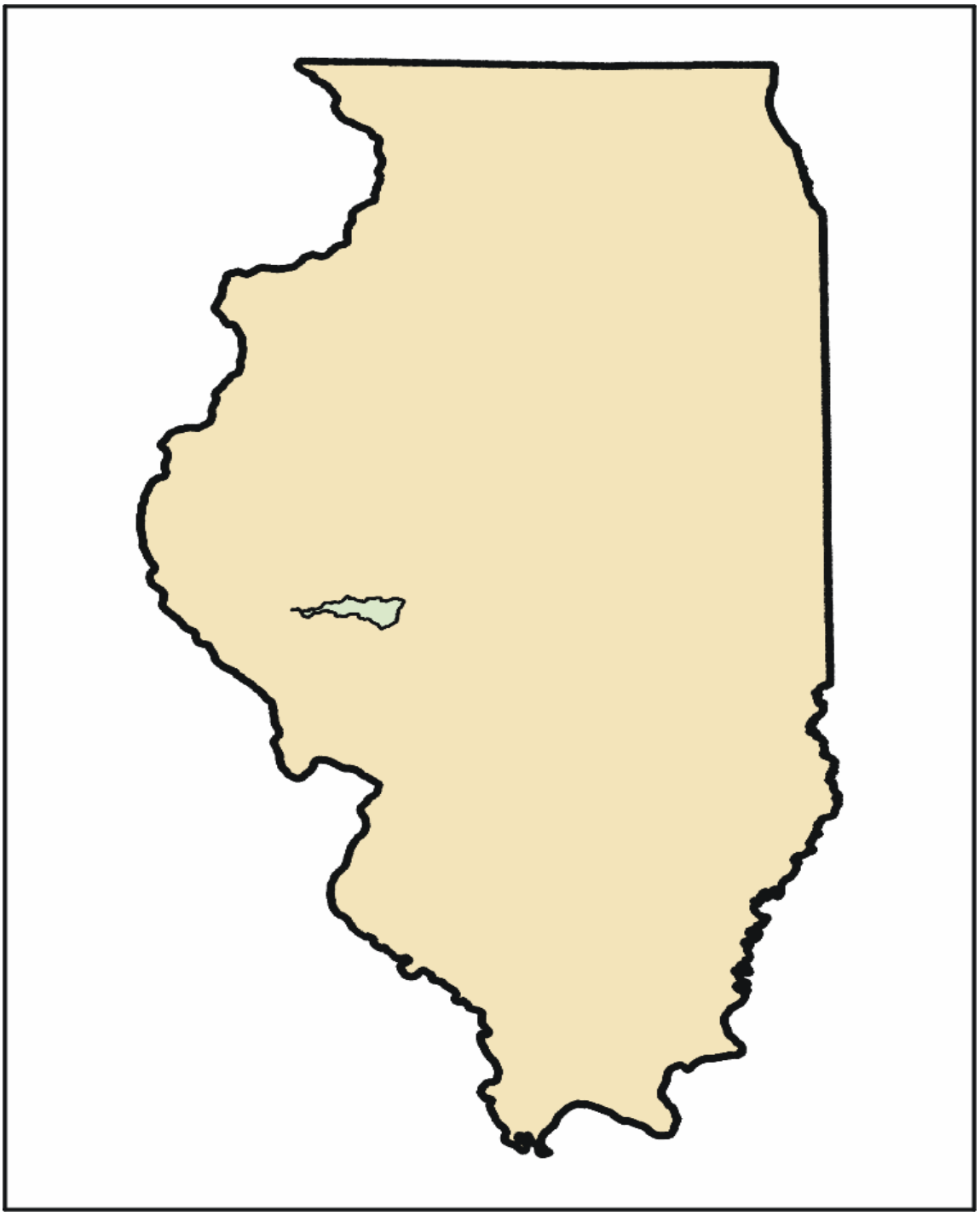


Aerial Assessment Report on Mauvaise Terre River
June 2005

Prepared for IL Dept. of Agriculture by Wayne Kinney

The impaired water in this project is Mauvaise Terre Lake, North Fork Mauvaise Terre Creek and Mauvaise Terre River. In August 2004 the Quarterly Progress Report by Limno-Tech, Inc. found Mauvaise Terre Lake to be impaired by phosphorus, nitrate and manganese. North Fork Mauvaise Terre Creek is impaired by manganese and low dissolved oxygen while Mauvaise Terre River is impaired by fecal coliform bacteria.

The conclusions of the report find that the potential sources of phosphorus and nitrate to Mauvaise Terre Lake include agricultural sources, existing sediments, treated combined sewer discharges, and possibly failing private sewage disposal systems. The primary source of manganese to both Mauvaise Terre Lake and North Fork Mauvaise Terre Creek may be background sources due to naturally high concentrations in area soils. The primary source of low dissolved oxygen in North Fork Mauvaise Terre Creek is agricultural runoff.

