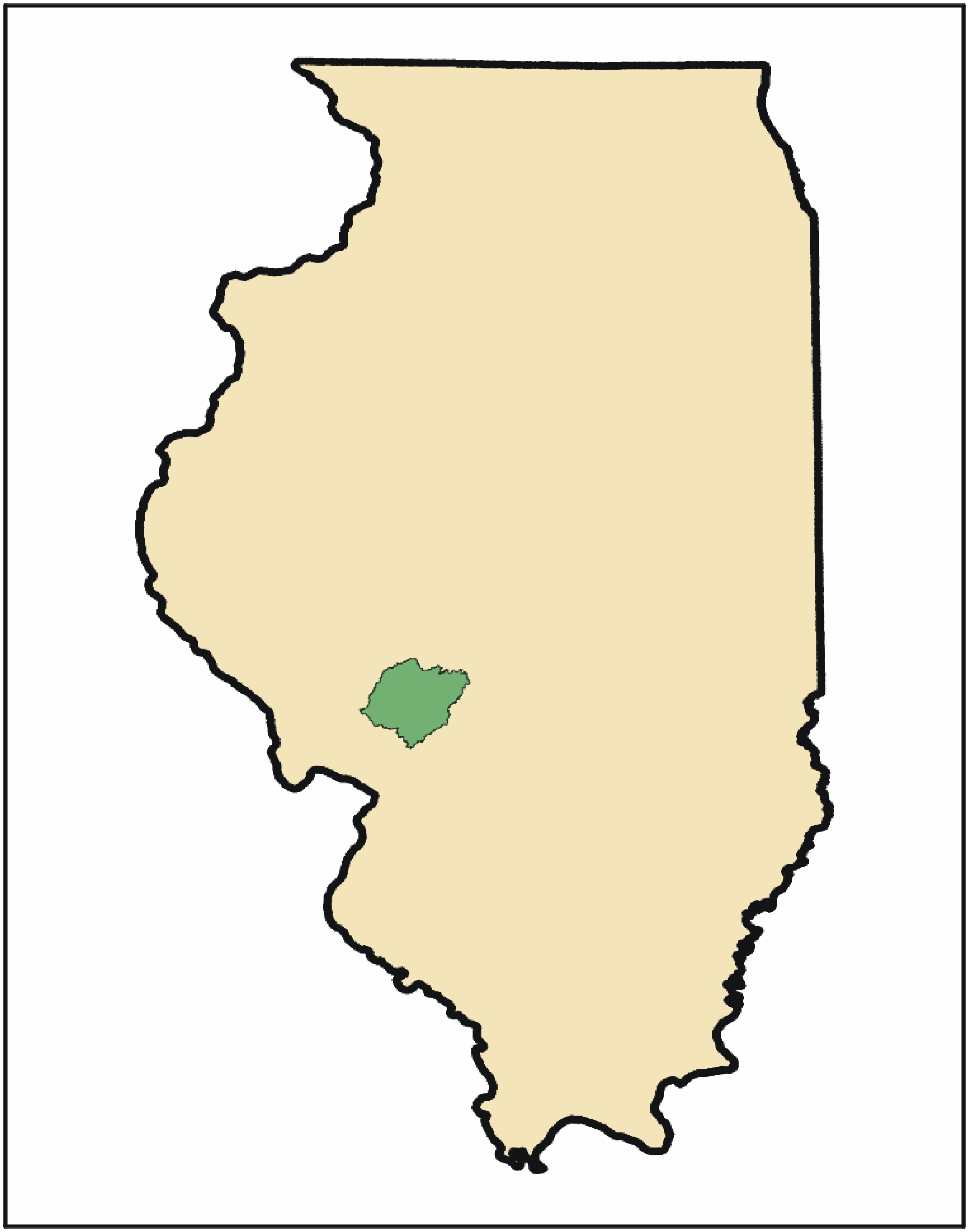


AERIAL ASSESSMENT OF MACOUPIN CREEK: MACOUPIN AND JERSEY COUNTIES

JULY 2005

Prepared by WAYNE KINNEY for IL. DEPARTMENT OF AGRICULTURE

In August 2004, Limno-Tech, Inc. completed Stage 1 work on the Macoupin Creek Watershed. The conclusions drawn indicate that TMDLs are warranted on the upper Macoupin (segment DA 05) and the lower Macoupin (segment DA 04). Segment DA-04 is warranted based on manganese, dissolved oxygen and fecal coliform. Segment DA-05 is warranted based on manganese and dissolved oxygen. The potential sources of manganese are erosion and streambank erosion of soils naturally enriched in manganese. Potential sources contributing to low dissolved oxygen include algal respiration and decomposition, sediment oxygen demand, degradation of CBOD, nitrification of ammonia (from agricultural lands and failing septic systems), and municipal sources. (Quarterly Progress Report, Macoupin Creek Watershed, August 2004, Limno-Tech, Inc.)

According to the issued report, Segment DA-04 begins at the Rte. 67 Bridge near Rockbridge and extends upstream for 19.73 miles. Segment DA-05 begins at the upper end of DA-04 and extends upstream an additional 43.89 miles. This Aerial Assessment report is based on video footage of Macoupin Creek beginning near Coops Mound, southeast of Standard City and continues downstream to a point approx. 1 mile below the Rte. 67 Bridge near Rockport.

There is a USGS Stream Gage on Macoupin Creek near Kane, IL. The “Annual Maximum Peak Discharge” measurements from this record have been analyzed and used to determine a return frequency discharge curve for this gage and then used as a benchmark for flow estimates throughout the watershed.

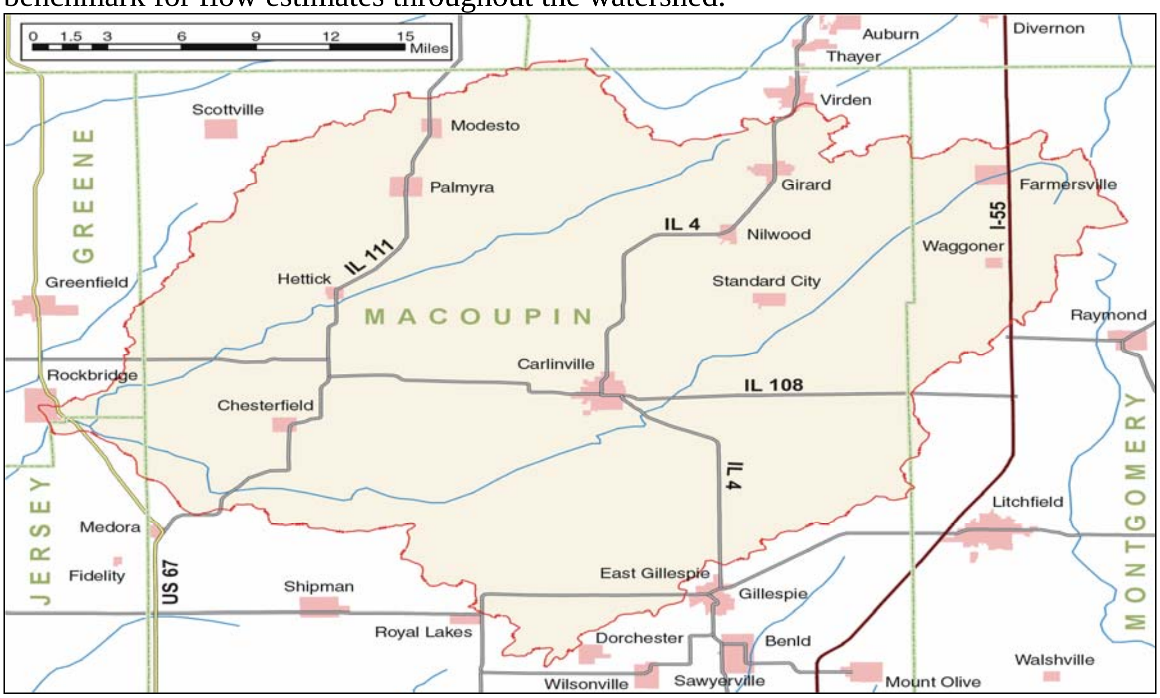


Fig. 1 Watershed Area of Macoupin Creek

Assessment Procedure

Low level geo-referenced video was taken of Macoupin Creek in March, 2004. Video taping was completed by Fostaire Helicopters, Sauget, IL, 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 mapping began at Coops Mound near Standard City and progressed downstream to approx. 1 mile below the Rte. 67 Bridge near Rockbridge. 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 then used to identify and locate the points where ground investigations were needed to verify aerial assessment assumptions and gather additional data.

The ground investigations or “ground truthing” is intended to accomplish two primary functions. First, it provides those viewing videos the opportunity to verify the correct interpretation of the video. Second, the video allows the user to identify and gather field data at the most appropriate locations to more closely represent the entire study portion of the stream.

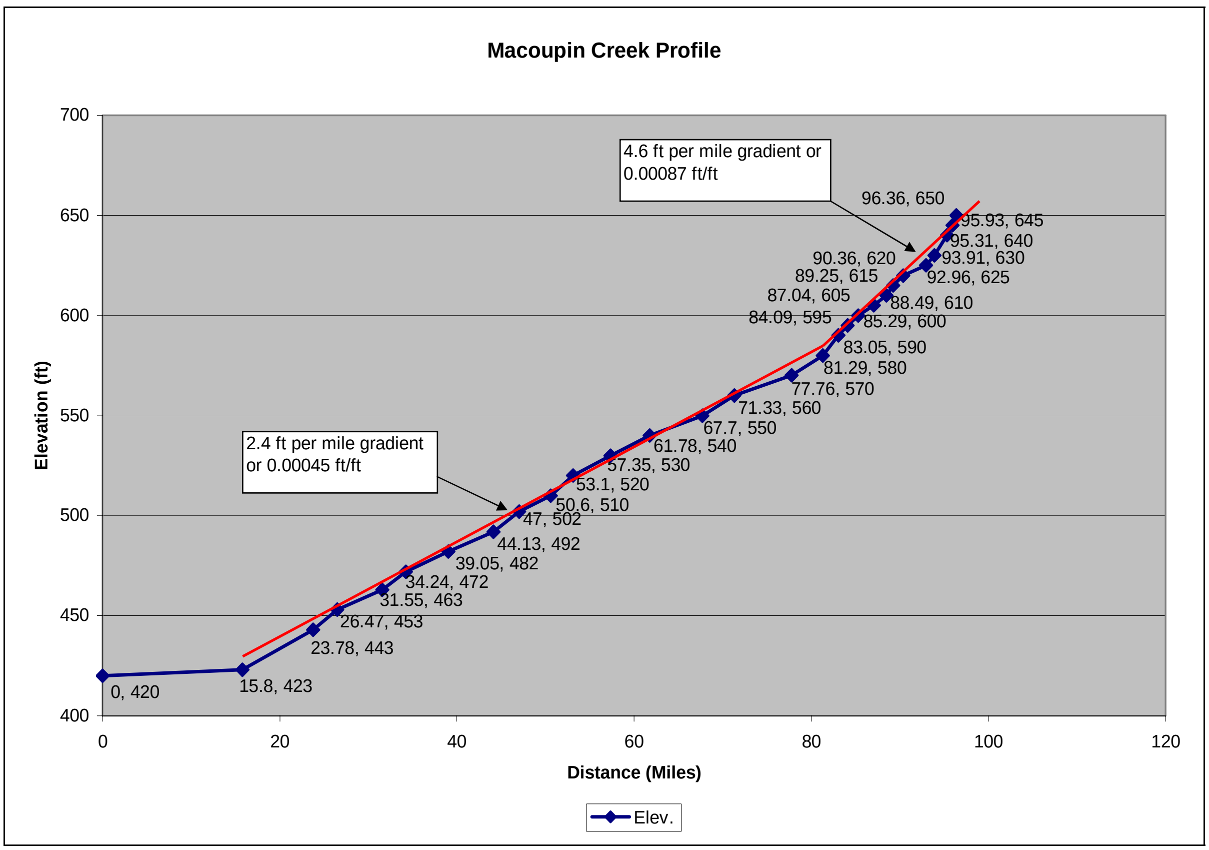


Figure 2. Channel Profile of Macoupin Creek

Detailed elevation data is not available; therefore the channel slope is 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. However, this method is used because it incorporates sinuosity into the calculation and allows the channel slope to be assume equal to “valley slope” in order to estimate channel capacity, velocity, etc., although there are short segments where the channel slope may differ significantly near roads, logjams, knickpoints, etc.

The DVD has been divided in “chapters” of approximately ten minutes of video (Fig. 3) 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 reach, it will also provide an assessment and treatment recommendations by chapter. The chapter divisions are clearly arbitrary and do not reflect “change points” in the stream characteristics or treatment recommendations. For clarity the conclusions and recommendations are presented for each stream “chapter”.

