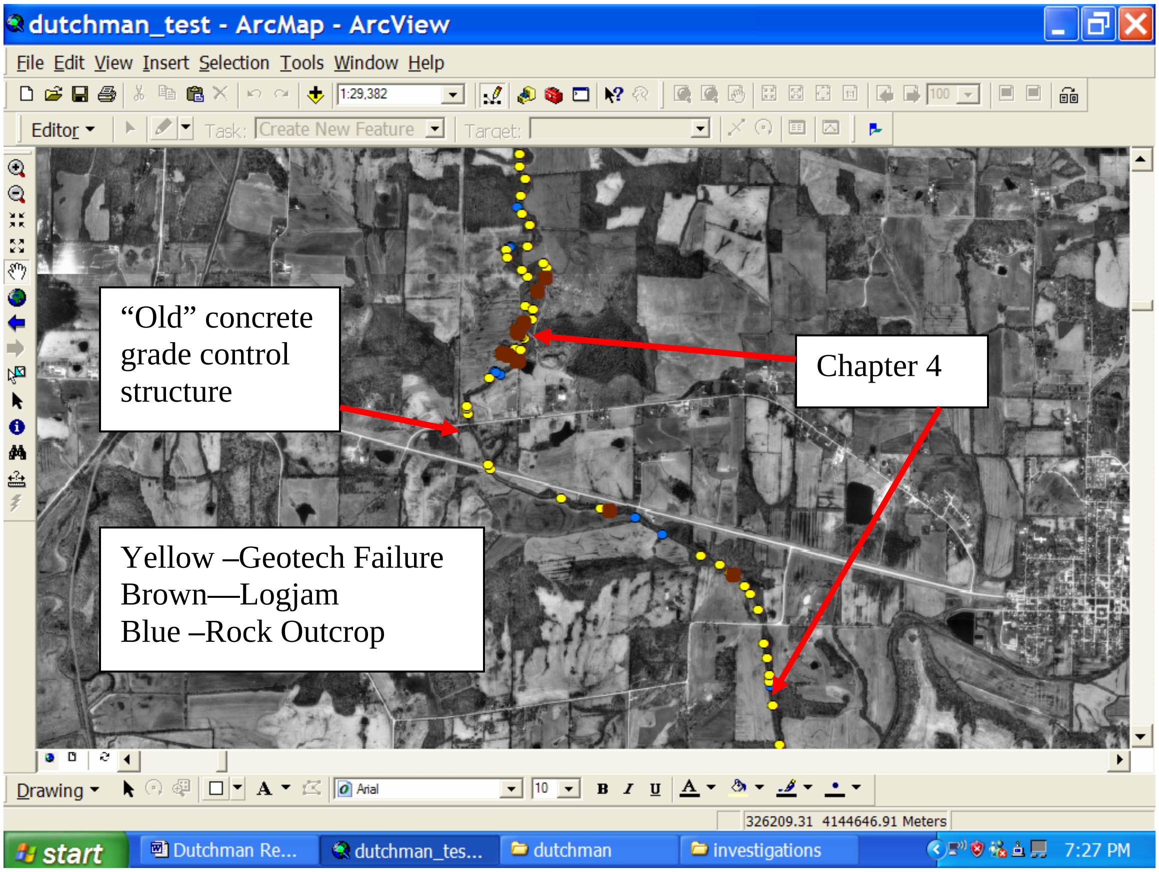


Fig. 16 Chapter 4 Dutchman Creek

Chapter 4 has less than 20 geotechnical failures identified in 2.7 miles compared to 30 or 40 in chapters 2 and 3. The assessment suggests that the downcutting in Chapter 3 has not migrated as far upstream as Illinois Route 146, but is above Old Cypress Road. In addition there is an old concrete grade control structure just below the Old Route 146 bridge (DVD time 18:25). However, the structure is not in good shape and cannot be depended on to halt any downcutting. This structure demonstrates that with fine bedload, grade controls can be spaced farther apart without losing the ability to pass bedload.

The recommendation for Chapter 4 is to again install Newberry Rock Riffle Grade Control Structures or Cross Vanes to control bed instability and increase aeration. Even though the stream is near equilibrium below Route 146 the grade controls should be built along the entire reach to gain the maximum aeration possible.