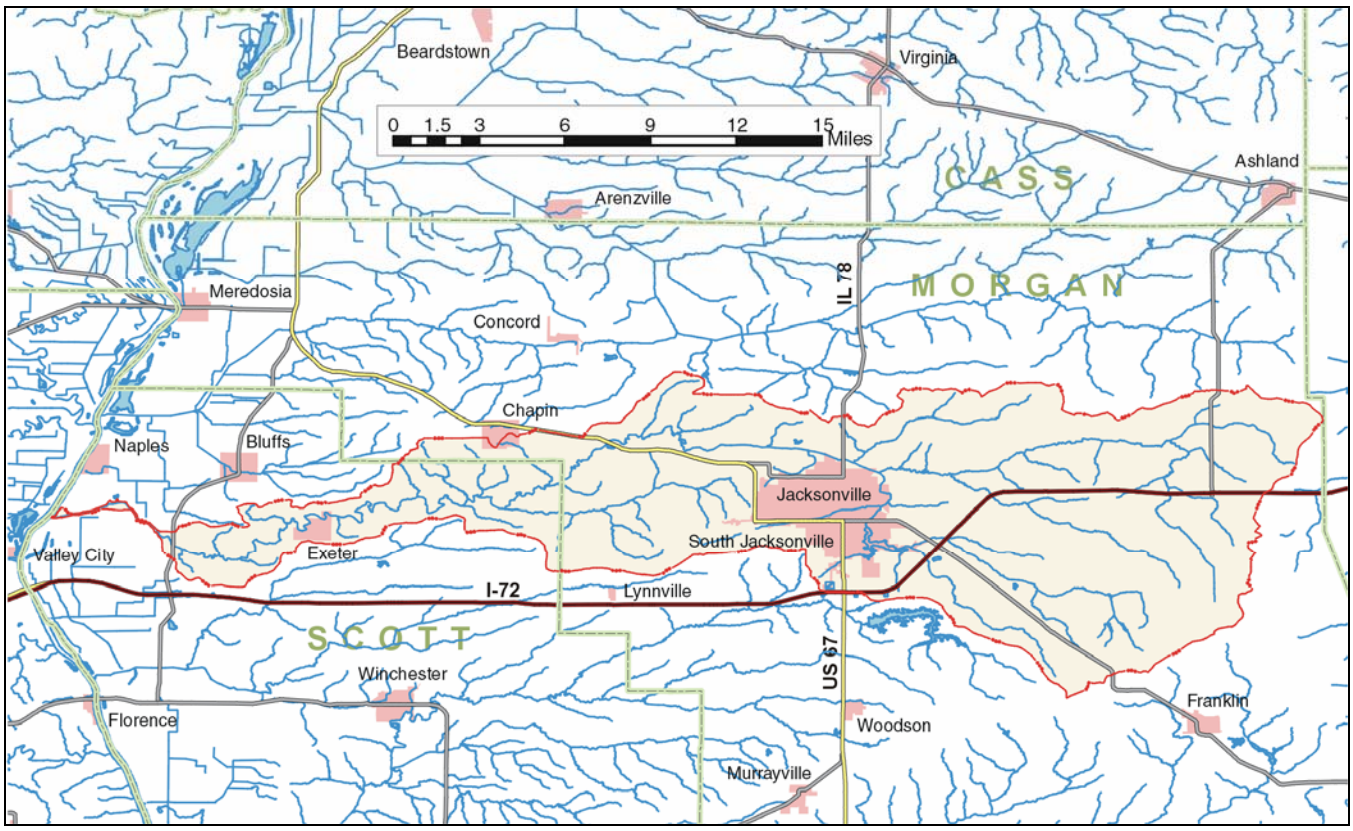


Fig. 1 Project Area Map

Assessment Procedure

Low level geo-referenced video was taken of Mauvaise Terre Creek and Mauvaise Terre River in April, 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 the confluence Mauvaise Terre River and the Illinois River near Naples, IL. Video mapping progressed upstream until the stream size and vegetative cover would not allow the

capture of useful video images near Interstate 72 just east of Jacksonville, IL. 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.

Ground investigations or "ground truthing" was then completed for IDOA 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.

Detailed elevation data is not available; therefore the channel slope is calculated from USGS topo maps by measuring the channel length between contour lines (Fig. 3). 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 assumed 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.