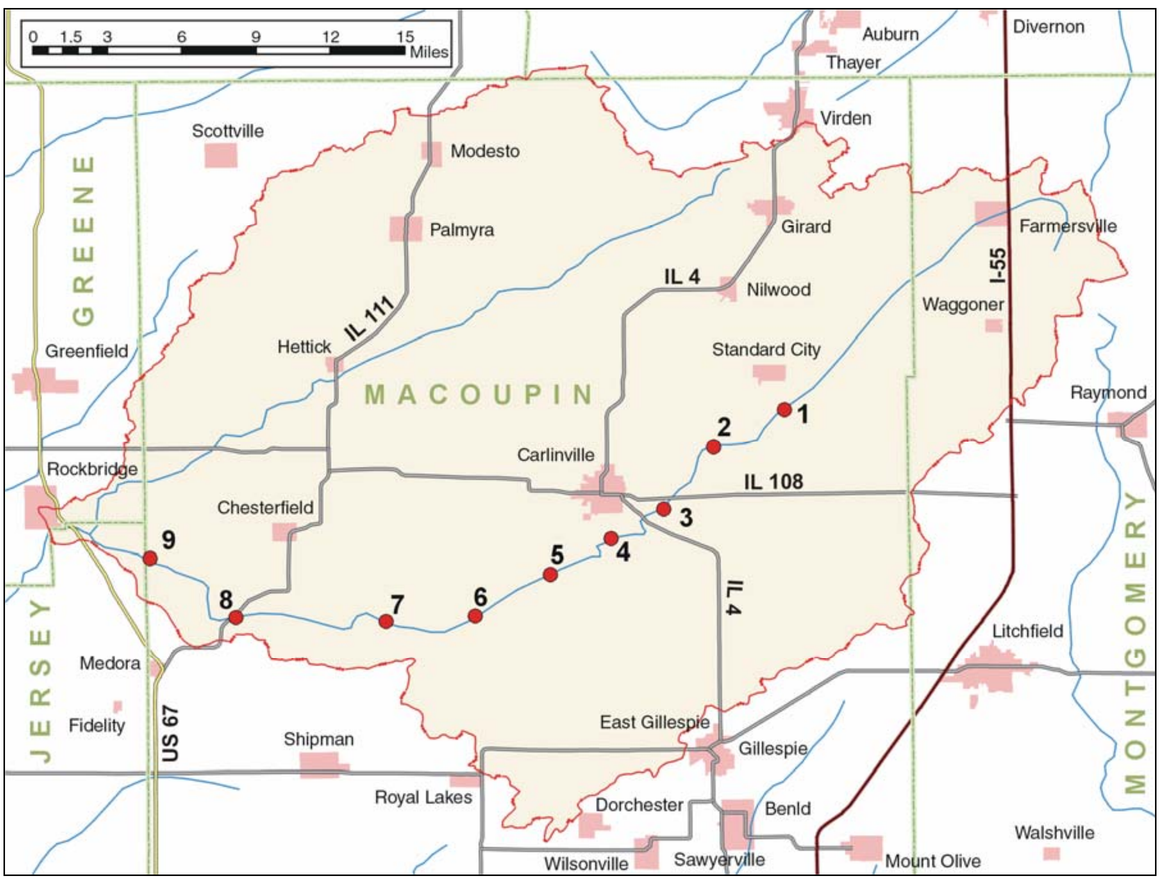


Figure 3. Study Reach with Chapter Divisions

The Chapters on the DVD's can be located using the following chart.

DVD Disc No.	Chapter on DVD	Chapter on Map (Fig. 2)
1	2	1
1	3	2
1	4	3
1	5	4
2	2	5
2	3	6
2	4	7
2	5	8
2	6	9

The major factors indicating channel condition identified from the aerial assessment have been totaled by DVD chapter in Table 1 below. This tabulation allows a general comparison of the relative dominance of features found in each chapter and provides a means of comparing stream characteristic between chapters. A discussion of the major differences will follow later in this report.

Features Identified by Chapter

Chapter	Rock Outcrop	Logjam	Geotech Failure	Deposition	Bed Control	Break Point	Erosion	Severe Erosion
1	0	2	4	0	1	1	67	9
2	21	4	8	2	0	3	52	2
3	33	3	4	0	0	3	15	1
4	2	7	27	1	0	1	55	4
5	0	6	7	1	0	1	56	3
6	11	6	9	3	0	0	78	4
7	14	6	15	10	0	1	64	23
8	10	2	28	4	0	3	78	19
9	3	1	28	3	2	0	50	40
Totals	**94**	**37**	**130**	**24**	**3**	**13**	**515**	**105**

Table 1. Features by Chapter Identified by Aerial Assessment

Nine cross sections were taken at selected locations on Macoupin Creek after viewing the DVD's. The cross sections are located at "riffle" locations to best represent the channel characteristics and to allow for comparison of width, depth, x-sec. area, etc. along the channel at similar geometric locations. The results of the hydraulic analysis at each site is presented in summary form in Table 2 and each cross section is provided in more detail in Appendix A. Aerial views of cross sections locations are shown in Figs. 4-12. Exact locations as Eastings and Northings can be found in Appendix A

CROSS SECTION SUMMARY – MACOUPIN CREEK													
X-sec	ADA	Q2 cfs	BKF cfs	BKF/sq.mi.	BKF Width	Max D	Vel. FPS	W/D	Top Bk. Depth	BKF X- Area	Top Bk X- Area	BKF cfs/ Q2 cfs	Top Bk/ BKF area
1	104.6	2302	1045	10.00	72	8.9	2.2	10.9	8.9	481	481	0.45	1.00
2	160.2	2984	1615	10.10	80	9.4	3	11.8	11.3	544	716	0.54	1.32
3	163.9	3038	1945	11.90	95	9.6	3	13.9	13	649	1032	0.64	1.59
4	174.5	3016	1959	11.20	62	12.7	3.3	6.5	14.8	589	726	0.65	1.23
5	247	3611	2706	10.90	77	11.3	4	8.9	11.8	669	720	0.75	1.08
6	295	4155	3125	10.60	90	14.2	3.3	8.6	15.9	938	1198	0.75	1.28
7	314	4365	3365	10.70	98	12.3	3.9	11.2	15.3	854	1260	0.77	1.48
8	390	5180	4087	10.50	117	15	3.4	11.2	20.9	1219	2067	0.79	1.70
9	400	5284	4317	10.80	89	15	4.5	8.2	18.2	974	1310	0.82	1.34

Table 2. Summary of Cross Section Data

A plot of the discharge probability curve from the USGS Gage# 5587000 (Fig. 13) indicates the 2 yr. discharge (50% probability) at approx. 9500 cfs and the 1.5 yr. discharge (67% probability) at approx. 8000 cfs. The drainage area at Gage#5587000 near Kane is 868 sq. miles; therefore the discharge per sq. mile is 10.6 cfs/sq. mi. and 9.2 cfs/sq. mi. respectively for the 2 yr. and 1.5 yr. R.I. discharge. The discharge at the field determined “bankfull” stage in the study reach ranges from 10.0 to 11.9 cfs/sq. mi. (Table 2). The drainage area increases from 104.6 sq. mi. at X-Sec 1 to 400 sq. miles at X-Sec 9 however the discharge per sq. mile remains in a very narrow range. While this is not “typical” of many watersheds, it should be noted that Macoupin Creek has a very uniform valley slope of approx. 2.4 ft per mile throughout the entire study reach that contributes to the similar discharge values.

Cross section 1 was chosen due to a stable rock bed that would severely limit the ability of Macoupin Creek to incise at this location. The “bankfull” discharge at this location should therefore be very near to the “top bank” elevation. The data shows that in fact the discharge calculations at top bank allow a discharge of 10.0 cfs/sq. mile which compares favorably with the USGS Gage at Kane for a 1.5 to 2 yr. R.I. discharge. Therefore the “bankfull” discharge at cross section 1 is assumed to be at top bank and has been used as a guide for other bankfull determinations in addition to field indicators.