There is about 12 feet of gradient in this reach so it may be possible to build 12 grade control structures with one foot of effective height. Since the channel is considerably smaller in this chapter, each riffle will require only about 250 tons of stone and cost an estimated $10,000 each. The total estimated cost of treatment for Chapter 4 is $120,000.

Recommended Treatment for Chapter 5

Chapter 5 begins approximately 0.75 miles above Old Route 146 and continues upstream to just below Buncombe Road. See Figure 17

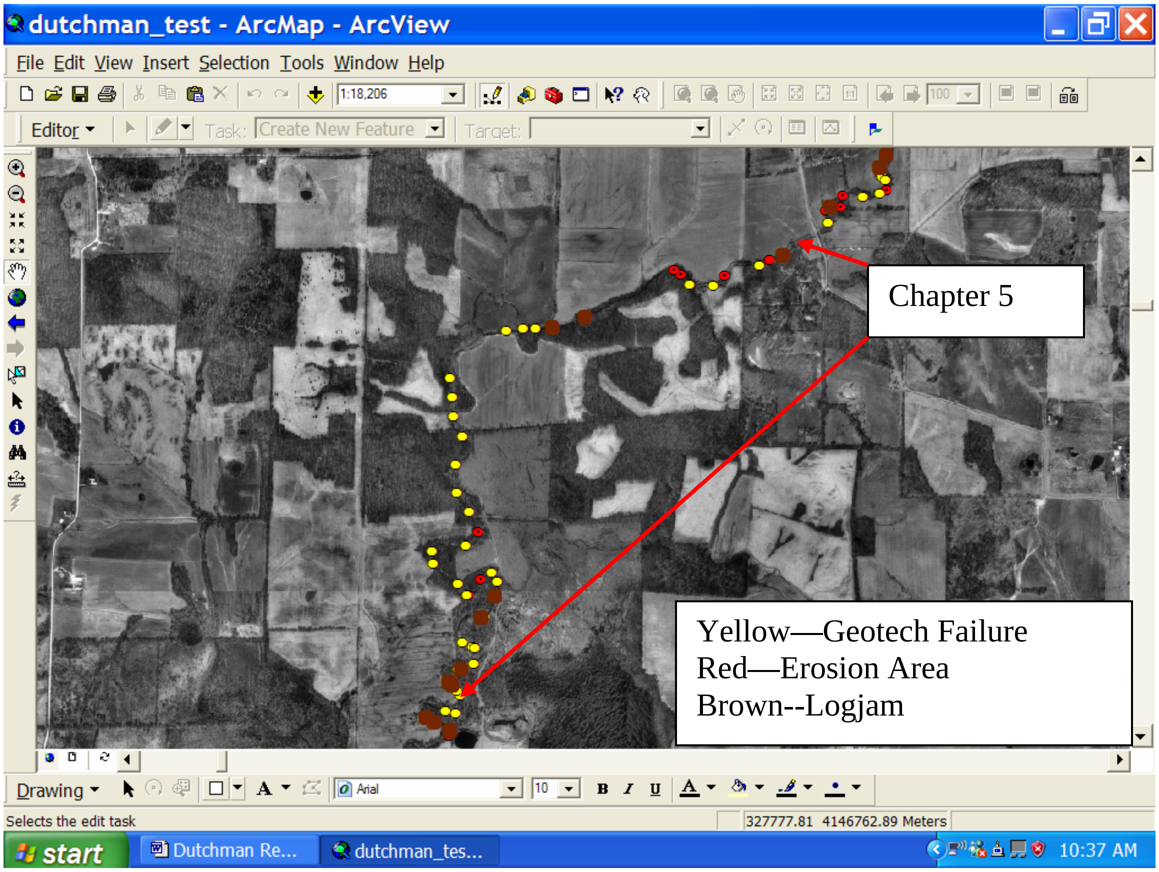


Fig. 17 Chapter 5 Dutchman Creek

This reach is approximately 2.25 miles long with 26 geotechnical failures and 6 erosion sites identified. Cross section 4 is located very near the upper end of Chapter 5 and there is a “knickzone” at this location. Therefore, the channel stability identified at Cross Section 5 below Illinois Route 146 is an isolated segment with downcutting occurring above and below.

Chapter 5 also has the first sites identified as erosion sites rather than geotechnical failures. The erosion sites are on outside bends and represent bank failure due to scouring action rather than soil conditions, although there is likely a component of both present at some sites. These erosion sites then become candidates for lateral bank stabilization and also present another opportunity to create turbulence and therefore re-aerate the flow. The recommendation for Chapter 5 will include grade control and bank protection.