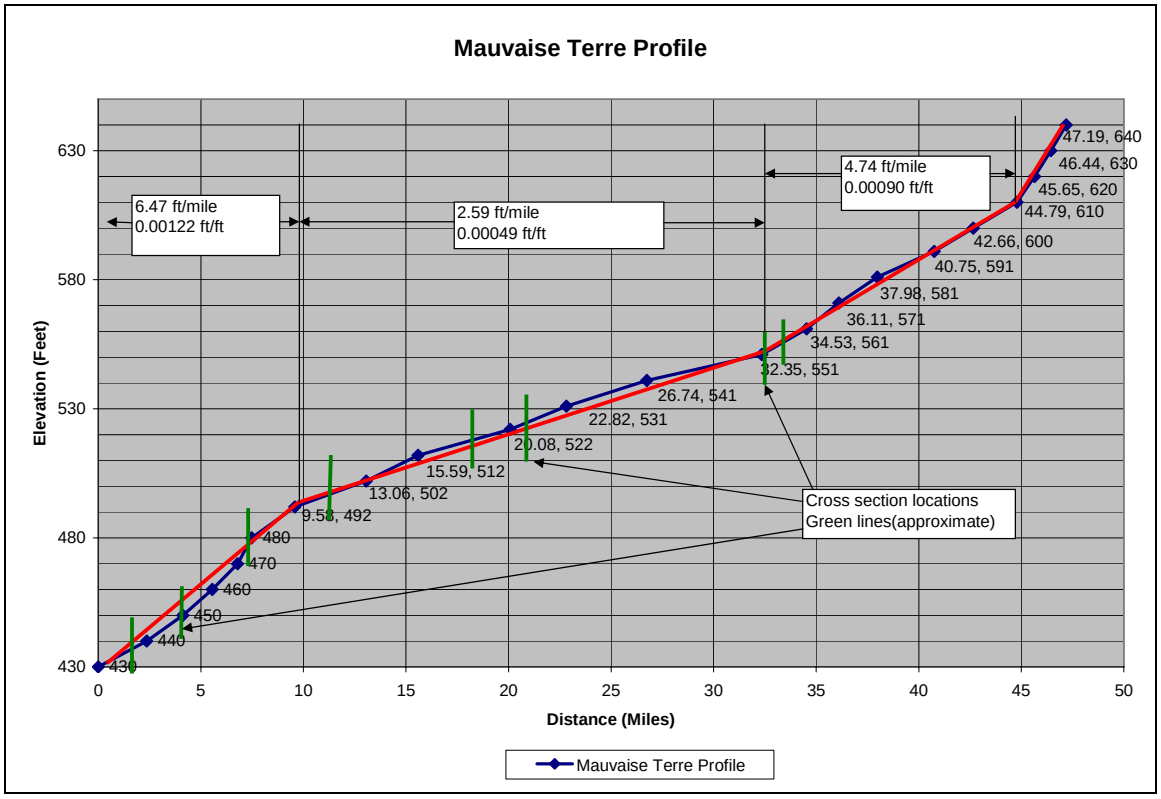


Fig.2 Mauvaise Terre Valley Profile

USGS Stream Gage 05586000 on North Fork of Mauvaise Terre Creek near Jacksonville is located above our study reach and drains 29.1 sq. mile s. This gage has been used to build an Exceedence Probability Curve to help refine field determined "bankfull flow" estimates. Geomorphic "bankfull" or "channel forming" flow is typically found near the 1.5 year return interval peak flow. Using flow data from 1980 thru 2004 the 1.5yr. peak flow is estimated at 500cfs or 17.18 cfs per sq. mile at gage 05586000. (Fig. 3)