Fig. 4 Cross Section 1 Location

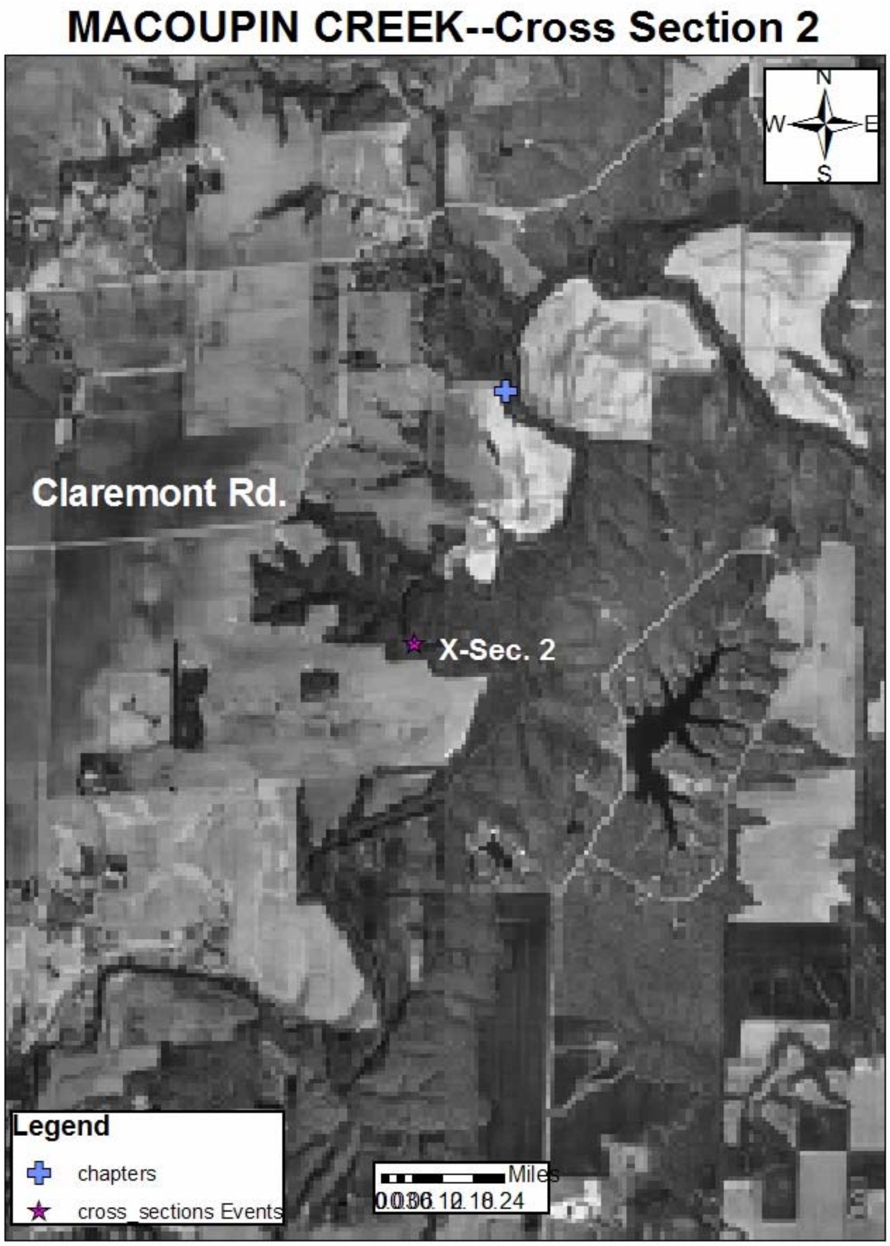


Fig. 5 Cross Section 2 Location

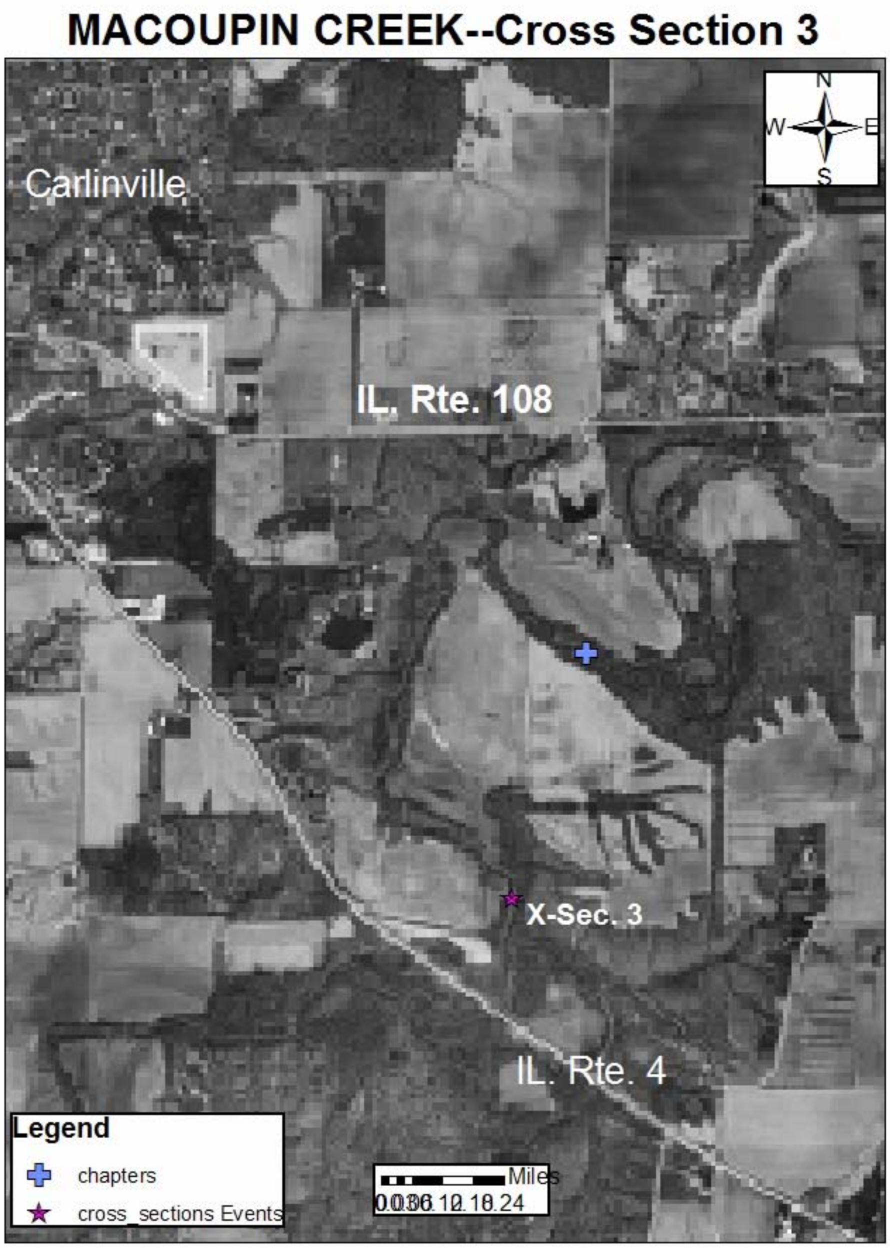


Fig. 6 Cross Section 3 Location

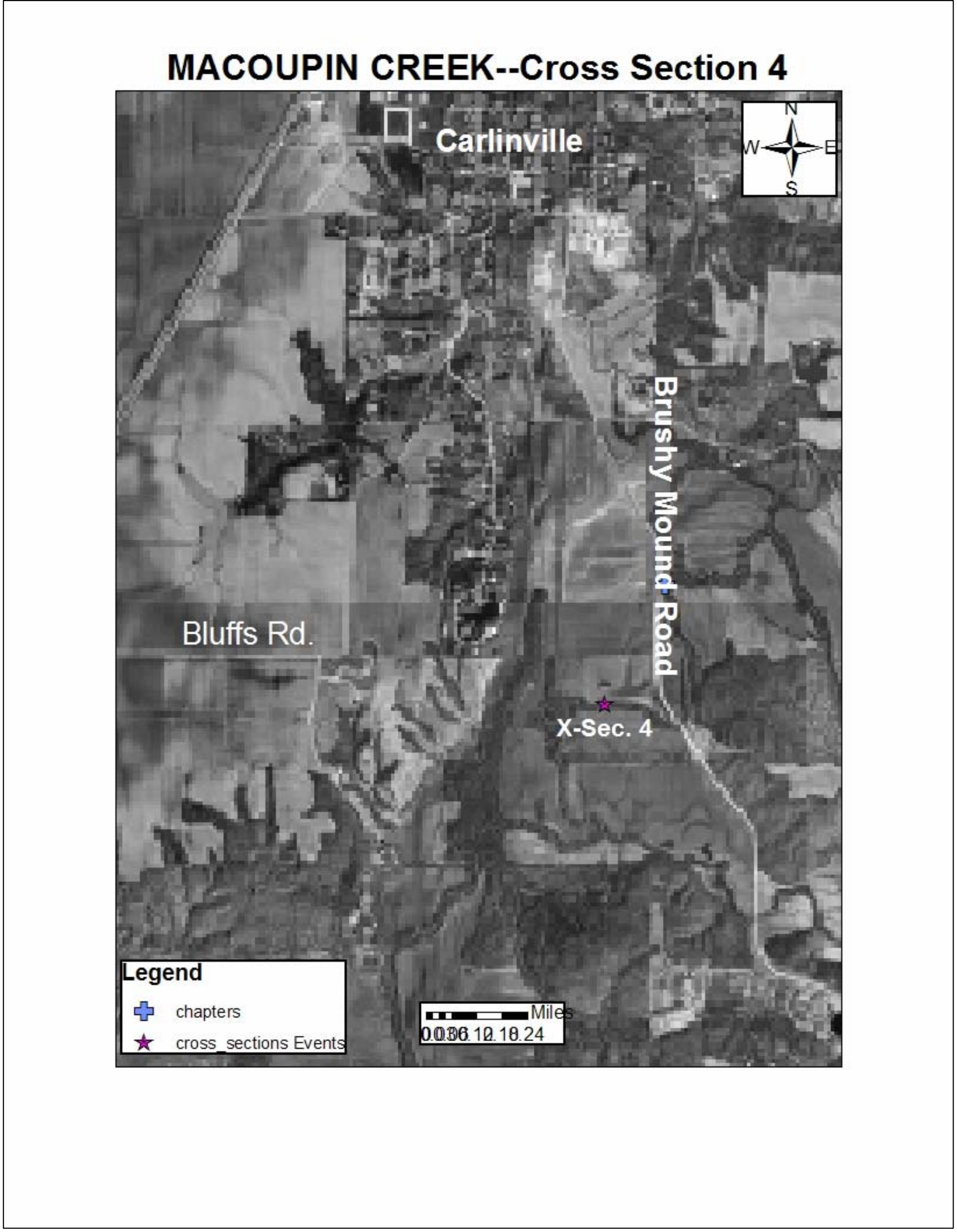


Fig. 7 Cross Section 4 Location

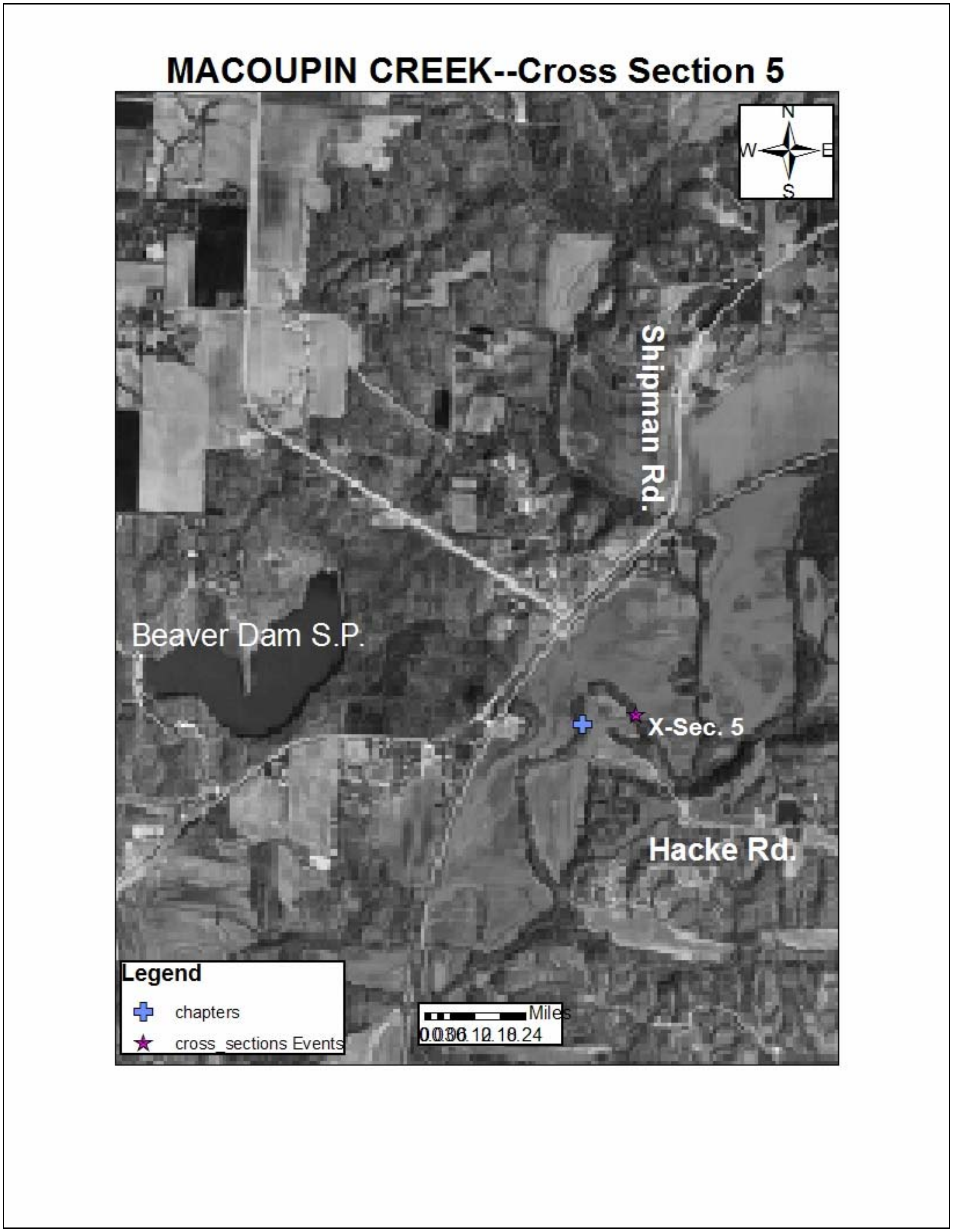


Fig. 8 Cross Section 5 Location

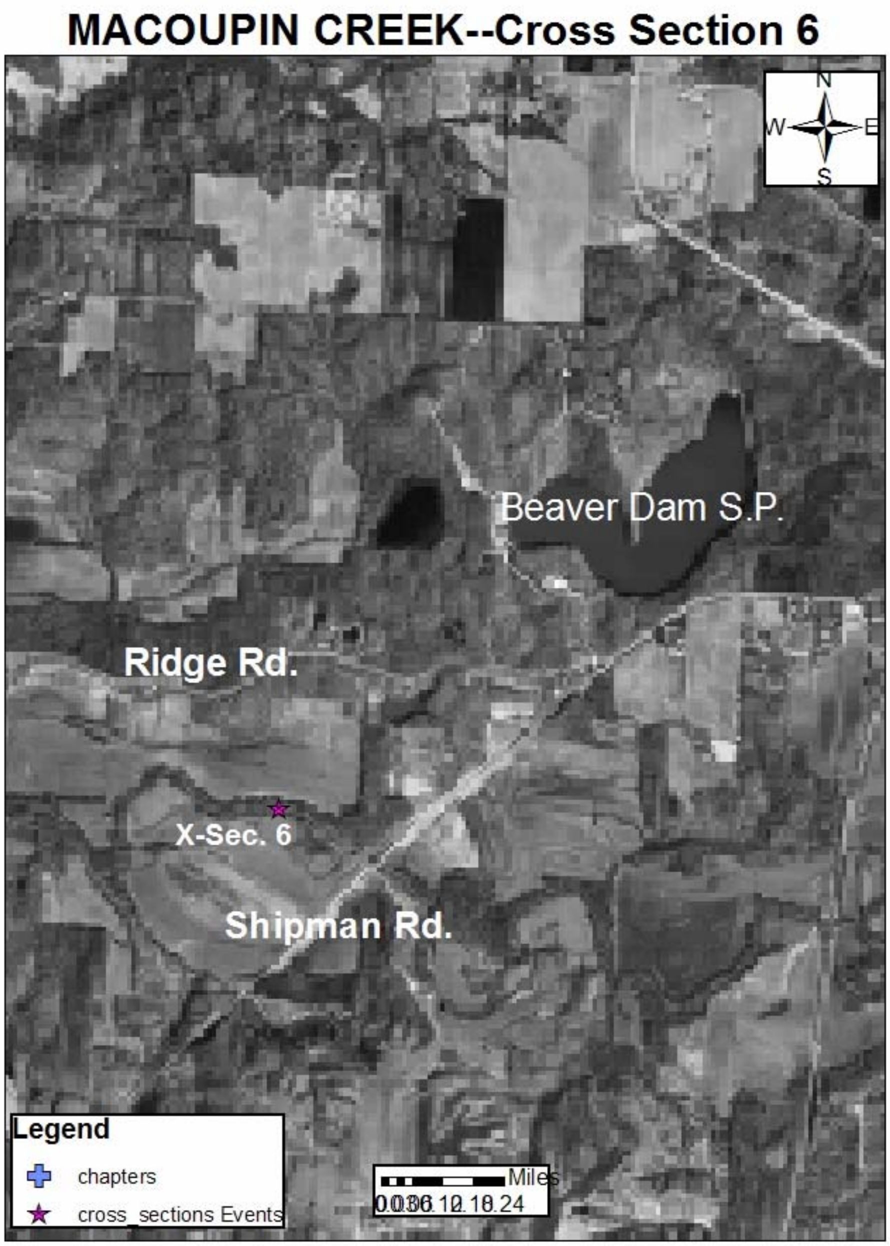


Figure 9 Cross Section 6 Location