The entire reach of Chapter 5 is recommended for grade control, and with a total of approximately 11 feet of gradient in this section there is opportunity to build 11 structures with each having a 1.0 foot of net overfall. Each riffle will require approximately 250 tons of stone at a cost per riffle of $10,000. The estimated total cost for riffles will be $110,000.

The primary erosion sites identified are segments where the riparian area is very narrow and there is active erosion. By protecting the banks from additional lateral movement, the existing riparian area will be preserved to aid in maintaining cooler water temperatures. It is recommended that Stream Barbs be considered rather than Stone Toe Protection for these sites for two reasons.

First, Stream Barbs project into the channel and produce more roughness and turbulence, helping the re-aeration of water. Second, Stream Barbs are spaced approximately 75 to 100 feet apart allowing for a large portion of the riparian area to be undisturbed. STP on the other hand requires continuous access to the eroding bank and often requires removal of much of the riparian area to gain access for construction.

Potential Stream Barbs locations are found at DVD times of 20:19, 21:28, 23:19, 23:39, 23:48, 24:37 and 25:00. Each site is estimated to require an average of five Stream Barbs at 50 tons each for a total of 250 tons or $7500 per site. The total estimated cost for Stream Barbs in Chapter 5 is $52,500.

Recommended Treatment for Chapter 6

This chapter is approximately 2.2 miles long with 13 identified geotechnical failures and 5 erosion sites. (Fig. 18) There are no identified grade controls other than two field road crossings, therefore the downcutting from Chapter 5 can and has moved through Chapter 6. In addition, there are some reaches of channel that have been straightened, which are contributing to the downcutting problems.

There is approximately 10 feet of gradient in this reach allowing for approximately 10 grade control structures with 1 foot of net overfall. The stone required for each structure in this reach will be approximately 225 tons for a cost of $9,000 per structure. The total estimated cost for grade control in Chapter 6 is $90,000.

The 5 erosion sites needing lateral bank stabilization are at DVD times of 25:52, 26:10, 28:22, 29:36, and 29:55. Stream Barbs are recommended at each site for the same reasons as stated for Chapter 5 and the cost per site will be the same. The estimated cost to install Stream Barbs at 5 sites in Chapter 6 is $7500 per site or $37,500 for all 5 sites.