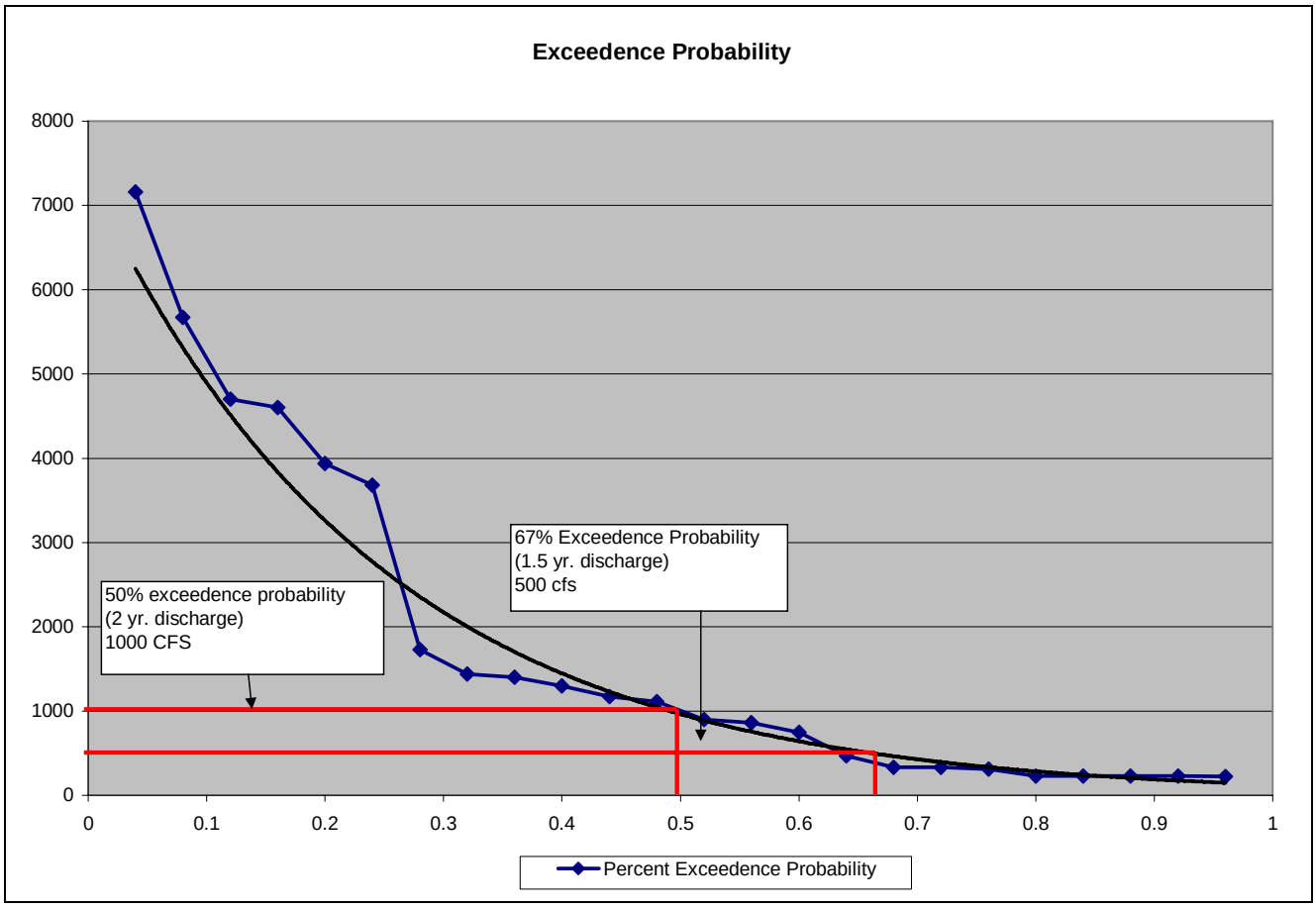


Fig. 3 Exceedence Probability Curve for USGS Gage 05586000

The DVD has been divided in "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. (Figure 4) Although the report will begin with a broader more general assessment of the entire study reach, it will also provide conclusions and recommendations for each stream "chapter" or group of "chapters". The chapter divisions are clearly arbitrary and do not reflect "change points" in the stream characteristics or treatment recommendations.