Fig. 10 Cross Section 7 Location

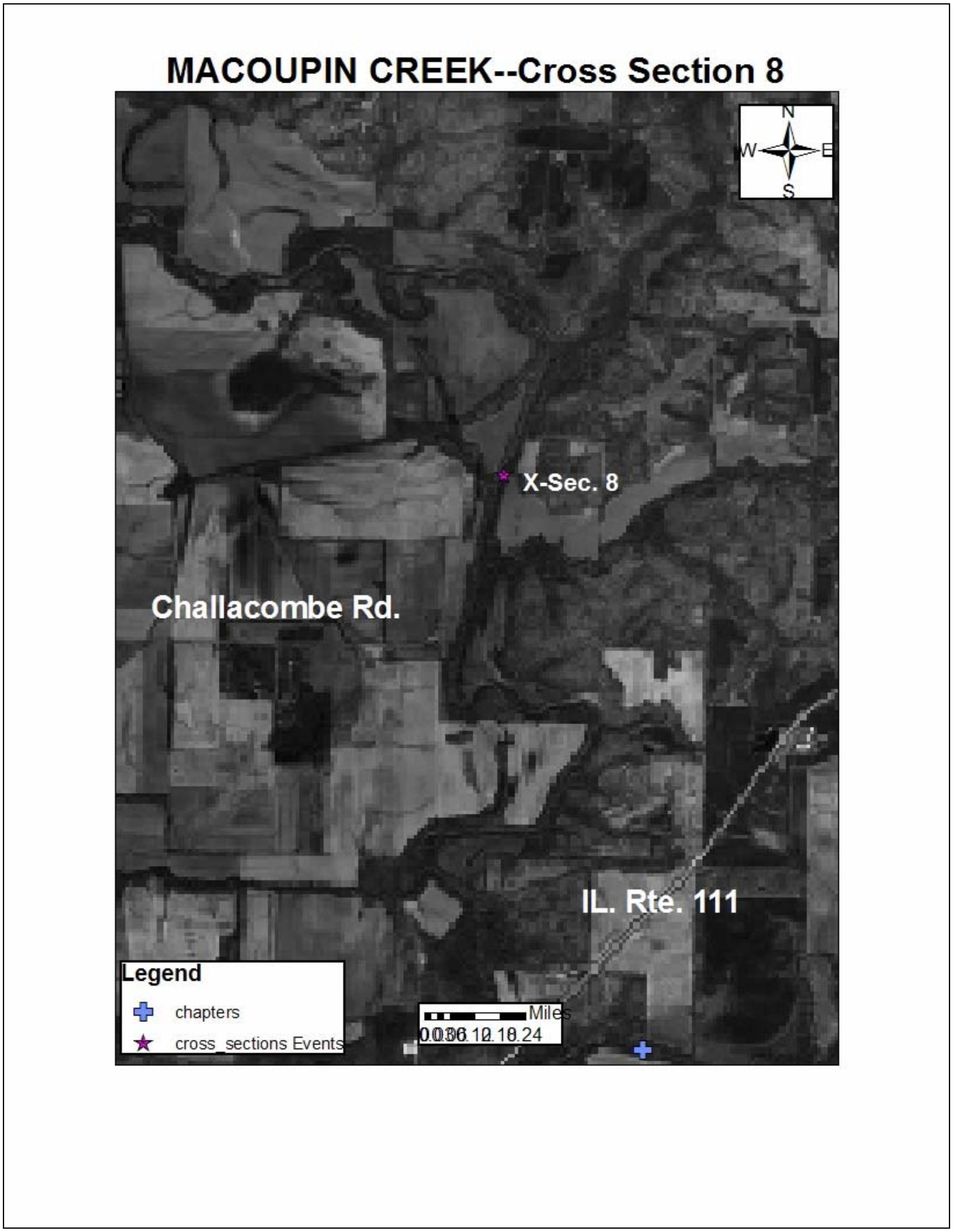


Fig. 11 Cross Section 8 Location

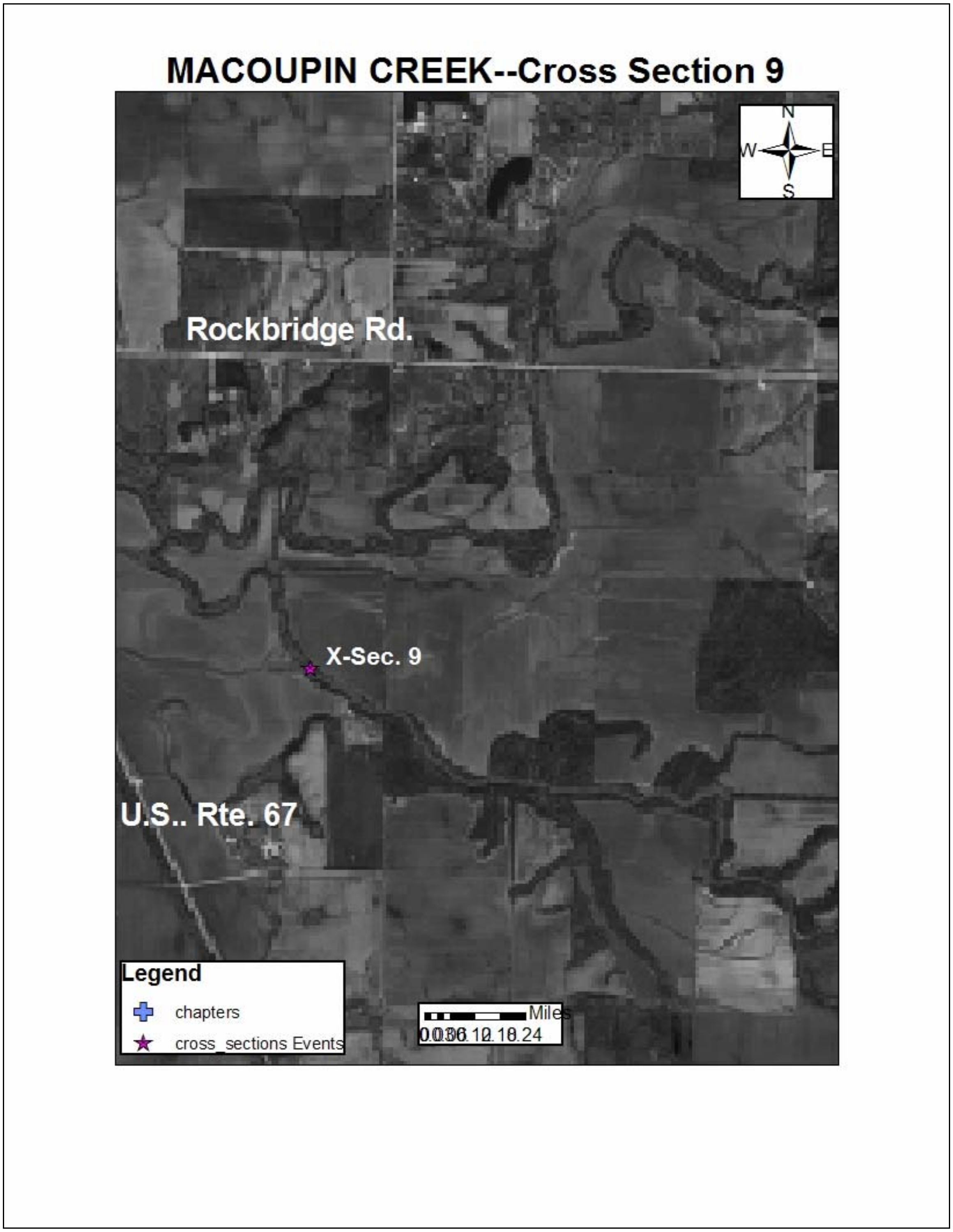


Fig. 12 Cross Section 9 Location

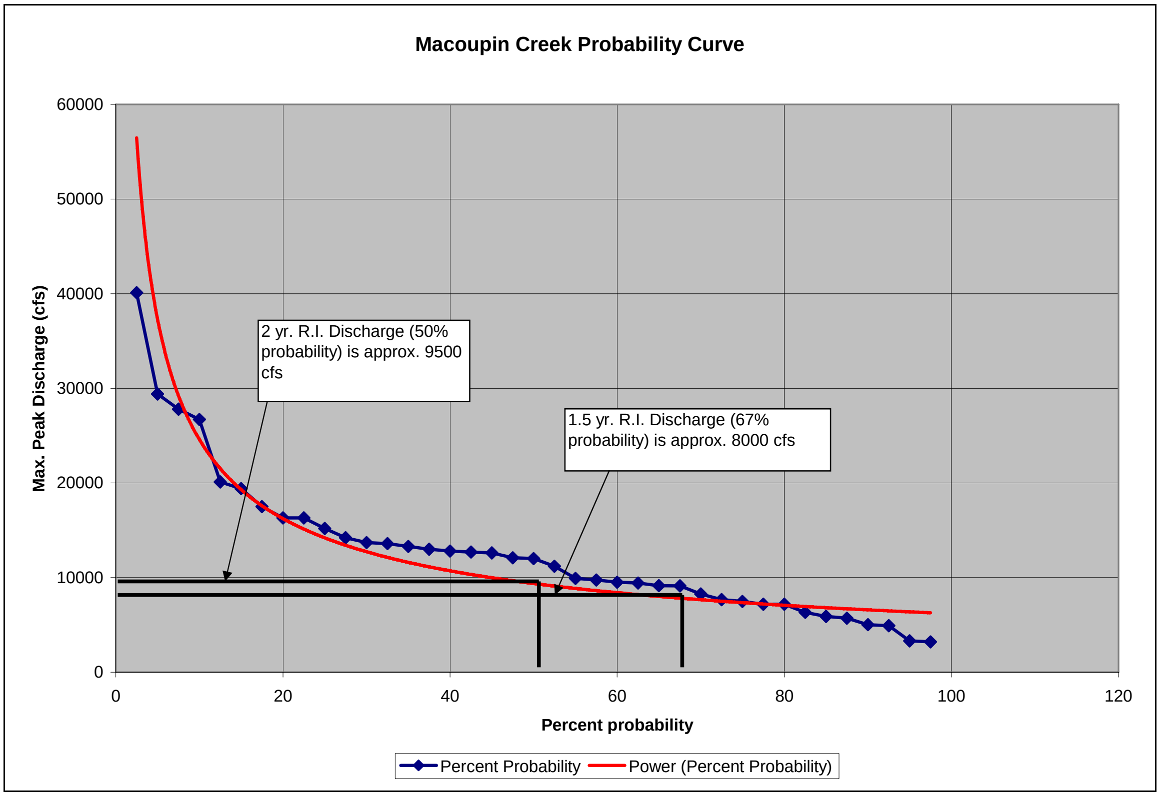


Fig. 13 Macoupin Creek Discharge Probability Curve (USGS Gage # 5587000) for 1965-2004.

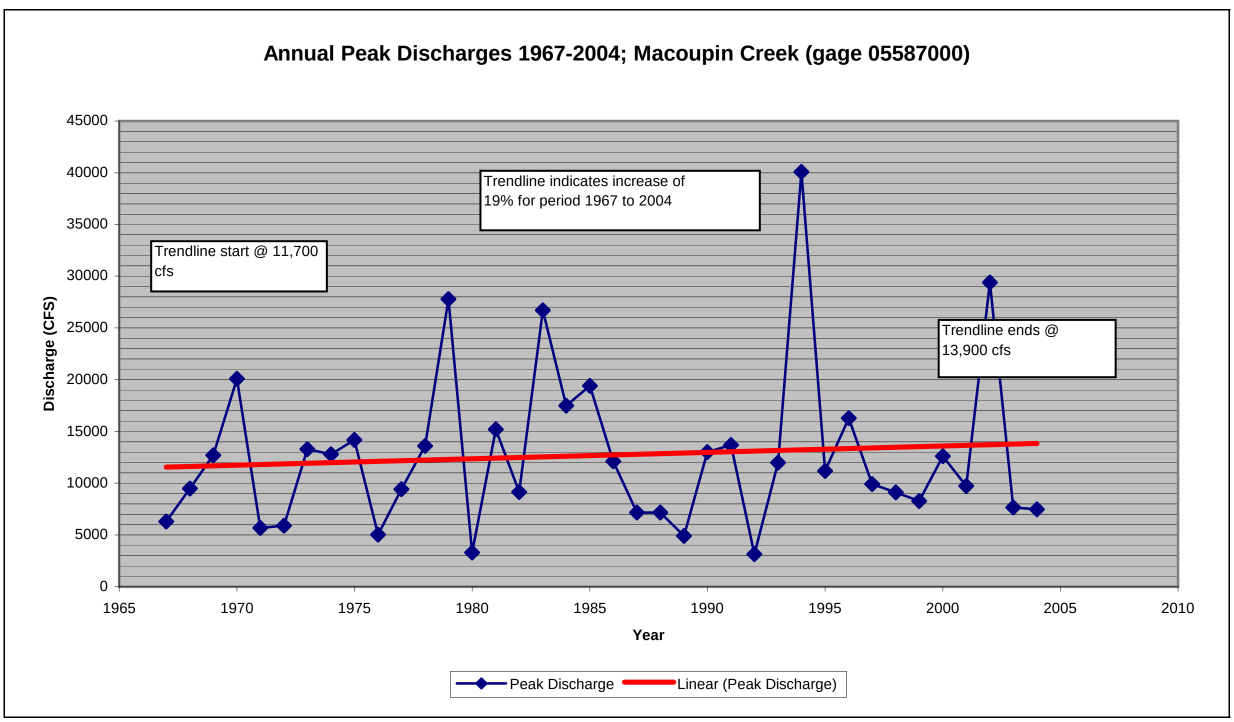


Fig. 14. Linear trendline for Annual Peak Discharge Macoupin Creek (1967-2004)