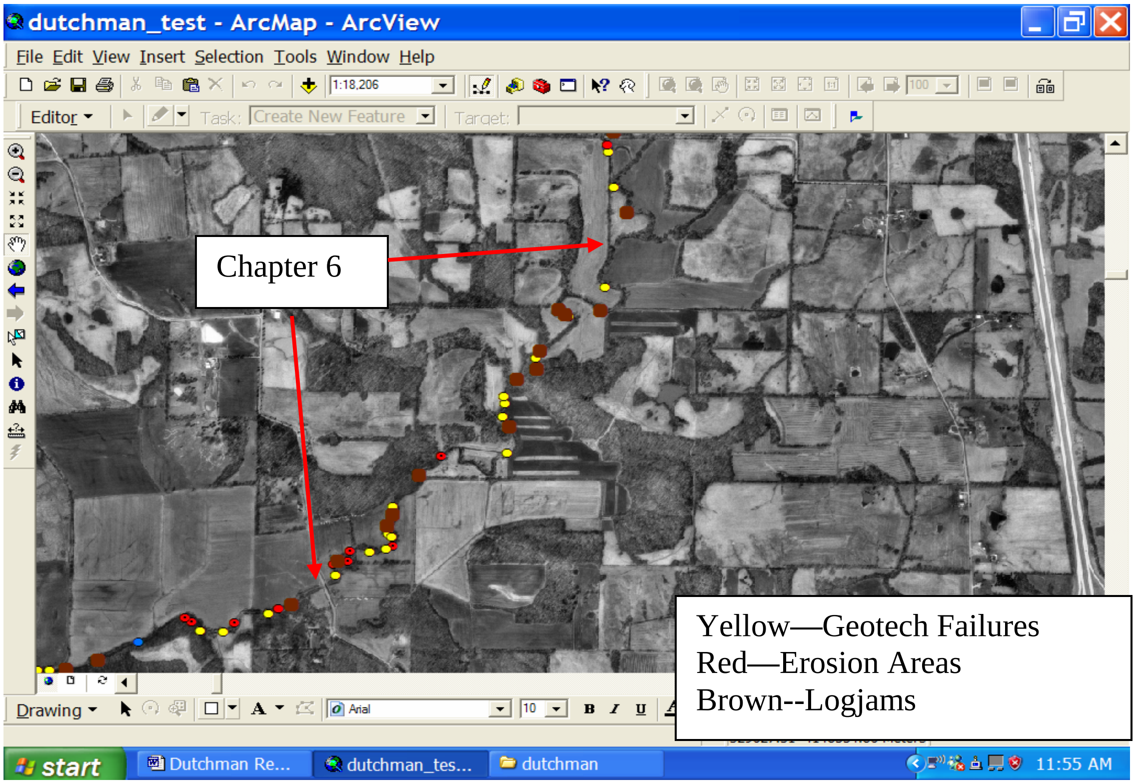


Figure 18 Chapter 6 Dutchman Creek

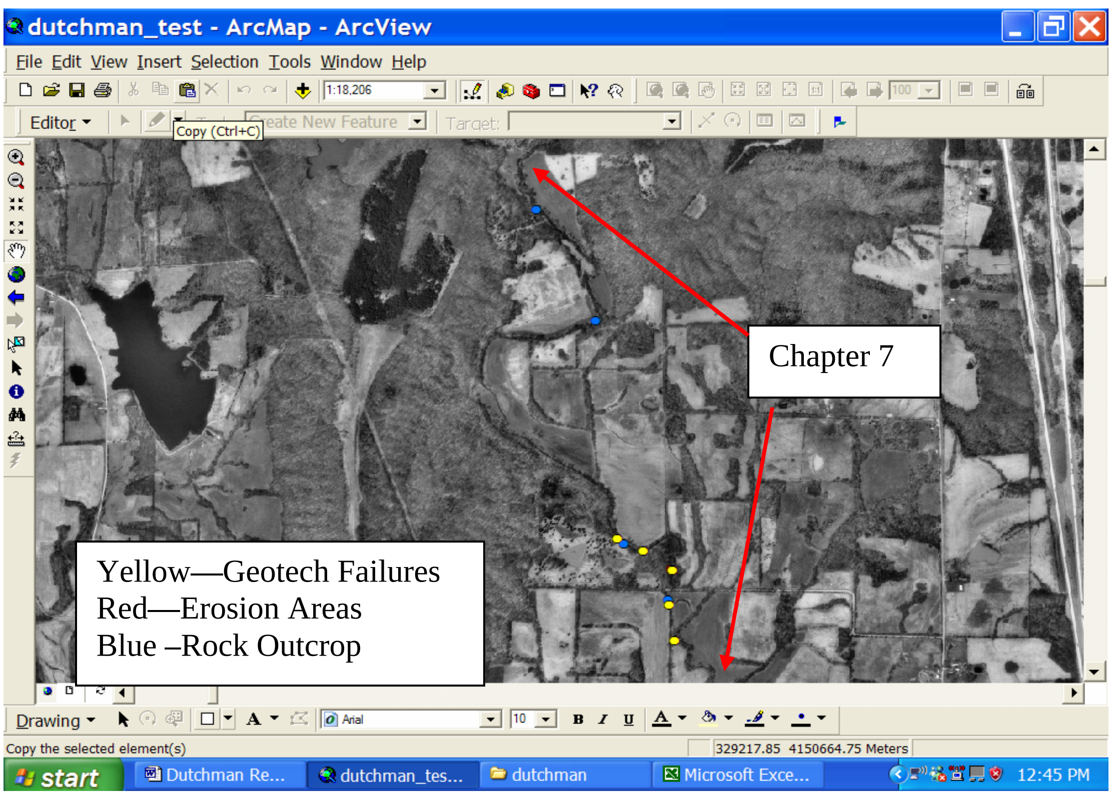


Fig. 19 Chapter 7 Dutchman Creek

Recommended Treatment for Chapter 7

This reach begins below Brown Road and extends upstream for approximately 2.2 miles. This reach has only 5 geotechnical failures identified and 2 erosion sites (See Fig. 19).

The recommended treatment for Chapter 7 is to install grade control with 1 foot of net drop allowing for about 10 structures in this reach. As in chapter 6, the cost per structure will be $9,000 for a total cost of $90,000.