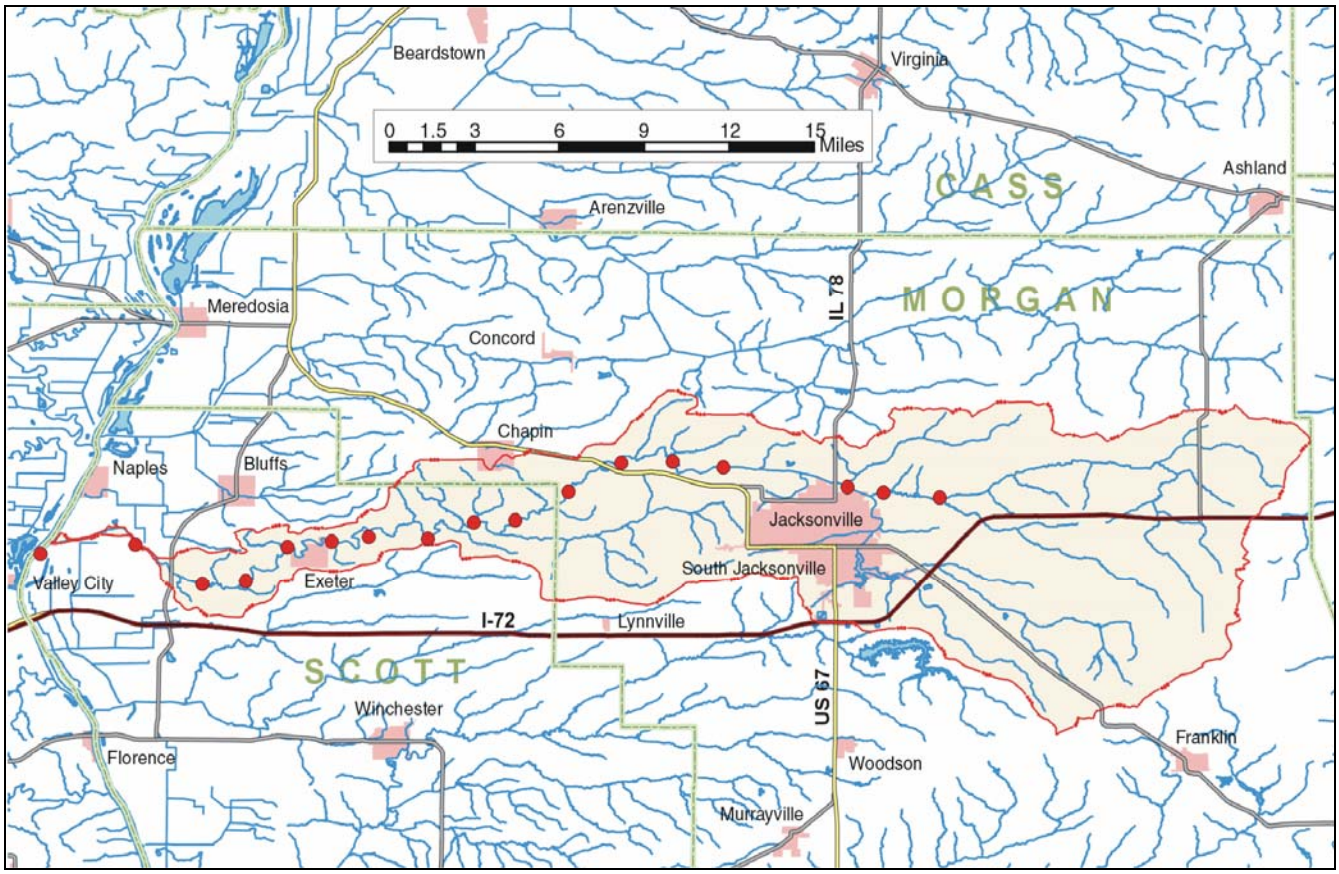


Fig. 4 Chapter Divisions on DVD

Features Identified by Chapter							
Chapter No.		**Erosion**	**Breakpoint**	**Deposition**	**Logjam**	**Geotech**	**Bed Control**
Disc 1	2	4	0	0	1	0	0
	3	16	8	0	2	11	1
	4	17	6	4	1	10	0
	5	19	17	1	1	1	0
	6	10	15	4	0	2	0
	7	15	4	2	1	2	0
	8	15	6	5	3	2	1
	9	16	2	3	2	4	1
	10	8	0	0	0	0	0
Disc 2	2	20	4	0	0	1	0
	3	19	2	3	3	2	0
	4	14	1	0	4	0	0
	5	19	1	2	5	0	0
	6	8	0	1	6	0	0
	7	24	0	0	8	0	1
	8	20	1	0	4	0	4
	9	18	4	0	8	0	1
	10	9	0	0	2	0	1
TOTAL		271	71	25	51	35	10

Table 1. Features Identified on Aerial DVD

The cross section data collected in Mauvaise Terre Creek is presented in Table 2. Bankfull discharges have been estimated by observing field indicators such as, flat depositional areas, washed root zones and change in bank angle. The field data has then been used with the Streambank Inventory and Evaluation data form developed by NRCS. This procedure allows for comparison of observed field conditions with "regional curve" predictions of channel dimensions, USGS Flood-Peak discharge predictions from Water-Resources Investigations Report 87-4207, and bedload material movement with velocity required for transport. The fact that there is discharge data available for North Fork Mauvaise Terre makes this a good analytical tool. Appendix A at the end of this report contains the NRCS Streambank Inventory and Evaluation of each cross section.

Cross section data collected shows a maximum discharge per square mile of 12.6 cfs at "geomorphic bankfull" or "channel forming discharge" at Cross Section 1 on North Fork Mauvaise Terre which is 43% of the predicted Q2 discharge and is approx. a 1.3 yr. return interval as predicted by gage 05586000. The bankfull discharge field indicators are however approx. 1.7 feet below the floodplain elevation, strongly suggesting past incision. However the channel slope diminishes from 4.74 ft. per mile to 2.59 ft. per mile between X-sec 2 and X-sec 3 and the maximum channel capacity and bankfull discharge become the same. X-Sec 6 just below the confluence of Willow Creek has a particularly low capacity at 36% of the predicted Q2 discharge.

Cross Section Data: NRCS Streambank Inventory and Evaluation Procedure

X-Sec	Easting	Northing	ADA Sq. M.	Valley Slope ft/mi.	Q2 CFS	BKF CFS	Width ft.	Mean Depth	W/D	Vel. FPS	Bedload In. Dia.	CEM (Simon)	CFS sq. mi.	BKF cfs /Q2 cfs
1	739133	4402912	41.98	8	1236	529	41	4.42	9.28	2.9	1	3	12.6	0.43
2	740154	4403656	48.5	5.3	1140	588	36	5.13	7.02	3.2	1	4	12.1	0.52
3	738199	4403795	91.95	5.3	1889	902	59	5.4	10.93	2.8	1	2	9.8	0.48
4	725220	4402633	120.71	3.9	2021	936	79	5.3	14.91	2.2	3	2	7.8	0.46
5	725128	4402503	121.71	3.9	2034	1224	53	7.66	6.92	3	3	2	10.1	0.60
6	722754	4400943	140.82	3.9	2282	794	42	6.76	6.21	2.8	1	2	5.6	0.35
7	717526	4401125	150.49	3.3	2220	1458	74	6.8	10.88	2.9	1	1	9.69	0.66
8	714315	4399915	153.63	3.2	2216	1653	76	5.47	13.89	4	4	5	10.76	0.75
9	711844	4398198	156.8	3.3	2306	1596	118	4.12	28.64	3.3	3	5	10.17	0.69
10	711679	4397996	156.8	3.3	2306	1713	72	5.85	12.31	4.1	3	5	10.92	0.74
11	708358	4398606	161.2	3.7	2482	1793	62	7.43	8.17	3.9	1	3	11.1	0.72

Table 2. Cross Section Data

General Observations

1. Mauvaise Terre can be clearly divided into three sections. The Upper Reach (Chapters 8-10 Disc 2) has a valley slope of 4.74 ft./mile and is incised. Some attempts at grade control have been completed (X-sec 1) and a farm crossing above X-sec 2 is serving as grade control. The Middle Reach (Chapters 8 Disc1-Chapter 7 Disc2) has a much lower gradient at 2.59 ft./mile and is a channelized stream, well connected to the floodplain, with no indications of serious downcutting. The Lower Reach (Chapter 7-3 Disc1) is much steeper at 6.47 ft/mile with many rock outcroppings and breakpoints. This reach has higher

velocities, larger bedload transport capability and has a generally stable bed due to the rock substrate.