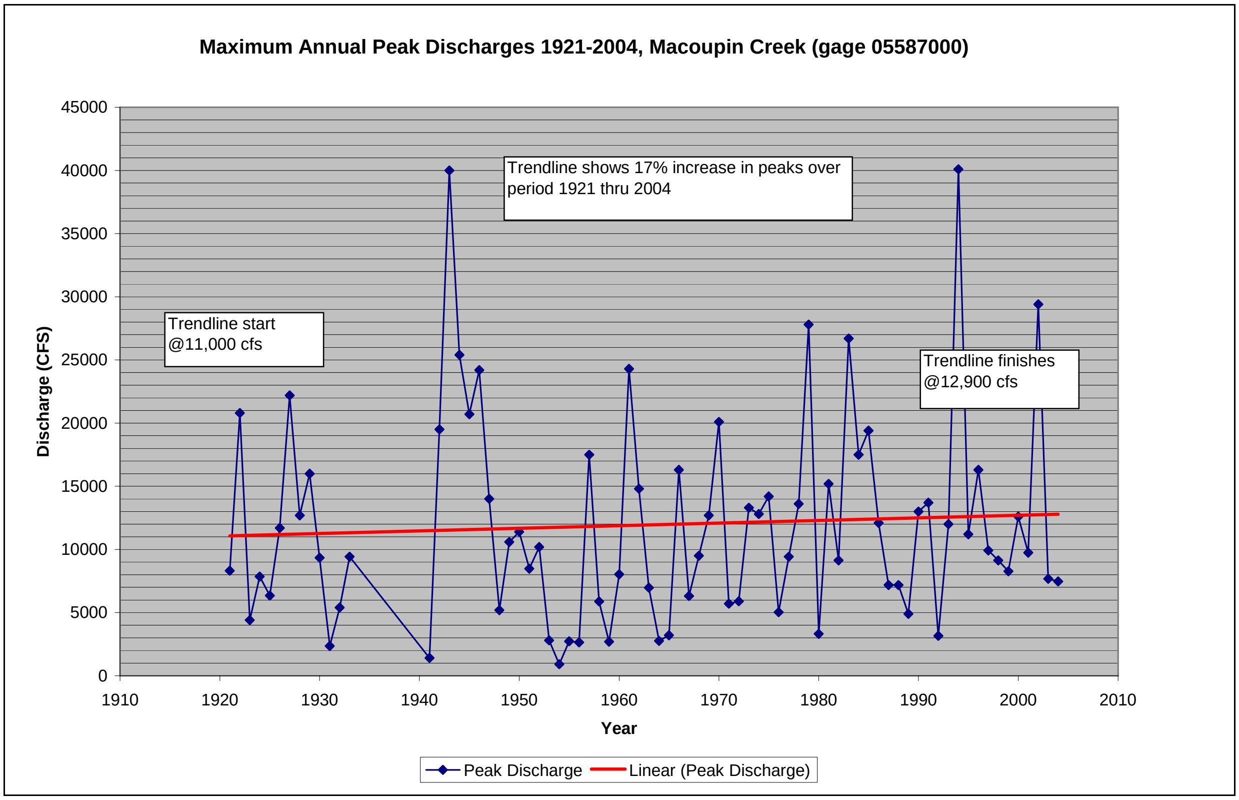


Fig. 15 Linear trendline for Annual Maximum Discharge Macoupin Creek 1921-2004

Macoupin Creek is experiencing extensive streambank erosion as indicated by the instances of erosion, severe erosion and geotechnical failures identified by the aerial assessment. (Table 1) Changes in landuse, climatic changes, etc. resulting in modified flow regimes can lead to system-wide channel adjustments resulting in extensive streambank erosion. Therefore, a plot of “Maximum Annual Peak Discharges” from USGS records at Gage #5587000 has been used to determine a trendline for annual peak flows which are the flows that in turn determine the channel dimensions over time. The plot was made for all records from 1921 thru 2004 and also for a shorter period of 1967-2004. The plots show an increase of 17% and 19% respectively when a linear trendline is applied to the data. Similar plots of 25 watersheds in Illinois for the 1967-2004 period range from an increase of 350% or more in Crab Orchard Creek near Marion IL to a decrease of 43% in Bay Creek near Pittsfield. Of the 25 USGS gages analyzed 16 were found to have increased trendlines in annual maximum peaks and 9 were found to have decreased trendlines for annual maximum peaks. Based on this analysis it is assumed that the streambank erosion in Macoupin Creek is not the result of a major change in flow regime causing a system wide adjustment.

A comparison of the “Max. Bankfull Depth” at geomorphic bankfull and the “Top Bank Depth” show that cross sections 2 thru 9 are all incised. The amount of incision ranges from 0.5 ft. to 5.9 feet with the most incision occurring at the lower three cross section locations. (Fig. 16) Incision then seems to be a more likely candidate to explain the extensive streambank erosion identified in the aerial assessment.

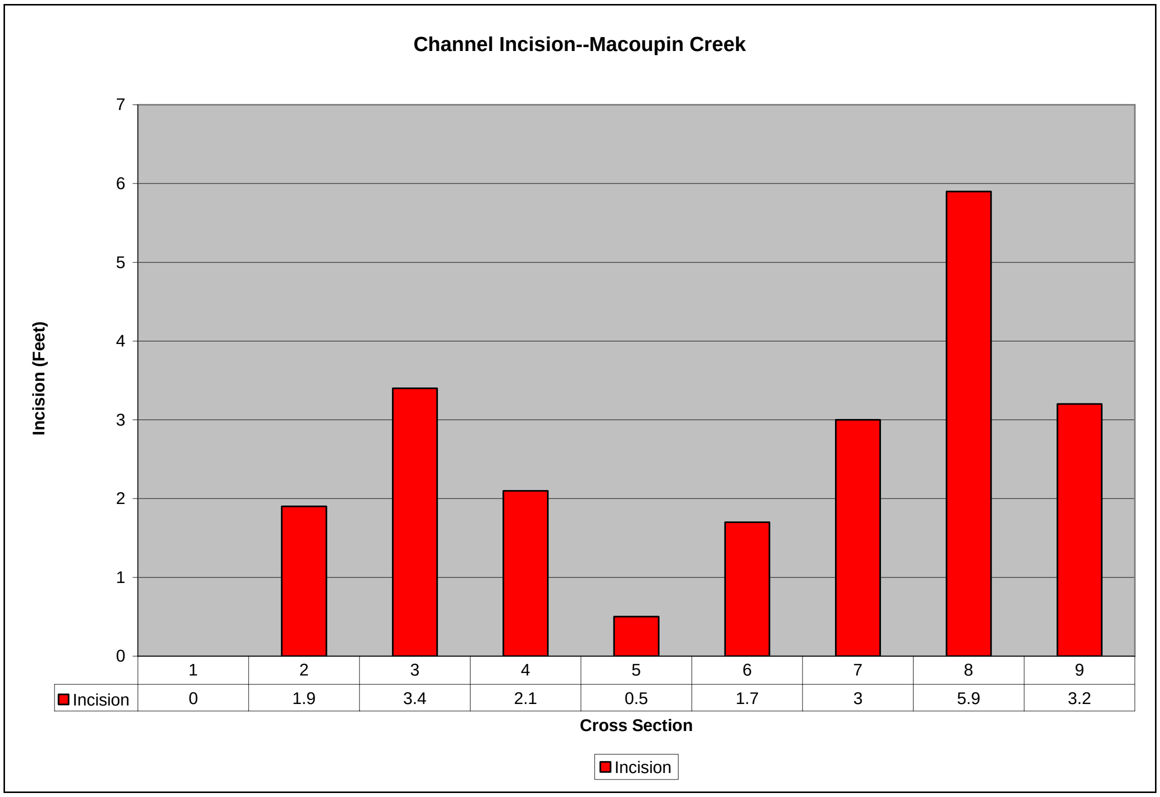


Fig. 16 Incision at cross section locations (riffles) on Macoupin Creek

General Observations

1. Aerial Assessment shows streambank erosion and geotechnical failures through out the entire study reach.
2. Chapter three is the most stable reach and it also has the highest occurrence of rock outcropping in the channel.
3. There are natural and/or manmade grade controls found at various points through out the study reach. These grade controls are critical to preventing even more incision from occurring and need to be maintained or improved.
4. There are significant areas of channel within the study reach that have been channelized and much more channelization has taken place below the study area. According to the “Upper Macoupin Creek Watershed Restoration Action Strategy Watershed Resource Inventory” completed by the Macoupin Co. SWCD in 2002, there has been 1.2 miles of Macoupin Creek channelized in the study reach and 10 miles of stream channelization below the project area completed in 1926. These channel modifications are the probable driving forces behind the observed incision.
5. One “grade control” stream crossing just below IL. Rte. 67 failed in 1995 by local accounts, and another upstream of IL. Rte. 67 has approx. 4 ft. of overfall and appears to be a likely candidate for failure as well. The failure of this second “grade control” would allow more incision to progress upstream through the study

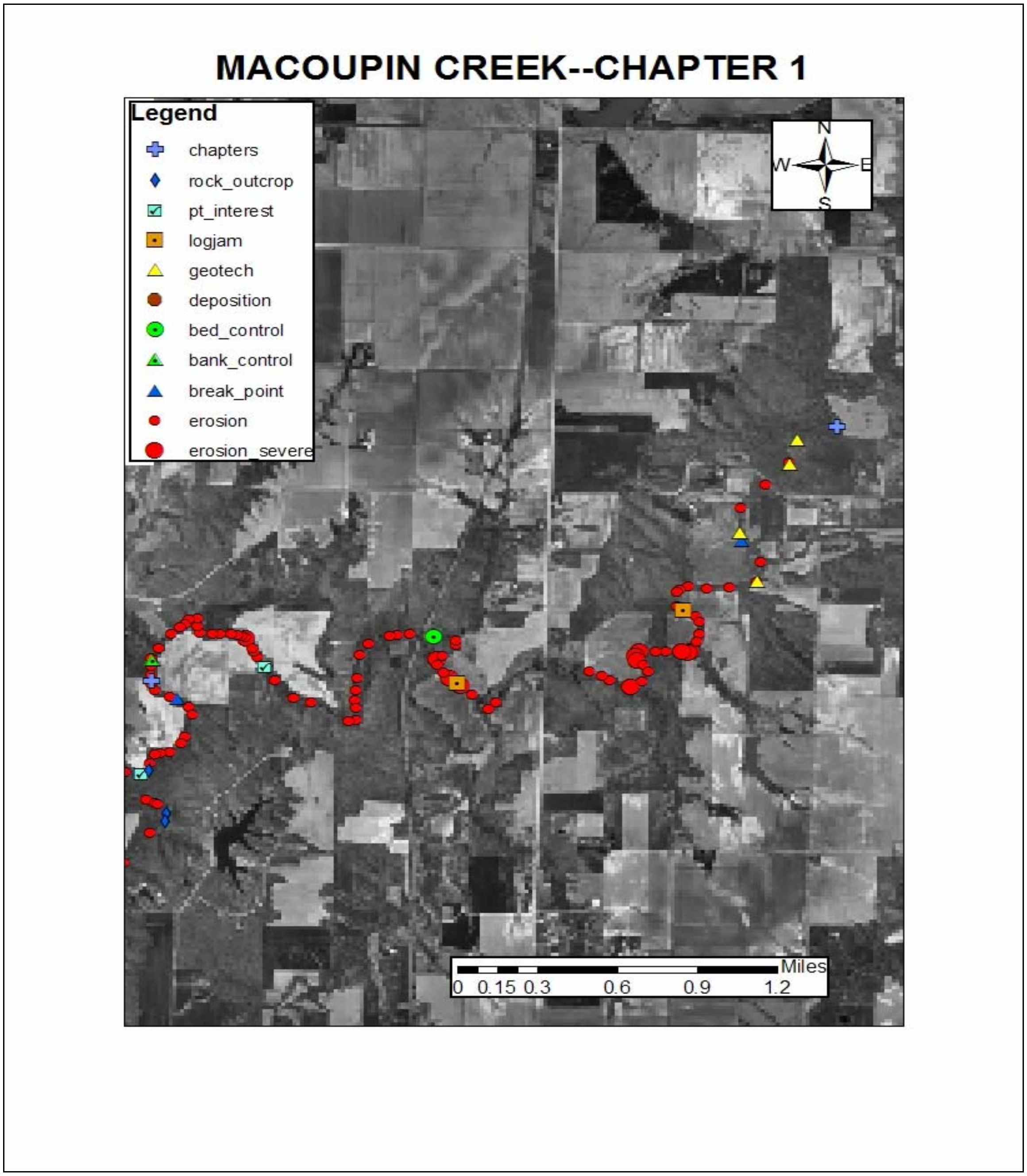
area, although there are some natural rock outcroppings that will at least partially control the incision.

6. Maintenance of existing grade controls and installation of additional grade control structures to halt the incision process appears to be the best immediate course of action and will enhance the opportunity to increase dissolved oxygen as well as reduce the contribution of manganese from streambank erosion and therefore help to meet the TMDL standards.

Conclusions and Recommendations:

Chapter 1

This reach begins near Coops Mound and extends downstream approx. 4.5 miles. Cross section #1 is located in this chapter on a stable rock bed at 11:08 on the DVD. There is also an existing concrete dam in this chapter at 16:12 on the DVD that appears to be in very good condition. Below the stable bed at 11:08 the streambank erosion increases dramatically. At 11:08 (X-sec 1) the channel is connected to the floodplain and there is no incision, but at X-sec 2 (21:43) the channel has incised by about 2 ft. The recommended treatment for this chapter below 11:08 is then to install Rock Riffle Grade Controls utilizing the existing structure at 16:12 as part of the overall design.
The total length needing Rock Riffles is approx. 2.7 miles found in two sections. Approx. a 1 mile reach above the Standard City Rd. and below X-sec.1, and a second reach approx. 1.7 miles long below the existing concrete structure. Six bankfull widths in Chapter 1 would suggest a spacing of 450 ft. and a height of 1.5 to 2.0 ft. Preliminary data suggests a riffle height of 3.5 ft. would not increase out of bank flow and therefore have no impact on surrounding landuse. Each Rock Riffle will then require about 300 tons of stone and a total of 11 riffles per mile would be required at 6 bankfull widths. The estimated cost is then approx. $9,000 per riffle and $99,000 per mile of stream channel. The total cost for grade control in Chapter 1 is then $267,300.
However, given the small diameter bedload and lack of “deposition” found, especially above the existing concrete structure, it may be feasible to consider widening the spacing of the Rock Riffles if sufficient data can be collected to insure that the bedload will continue to be passed through the stream channel. Under conditions similar to those found near the existing concrete structure, the riffles could possibly be spaced as much as 1500 ft. apart reducing the riffles required to approx. 4 per mile. The cost for grade control would then drop to $36,000 per mile or approx. $97,200 to treat Chapter 1.
There are a total of 80 erosion sites in Chapter 1, and some will require streambank stabilization in addition to the grade control. However the bed should first be stabilized before attempting to address the lateral migration and geotech failures, as erosion at many sites can be expected to be dramatically slowed or eliminated by the effects of the grade controls.