There are erosion sites at DVD time 30:46, 30:59 and 31:46 that can be treated to prevent lateral migration and also increase aeration. Each site is suitable for approximately 4 Stream Barbs at a cost of $6,000 per site for a total of $18,000.

This reach, as in all reaches should attempt to incorporate the grade controls with road crossings to increase the participation of local landowners. In Chapter 7 there is also a low water crossing on Brown Road with a culvert to handle low flow. This would present an opportunity to increase aeration by replacing the culvert with some type of low flow structure that would introduce more turbulence as there are a couple of feet of elevation difference at this site.

Recommended Treatment for Chapter 8

Chapter 8 begins below Dutchman Lake and continues upstream past the lake. (Fig. 20) Since there is a significant difference in the channel above the lake, the recommendations for this reach will be divided into two segments.

Below Dutchman Lake: This reach is only 0.6 mile in length and has no identified problem features. Cross section 2 is located in this reach and shows the channel to be severely incised and bank failure can be anticipated. The stability currently present is probably due to the rock outcrops in this reach. The gradient is 4.7 ft./mile and there is only about 3 feet of gradient in this reach, therefore only 2 grade controls can be built. The estimated cost for each structure is $9,000 each, therefore the total cost is $18,000 for this reach.

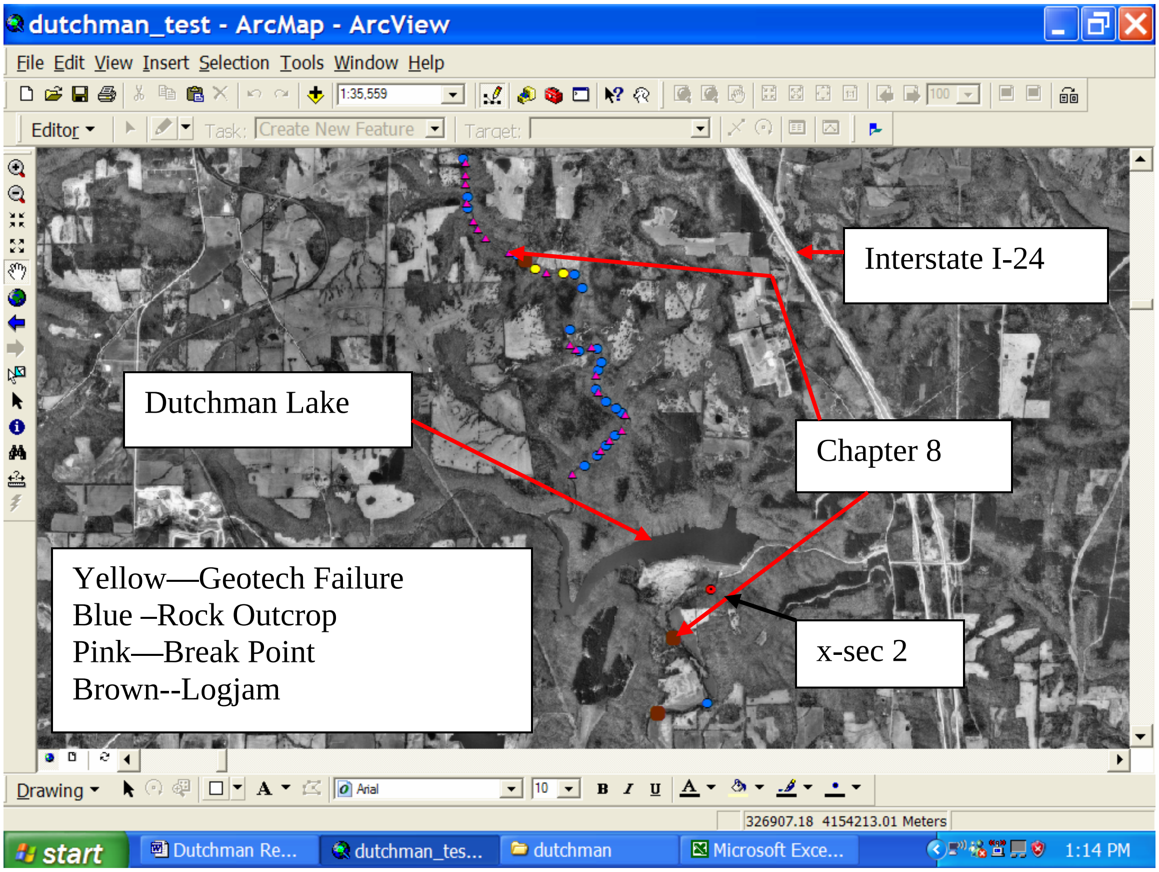


Fig. 20 Chapter 8 Dutchman Creek

One additional element that may be incorporated is to examine the possibility of adding a boulder field or other energy dissipation device at the outlet end of the principle spillway on Dutchman Lake. The turbulence generated as the overflow operates could do quite a lot of aeration considering the velocity of flow in the spillway pipe. There is no cost estimate for this recommendation as more investigation and consultation with NRCS will be required before any modification to the outlet structure can be recommended.