2. Bankfull calculations in the middle reach are at the very top bank and carry approx. 45-50% of the predicted Q2, which is slightly less than the 1.5 yr. R.I. discharge. The bankfull calculations in the upper reach compare well in discharge, however the bankfull depths determined in the field investigation are well below the top of the bank. In other words the upper reach is somewhat incised and not well connected with the floodplain. The lower reach bankfull discharge is somewhat higher at over 70% of the predicted Q2, but is incised even more than the upper reach with bankfull flows 3 ft. or more below the top of the bank.
3. A ten mile section from approximately Elev. 550 to Elev. 530 was found to have very deep standing water with no breakpoints or riffles. No cross sections were taken in this area due to the water depth. (Chapter 5-7 Disc 2)
4. The North Fork of Mauvaise Terre Creek and Mauvaise Terre River above the confluence with North Fork Mauvaise Terre Creek would benefit from Rock Riffle Grade Controls for stability and would also benefit the Low DO impairment on North Fork. (Upper Reach)
5. The Middle reach needs only lateral migration treatment.

Recommendations

1. The Upper Reach (Chapter 8-10 Disc 2) is approx. 5.3 miles in length with 47 erosion sites identified on the DVD. This reach is experiencing some downcutting and is incised so that Rock Riffle Grade Control structures can be installed to control downcutting, reduce lateral bank erosion and improve DO levels by increasing turbulence. There is at least one reasonable example of a grade control in place in Chapter 8. The design, purpose, or reason for installation is not known, however it is functioning well and appears to have been in place for a number of years.

   Structures similar to this can be safely placed to a height of 2 to 2.5 ft. above the existing grade according to preliminary calculations. Normal riffle pool sequences will occur at an approximate spacing of 6 bankfull widths, however with such small bedload it appears that bedload can be passed on a much wider spacing. In, fact the existing structure in Fig. 5 has maintained a 2.5 foot pool depth as a single structure on this reach.

TREATMENT COST FOR ROCK RIFFLES IN THE UPPER SECTION

Disc #	Chapter	Bankfull Width	Channel Length (ft)	Ave. Spacing	No. Riffles	Stone per Riffle	Ave. Cost/ton	Total Stone	Total Cost/Chapt.
2	8	40	13,800	240	57	175 tons	$25.00	9975	$249,375.00
	9	40	8900	240	37	175 tons	$25.00	6475	$161,875.00
	10	40	5600	240	23	175 tons	$25.00	4025	$100,625.00
Totals			28,300		117			20475	$511,875.00

Fig. 5 Existing Rock Riffle—Mauvaise Terre River

In addition to the Rock Riffles it is typical that 50% of the lateral bank migration will be dramatically slowed so that treatment is not needed. However the remaining 50% will likely need to have Stone Toe Protection or similar treatment. The following table shows an estimate by chapter in the upper reach that may need lateral bank treatment even after riffles are installed.

TREATMENT COST FOR STONE TOE PROTECTION-UPPER SECTION

Disc #	Chapter	Bankfull Width	Ave. Erosion Length	STP Rate (ton/ft)	Stone Required	Ave. Cost/ton	Total Cost/site	No. Sites	Total Cost/Chapt.
Disc 2	8	40	200	0.5	100	$25	$2,500.00	10	$25,000.00
	9	40	200	0.5	100	$25	$2,500.00	9	$22,500.00
	10	40	200	0.5	100	$25	$2,500.00	5	$12,500.00
TOTAL			600		300			24	$60,000.00

2. The Middle Reach (Chapt. 8 disc 1-Chapt 7 Disc 2) is approx. 16 miles in length with 143 erosion sites identified from the DVD. This reach is a lower gradient with fine bedload and no point bar accumulations. Therefore the treatment recommended for this entire reach is to use a hard toe protection to stabilize the banks and prevent lateral migration. Stone Toe Protection (STP) is the preferred

treatment and has been used successfully on Mauvaise Terre River in at least two places recorded on the DVD. Velocity in this reach is consistently 3.0 ft. per sec. or slower. Typical STP installation will be required on an entire meander bend that can be expected to be about 5 times the bankfull width. The following table then will summarize the need for bank stability in these 9 chapters that make up the Middle Reach.

TREATMENT COST FOR STONE TOE PROTECTION-MIDDLE SECTION

Disc #	Chapter	Bankfull Width	Ave. Erosion Length	STP Rate (ton/ft)	Stone Required	Ave. Cost/ton	Total Cost/site	No. Sites	Total Cost/Chapt.
Disc 1	8	74	370	0.75	277.5	$25	$6,937.50	15	$104,062.50
	9	74	370	0.75	277.5	$25	$6,937.50	16	$111,000.00
	10	74	370	0.75	277.5	$25	$6,937.50	8	$55,500.00
Disc 2	2	65	325	0.75	243.75	$25	$6,093.75	20	$121,875.00
	3	65	325	0.75	243.75	$25	$6,093.75	19	$115,781.25
	4	65	325	0.75	243.75	$25	$6,093.75	14	$85,312.50
	5	60	300	0.6	180	$25	$4,500.00	19	$85,500.00
	6	60	300	0.6	180	$25	$4,500.00	8	$36,000.00
	7	60	300	0.6	180	$25	$4,500.00	24	$108,000.00
TOTAL			2985		2103.75			143	$823,031.25

Fig. 6 Stone Toe Protection on Mauvaise Terre River above confluence with Willow Creek.