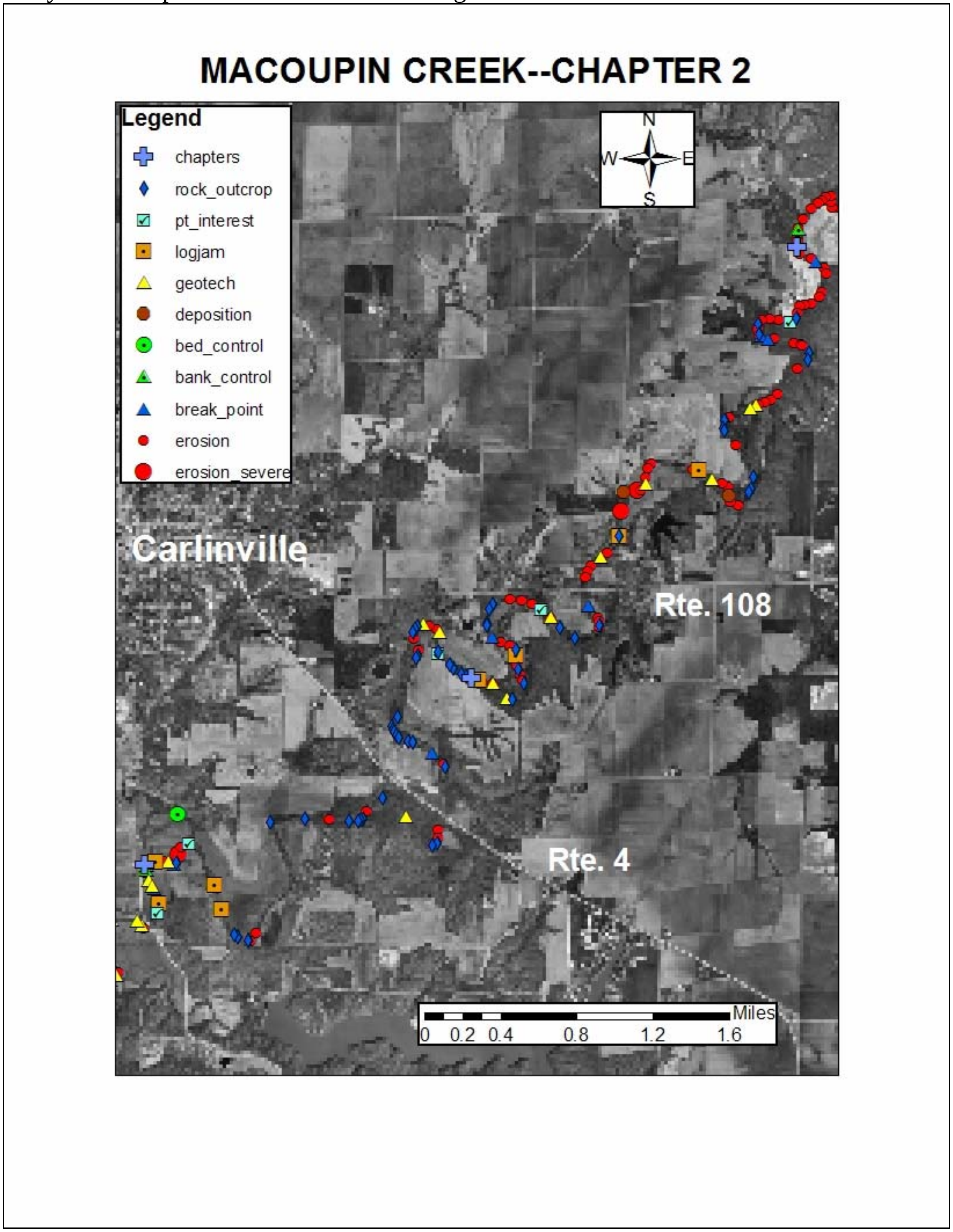


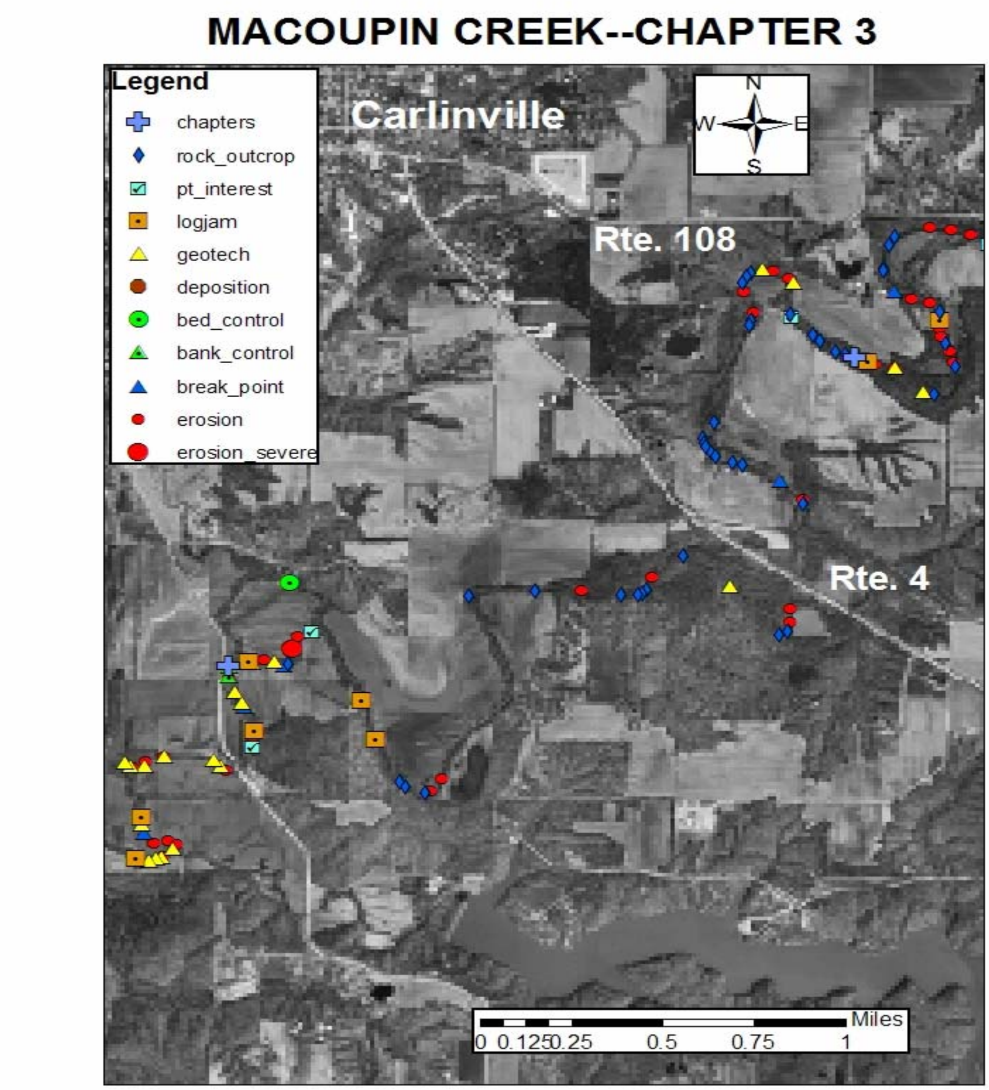
Chapter 2

This Chapter is approx. 5.4 miles long and ends about midway between IL. Rte. 108 and IL. Rte. 4. This reach of stream begins to be influenced by the rock outcrops found in the banks and sometimes the bed. However the channel has apparently incised 2 to 3 feet in this chapter and is a major factor in the 8 geotechnical failures identified. The lateral migration has created an additional 54 erosion sites. Again, using the same criteria for grade control to create riffle and pools in this 5.4 mile reach would require installation of a minimum of 4 riffles per mile if bedload can be passed or as many as 9 if spacing must be maintained at 6 bankfull widths. Each riffle in this chapter will require approx. 350

tons of stone at an estimated cost of $10,500 each. The cost per mile is then $42,000 under the first scenario or $94,500 under the closer spacing. Total cost for Chapter 2 is then $226,800 or $510,300 respectively.

Once again the use of streambank stabilization to control lateral migration should be delayed where possible until the effects of grade control can be determined.





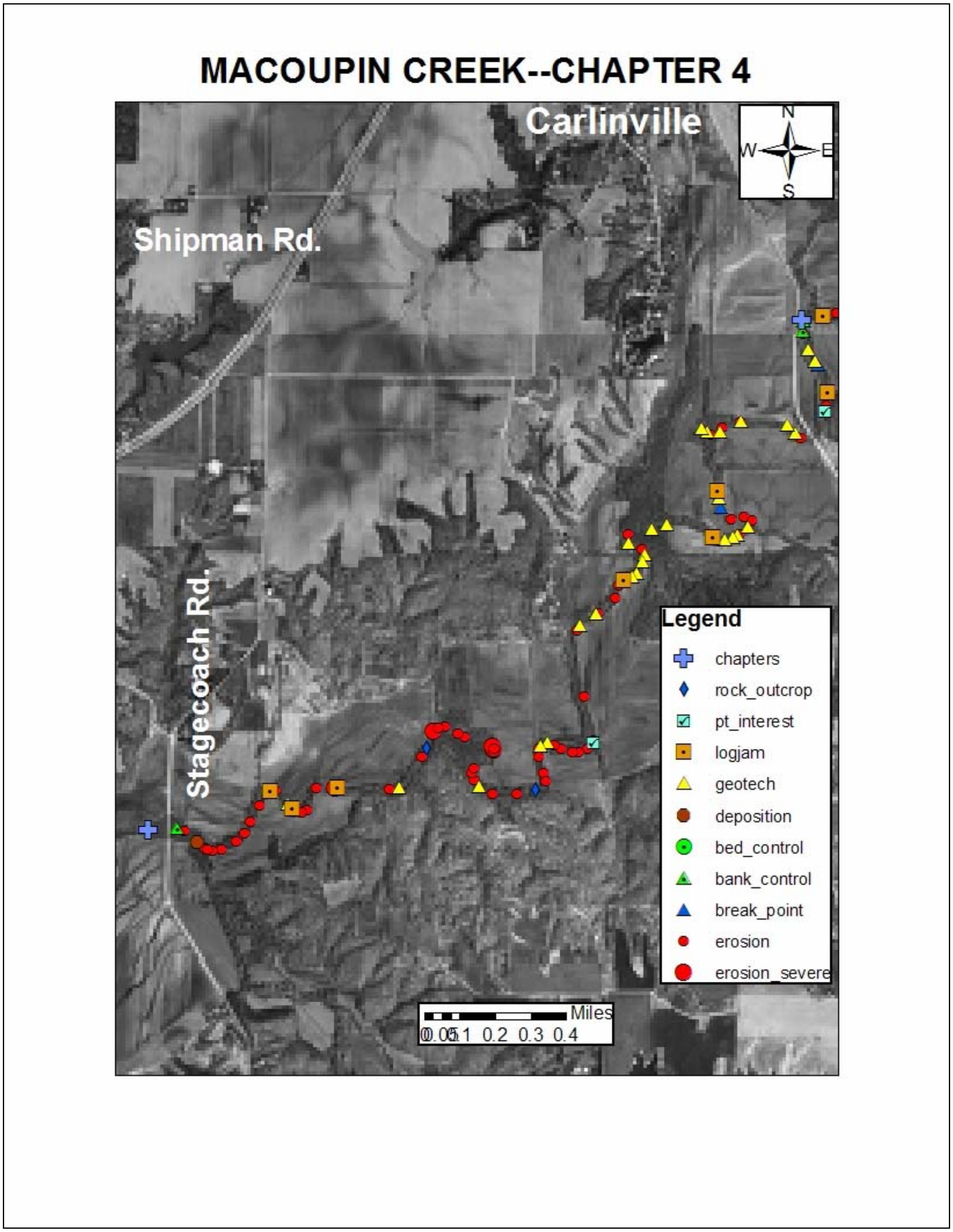
Chapter 3

This chapter begins midway between IL. Rte. 108 and IL. Rte. 4 and extends approx. 4.5 miles downstream. This reach is heavily influenced by rock outcrops in the banks and bed as evidenced by the presence of only 20 erosion sites in this entire reach, or about 25% of those found in Chapter 1. X-sec. 3 is located in this reach on a bedrock outcrop that extends across the bed of the channel approx. 500 ft upstream of IL. Rte. 4 (32:41 on DVD). However, this cross section indicates that the channel has incised over three feet in spite of the bedrock as the bedrock appears to be subject to fracturing and breaking when exposed to the elements.