Above Dutchman Lake: This reach is about 2.3 miles in length with the lower 1.1 miles having a gradient of 45.5 ft./mile. The next 1.2 miles then has a gradient of 20.6 ft./mile. In the DVD it appears this break in grade occurs at 39:30.

Downstream of this point, there is an abundance of large rocky substrate and a lot of turbulence so there is no need for a structure to increase aeration. There are 12 breakpoints and 16 rock outcrops identified in the reach from the video and only 2 geotechnical failures.

There are no recommendations for treatment in this reach.

Recommended Treatment for Chapter 9

This reach of approximately 2.3 miles begins with about 1.3 miles on a 20.6 ft./mile gradient and then increases to approximately 230 ft./mile for the remaining 1.0 mile (Fig. 21). There are 15 breakpoints, 6 rock outcrops and only 2 erosion areas identified in this reach. Similar to Chapter 8 above the lake, there is little need to add instream structures for aeration in this reach.

The two erosion areas are in pastureland at DVD time 42:09 and 42:56 and can be easily treated with Stone Toe Protection. Each is about 200 feet long and can be treated with 0.75 ton/ft. of stone at a cost of approximately $5,000 each. Therefore, the estimated total cost of treatment for Chapter 9 is $10,000.

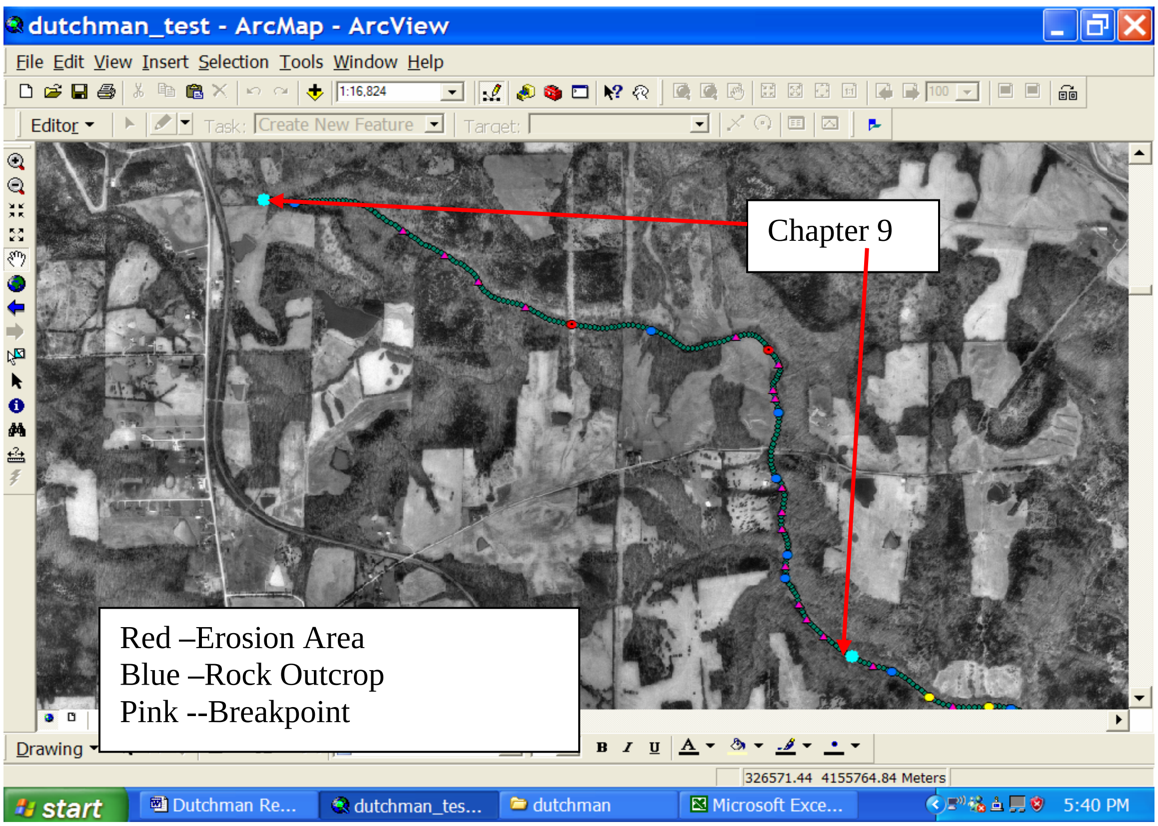


Fig. 21 Chapter 9 Dutchman Creek

Summary of Recommendations

Table 3 provides a summary of the estimated treatment needs and cost for each chapter in Dutchman Creek.

Estimated Cost to Implement Recommendations in Dutchman Creek					
Chapter	Riffles	Stone Toe	Stream Barbs	Est. Cost	Cost by Chapter
2	8			$208,000	$208,000
3	8			$120,000	
3		1200 ft..		$37,500	$157,500
4	12			$120,000	$120,000
5	11			$110,000	
5			35	$52,500	$162,500
6	10			$90,000	
6			30	$37,500	$127,500
7	10			$90,000	
7			12	$18,000	108,000
8	2			$18,000	$18,000
9		400 ft..		$10,000	$10,000
Totals	61	1600 ft..	77	$911,500	$911,500

Table 3 Cost Summary for Dutchman Creek Recommendations

Dutchman Creek above Dutchman Lake is steep and rocky with many opportunities for turbulent flow and aeration. Therefore, only two erosion areas are recommended for treatment to control lateral bank migration. Below Dutchman Lake, the gradient drops significantly and flow becomes sluggish or stagnant at low flow rates. In spite of the low gradient there is evidence that the creek is, and has degraded, probably as a result of the channelization that has taken place. Therefore, grade controls are being suggested as treatment for the following reasons:

1. Grade control structures will allow for “narrowing” the channel down at structure sites to increase velocities and turbulence to entrain more oxygen into the stream at low flow rates.