3. The Lower Reach, Chapter 2-7 Disc 1, have a much steeper gradient with the exception of Chapter 2 and pat of Chapter 3 which is in the Illinois River floodplain. Above the Illinois River floodplain there is an average gradient of almost 6.5 ft. per mile, more than two times that of the Middle Reach for 10 miles. There are 77 erosion sites identified in this reach. Cross sections 8-11 in these chapters show an incised channel with a bankfull discharge of approx. 70%-75% of the predicted Q2 discharge. The top of bank, or channel capacity however is larger still as the channel is incised from 2 ft. to 5 ft. below floodplain elevation. Preliminary calculations show that riffles can be constructed in this reach approximately 2.0 ft. above existing gradeline with no effect on flooding. Constructing riffle in this manner would create deeper pools, dissipate energy and reduce lateral bank migration, however it would do little to impact the impaired uses of this stream.
   The channel width in this reach is approx. 75 ft., therefore the proper riffle spacing would be approx. 450 ft or 11.7 riffles per mile of channel. The following table provides a cost summary for constructing a riffle-pool sequence in this reach.

TREATMENT COST FOR ROCK RIFFLES IN THE LOWER SECTION

Disc #	Chapter	Bankfull Width	Channel Length (ft)	Ave. Spacing	No. Riffles	Stone per Riffle	Ave. Cost/ton	Total Stone	Total Cost/Chapt.
1	2	70	14,400	n/a	n/a	n/a	$25.00	n/a	n/a
	3	70	14,400	450	32	400	$25.00	12800	$320,000.00
	4	75	10,200	450	23	450	$25.00	10200	$255,000.00
	5	75	12,200	450	27	450	$25.00	12200	$305,000.00
	6	75	13,800	450	31	450	$25.00	13800	$345,000.00
	7	75	12,900	450	29	459	$25.00	13158	$328,950.00
Totals			77,900		141			62158	$1,553,950.00

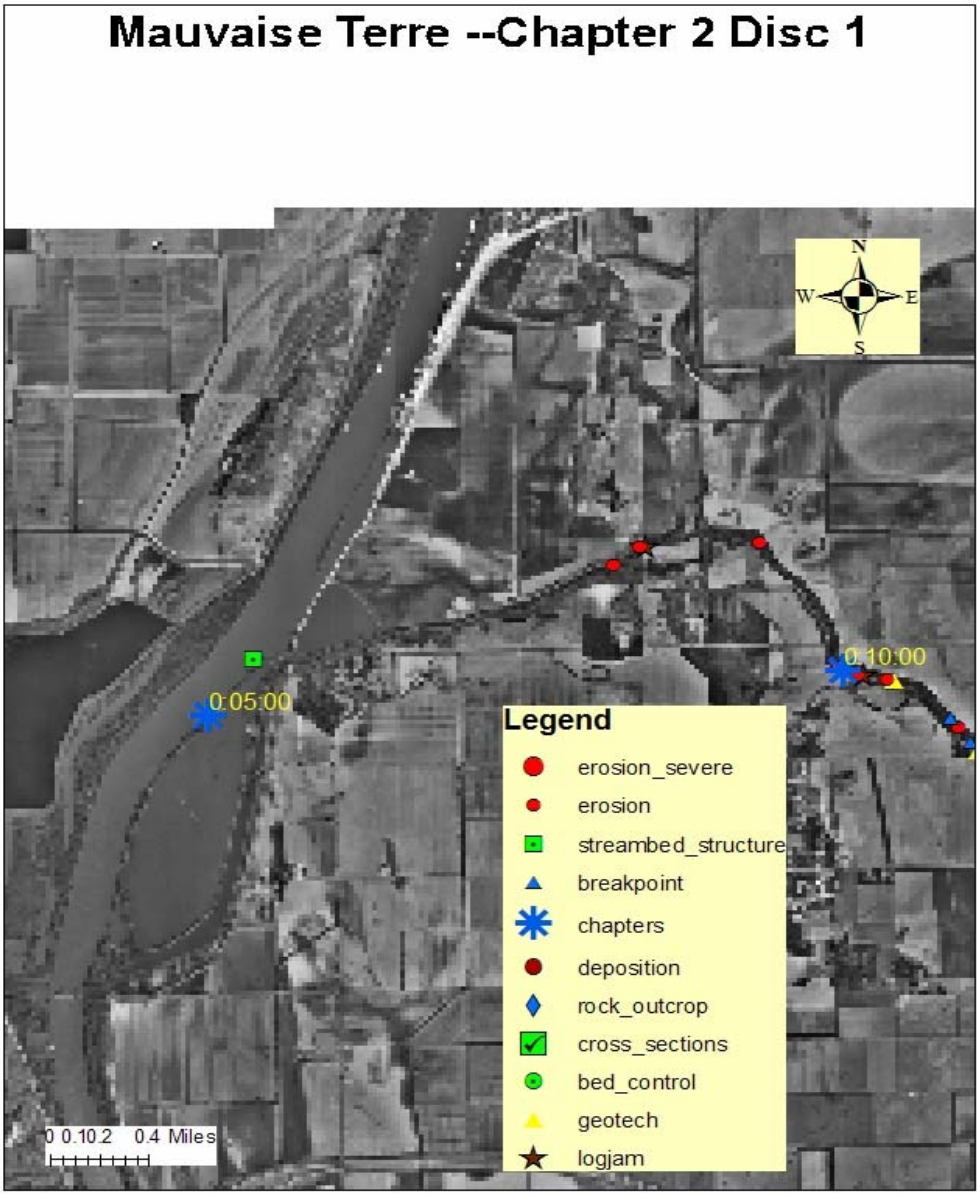
As in the upper reach, the riffle sequence can be expected to reduce or eliminate lateral movement on approx. 50% of the identified erosion sites. Therefore the remaining 50% will likely need some additional hard to protection to control lateral erosion. The following table summarizes the estimated cost for this treatment.