The recommendations for Chapter 3 are again to install Rock Riffle grade controls to create riffles and pools to halt channel incision and dissipate energy to help provide stability for the streambanks.
This chapter will require 8 riffles per mile at a 6 bankfull width spacing or 4 riffles if bedload can be passed at the wider spacing. Each riffle will require approx. 375 tons of stone at an estimated cost of $11,250. The cost per mile will then be $90,000 under the first option or $45,000 at the wider spacing. Total cost per chapter will be $405,000 or $202,500 if option 2 proves to be feasible.
No recommendation is made for lateral migration at this time pending evaluation of the grade control structures effectiveness in stabilizing the stream channel.

Chapter 4

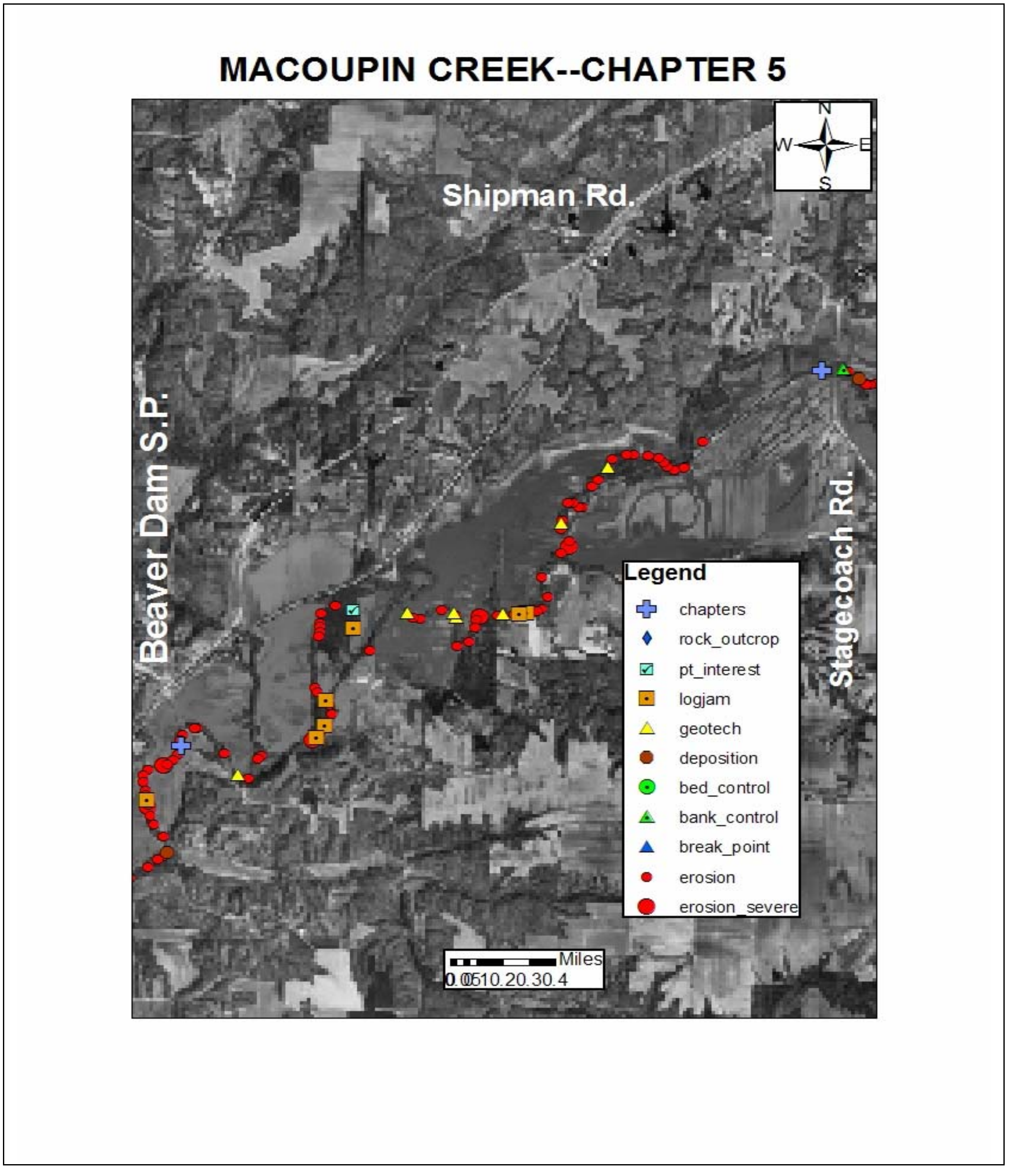
This chapter begins near Brushy Mound Road and ends at Stagecoach Road, a distance of approx. 3.9 miles. There are only two minor rock outcroppings in this chapter and the erosion sites are back up to a total of 86 with 27 of those being geotechnical failures.
At the very upper end of this chapter along Brushy Mound Road the channel impinges on the roadbank and a utility line potentially causing serious damage. One segment of this area has been treated with a traditional riprap technique, however an additional 1000 ft of bank treatment is needed to stabilize the area and prevent major damage. The use of Streambarbs and/or Stone Toe Protection would be warranted and the cost is estimated to be approx. $40,000. (DVD 40:06)
The upper two miles of this chapter contain most of the geotechnical failures and they appear to be the result of oversteepened banks and downcutting. X-sec. 4 is in this area and shows an incision of just over 2 feet and the channel shows signs of active downcutting, having a hard clay bed exposed in long segments.
The recommendation is to install Rock Riffle Grade control in this entire chapter with the cost per mile being approx. $60,000 per mile to install approx. 4 structures per mile at $15,000 per structure. The bedload in this reach is silt and clay and it highly likely that the spacing can be expanded to the wider spacing with no danger of preventing bedload transport. Additionally preliminary data suggest the riffle height can be increased to as much as 4-5 ft. without impacting out of bank flow. Therefore the preliminary estimate is for riffles in this chapter to be approx. 3 ft. high. The total cost for grade control in chapter 4 is then $234,000.


MACOUPIN CREEK--CHAPTER 4
Carlinville
Shipman Rd.
Stagecoach Rd.
N
W
E
S
Legend
chapters
rock_outcrop
pt_interest
logjam
geotech
deposition
bed_control
bank_control
break_point
erosion
erosion_severe
Miles
0 0.05 0.1 0.2 0.3 0.4

Chapter 5

This Chapter begins immediately below Stagecoach Road and extends downstream for 4.5 miles to near Macoupin Station. The upper end of this chapter begins with a channelized section of approx. 1 mile that appears stable with no erosion sites identified. Immediately below the channelized reach erosion sites become apparent with 66 sites identified in the remaining 3.5 miles of channel. X-sec. 5 is located near the end of this chapter and little or no incision has occurred at this site with only 0.5 ft. difference between “bankfull” depth and “top bank” depth. However, due to the low gradient of the stream and the depth of flow preliminary calculations show that even at this X-sec. riffles can be constructed up to 4 ft. high without creating increased flooding. Therefore the recommendation to reduce streambank erosion, increase DO and reduce the manganese from eroding banks is to install Rock Riffle grade controls. A profile survey will be particularly important in designing this reach as this area floods more frequently that some and there will be a need to substantiate the fact that riffles can be installed without effecting flooding.

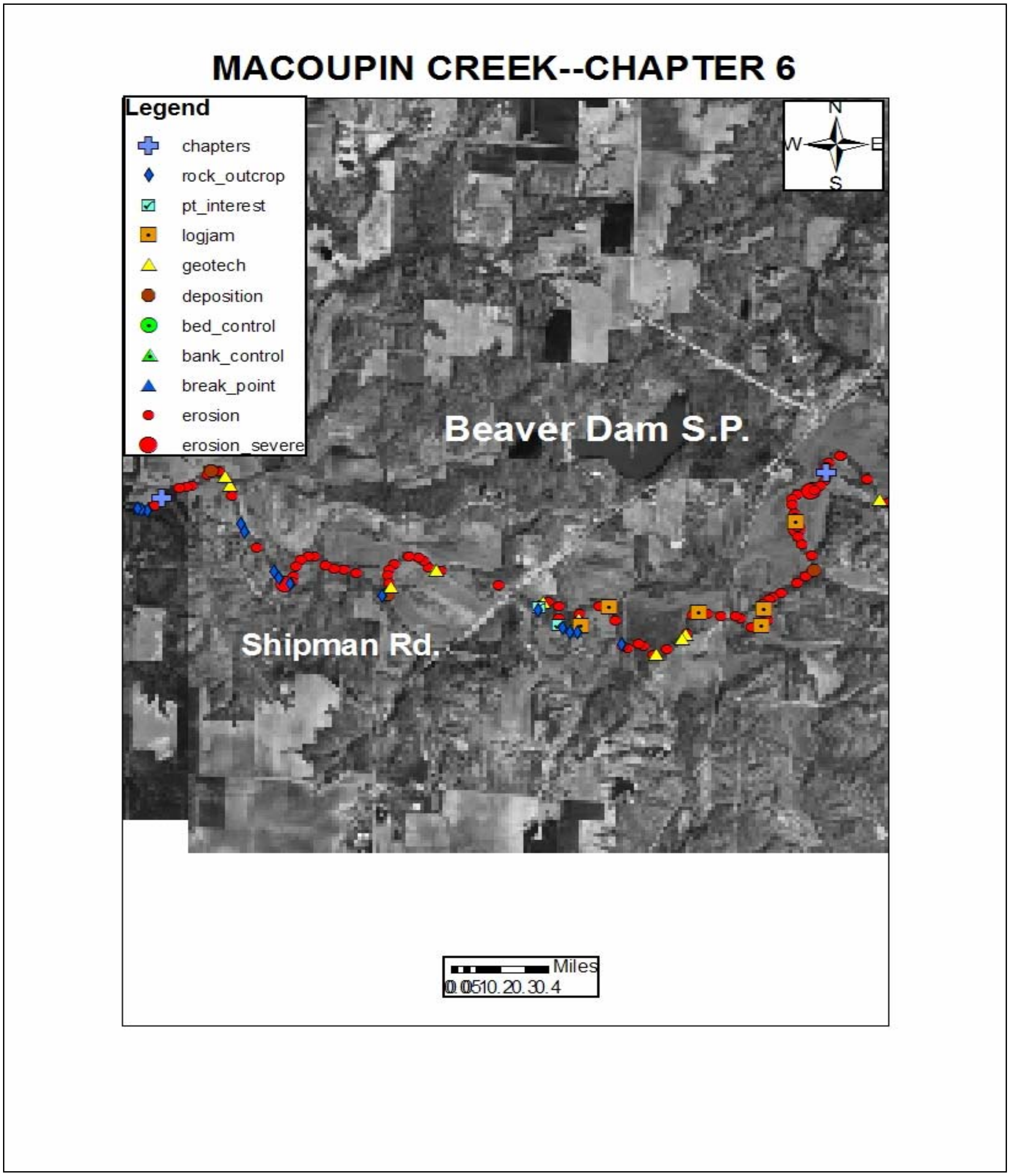
Riffles will be required at a rate of 4 riffles per mile and at 2 ft. high will require 375 tons of stone for each riffle. The estimated cost is then $11,250 per riffle or $45,000 per mile. The total cost for chapter 5 is then $202,500.



Chapter 6

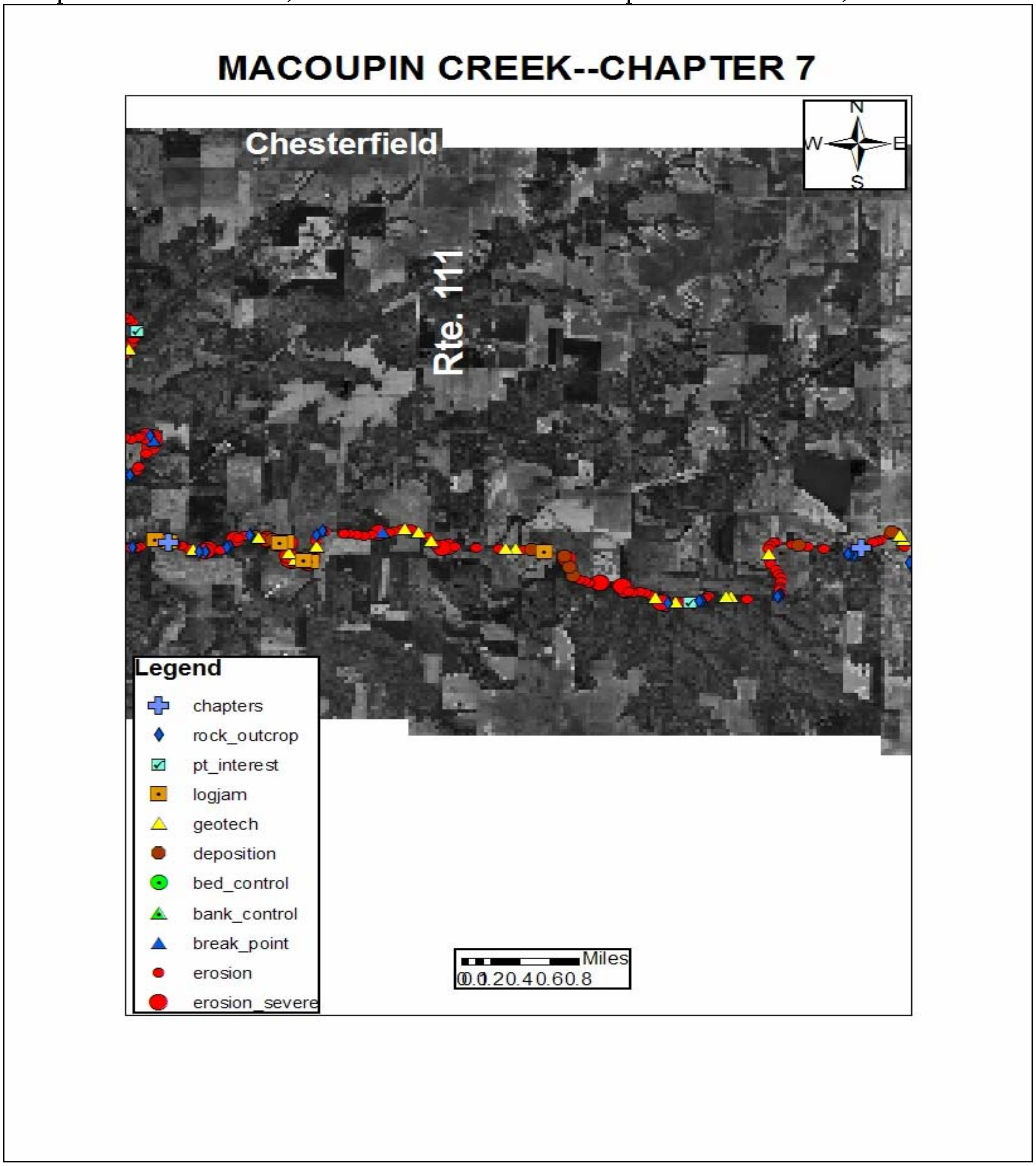
This chapter begins near Macoupin Station and ends approx. one half mile below the bridge on Ridge Road. The total length is approx. 4.5 miles. Unlike chapter 5 there are once again numerous locations with rock outcropping in the banks, but there is no bed control identified in this reach. X-sec. 6 in this chapter and indicates past incision of approx. 1.7 ft. with the preliminary calculation that 5 ft. riffles will not increase flooding at this site.