2. Grade control structures can be designed based on the channel gradient rather than the normal spacing of six bankfull widths. Spacing can be largely ignored as the bedload is relatively small and consists of mostly silts and clay that will pass through the grade control structures. Examination of an existing grade control structure below “old” Route 146 that has maintained a pool above the structure provides the evidence that this design method will work in Dutchman Creek.

3. Grade control structures can be either Newberry Rock Riffles or Rock Cross Vanes with Cross Vanes being the preferred method. Cross Vanes are preferred because they lend themselves better to “narrowing” the channel more during low flow rates and therefore are expected to provide improved re-aeration over Newberry Riffles.
4. Preliminary estimates indicate that structures less than 3.0 feet above the current bed will not increase flooding. However, a long profile of the channel will need to be completed to confirm this estimate and design the structures.
5. Bank failure identified is largely due to geotechnical problems as a result of channel incision. Installation of the planned grade control structures will halt current downcutting and partially reverse past incision to help alleviate some of the geotechnical failures.
6. Erosion areas caused by scouring action are recommended to be treated with Stream Barbs due to the increased aeration that will be achieved by using a method that will redirect flow as opposed to Stone Toe Protection that will only armor the base of the eroding bank. There are some areas where Stone Toe Protection has been recommended where redirected flow may create erosion problems on the opposite bank.

This report is not comprehensive enough to predict the effects of these recommendations on the DO levels in Dutchman Creek. Neither is it intended to provide sufficient detail to design and construct the recommended treatments. Additional information and design analysis will need to be completed in order to develop an implementation plan. This report is however intended to provide a reasoned approach to reducing the bank failure and potentially increasing DO levels in Dutchman Creek below the lake by using treatment methods that provide the maximum re-aeration, especially at low flow rates.

References:

(1) IEPA, Total Maximum Daily Load Development for Dutchman Creek Watershed, October 2003: pg. ES-1,2

(2) NRCS, Erosion and Sediment Inventory Procedures for Illinois, April 2001. Page 9

(3) Ibid. section i, page 10.

APPENDIX A

NRCS STREAMBANK INVENTORY AND EVALUATION FORMS FOR CROSS SECTIONS ON DUTCHMAN CREEK, JOHNSON COUNTY, ILLINOIS