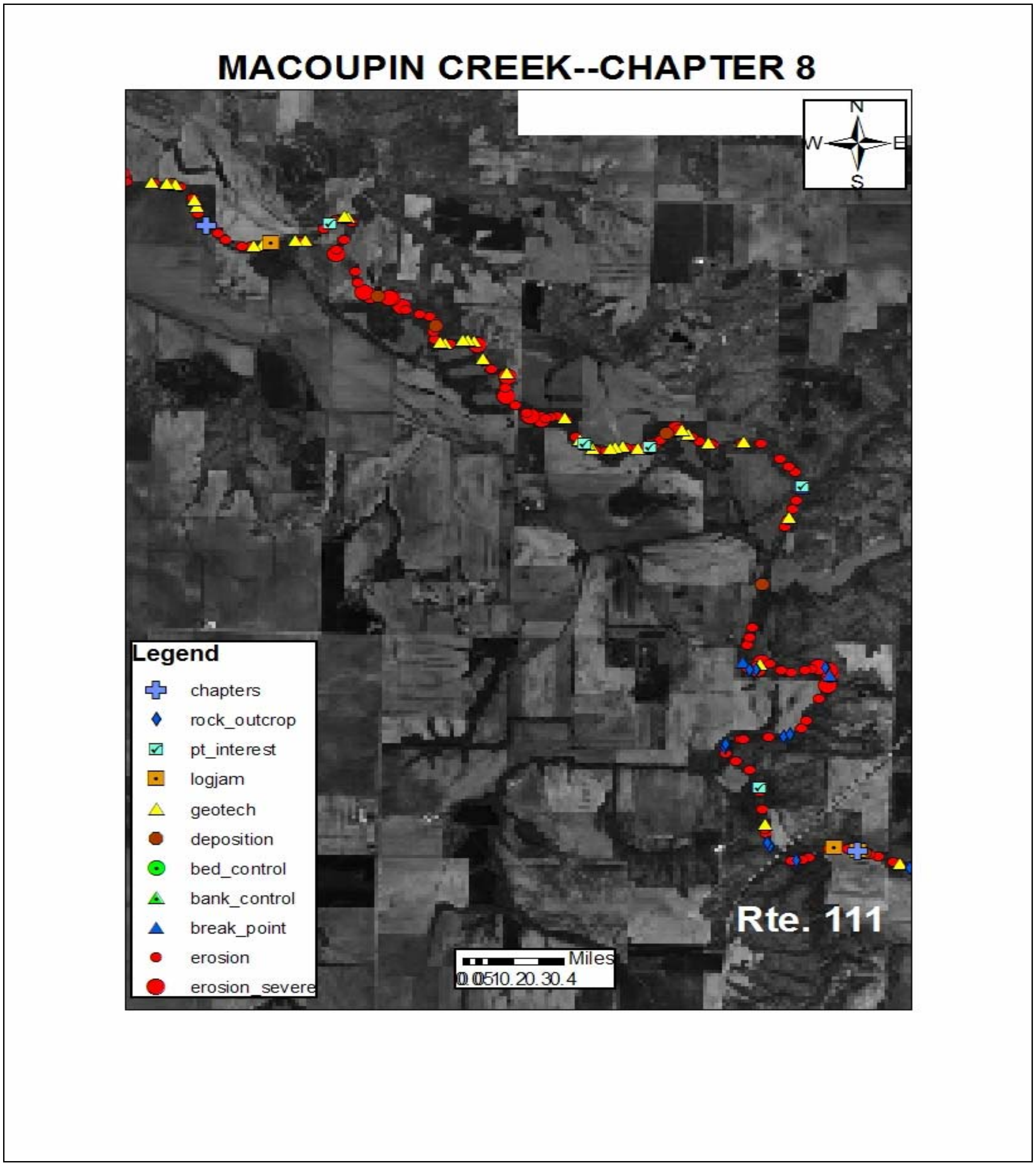
In order to improve DO, stabilize the streambanks and reduce manganese contributions to the stream the riffle pool sequence is again proposed. The riffles in this chapter are estimated at 3.0 ft. high and require 500 tons per structure. The estimates cost is then $15,000 per riffle and 4 will be required for each mile of stream channel. The cost per mile will then be $60,000 and the total cost for this chapter will be $270,000.



Chapter 7

This Chapter begins below Ridge Rd. and extends downstream for approx. 5.75 miles ending approx. 0.4 mile above IL. Rte. 111. Cross section 7 is located in a channelized portion of this reach and indicates and incision of approx. 3.0 ft. There are over 100 erosion sites identified in this reach including 15 geotechnical failures that are presumed to be the result of the incision. This reach has definite active knickzones and has been channelized in several places. The preliminary calculation on riffles in this reach indicates a riffle height of 4 ft. will have no impact on flooding, therefore riffles are recommended at 3 ft high and 4 structures per mile. With cost similar to Chapter 6 the cost per mile will be $60,000 and the total cost for chapter 7 will be $345,000.





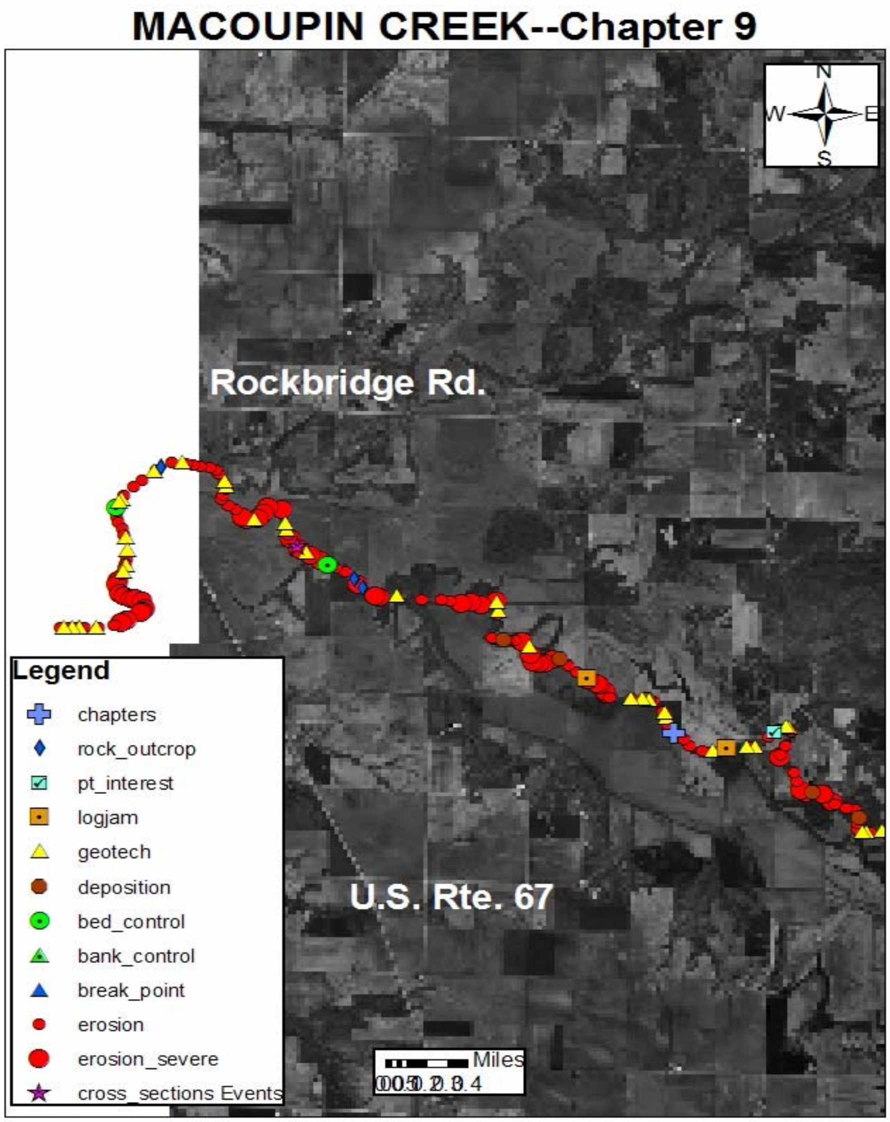
Chapter 8

This chapter begins approx. 0.4 mile above IL. Rte. 111 and extends downstream for 6 miles. This section is severely incised with X-sec 8 indicating an incision of over 5 ft. and there are 125 erosion sites identified. Twenty-eight of these erosion sites are geotechnical failure resulting from the incision.

This chapter represents the impact that will increasingly occur in the upper chapters if the incision is not addressed. It appears that the degradation has been greatest in this reach and no natural grade control has been identified to prevent the degradation from continueing to work upstream. There is a grade break on natural stone at DVD time 43:15 but it is unconsolidated stone and will not likely prevent the advancement of the downcutting. In this reach the riffles can be up to 5 ft. high with no increase in flooding, therefore the recommendation is to install riffle at 3.0 ft. high at 4 per mile. The cost estimate of each structure in this reach is $24,000 or $96,000 per mile. The total cost of riffles in chapter 8 is then $576,000.

Chapter 9

This chapter is approx. 5 miles long and ends below U.S. Rte. 67 approx. 0.75 mile. At the end of this chapter (57:15) there is an old road crossing that failed in 1995 according to local residents. The failure of this crossing has initiated more incision and a second crossing upstream at 53:44 appears to be holding back several feet of incision. Priority should be given to insuring that this crossing is maintained. In addition at 56:11 there is a manmade rock structure at a former bridge location that is slowing the progress of the incision initiated downstream. Incision at cross section 9 is estimated at 3.2 feet.
Again the preliminary calculations show that riffles can be constructed 5 ft. high with no increase in flooding. Therefore the recommendation is to construct 4 riffles per mile to a 3 ft. height at a cost of $24,000 per structure. The cost per mile is then $96,000 and the total cost for Chapter 9 is $480,000.



Summary

Macoupin Creek is being severely impacted by both past and active incision. Due to the modest velocities rock riffles can installed at significant heights of 2, 3, 4 or even 5 ft. creating significant turbulence on the backslopes with potential to increase the dissolved oxygen levels. In addition the riffles will provide additional stability to the streambanks, reduce geotechnical failures, and therefore reduce the input of sediment, especially sediment from the lower portions of the bank that are high in manganese.

Spacing of the Rock Riffles should be determined during the design phase when an accurate determination of bedload transport can be developed. However, observation of existing crossings, structures, etc. would suggest that a spacing of 6 bankfull width may not be required on Macoupin Creek to maintain pool depths.
Treatment of lateral migration on Macoupin Creek should be deferred until the riffle pool structures are constructed and evaluated to determine their effectiveness in reducing streambank migration and erosion.

Estimated Cost of Rock Riffles in Macoupin Creek by DVD Chapter

Chapter	Length (mi.)	No. Riffles	Cost/Mile	Total Cost
1	4.5	11-30	$36,000-99,000	$97-267,000
2	5.4	22-49	$42,000-94,500	$226-510,000
3	4.5	18-36	$45,000-90,000	$202-405,000
4	3.9	16	$60,000	$234,000
5	4.5	18	$45,000	$202,500
6	4.5	18	$60,000	$270,000
7	5.75	23	$60,000	$345,000
8	6	24	$96,000	$576,000
9	5	20	$96,000	$480,000
Total	44.05 mi	170-234		$2,635,500- $3,289,500

APPENDIX **A**

CROSS SECTION DATA