TREATMENT COST FOR STONE TOE PROTECTION-LOWER SECTION

Disc #	Chapter	Bankfull Width	Ave. Erosion Length	STP Rate (ton/ft)	Stone Required	Ave. Cost/ton	Total Cost/site	No. Sites	Total Cost/Chapt.
Disc 1	2	70	350	0.75	262.5	$25	$6,562.50	4	$26,250.00
	3	70	350	0.75	262.5	$25	$6,562.50	8	$52,500.00
	4	75	375	0.75	281.25	$25	$7,031.25	8	$56,250.00
	5	75	375	0.75	281.25	$25	$7,031.25	9	$63,281.25
	6	75	375	0.75	281.25	$25	$7,031.25	5	$35,156.25
	7	75	375	0.75	281.25	$25	$7,031.25	8	$56,250.00
TOTAL								42	$289,687.50

AERIAL MAPS OF STUDY AREA

BY CHAPTER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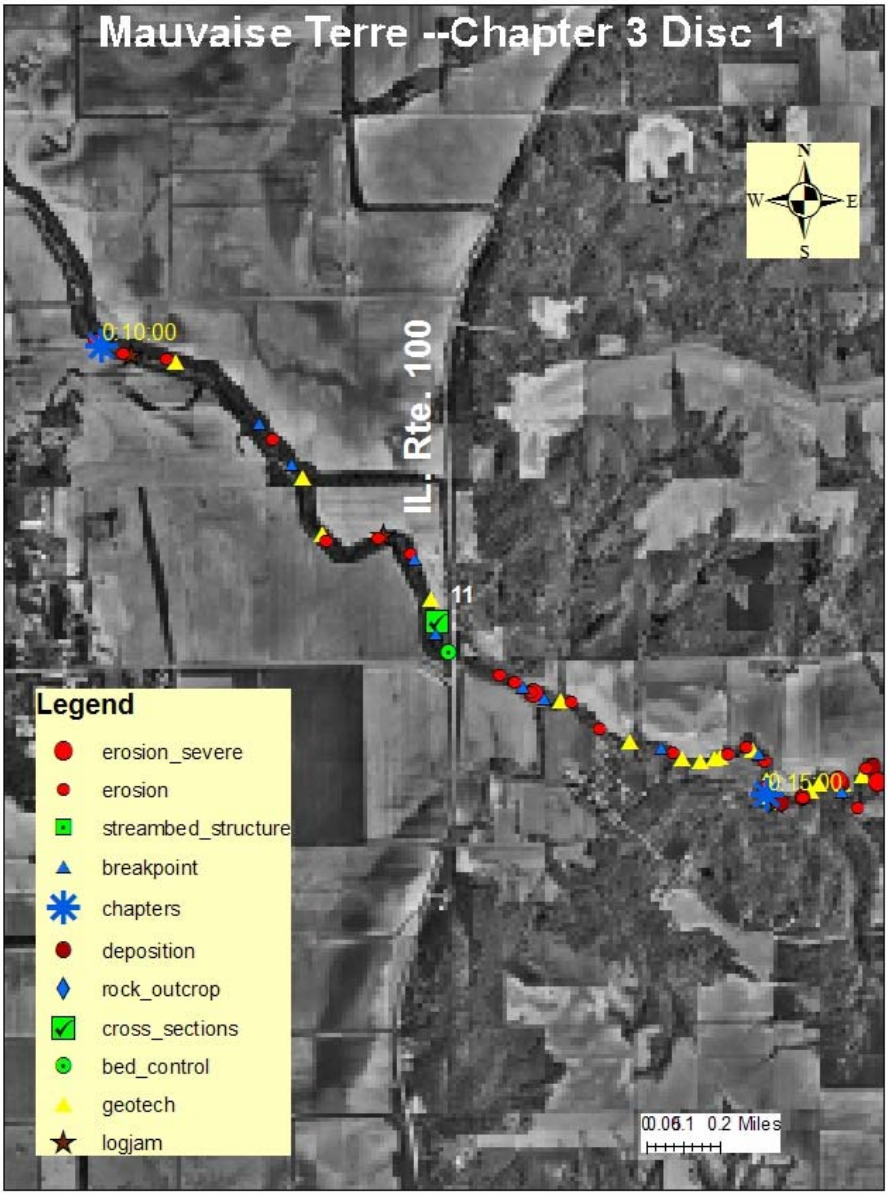
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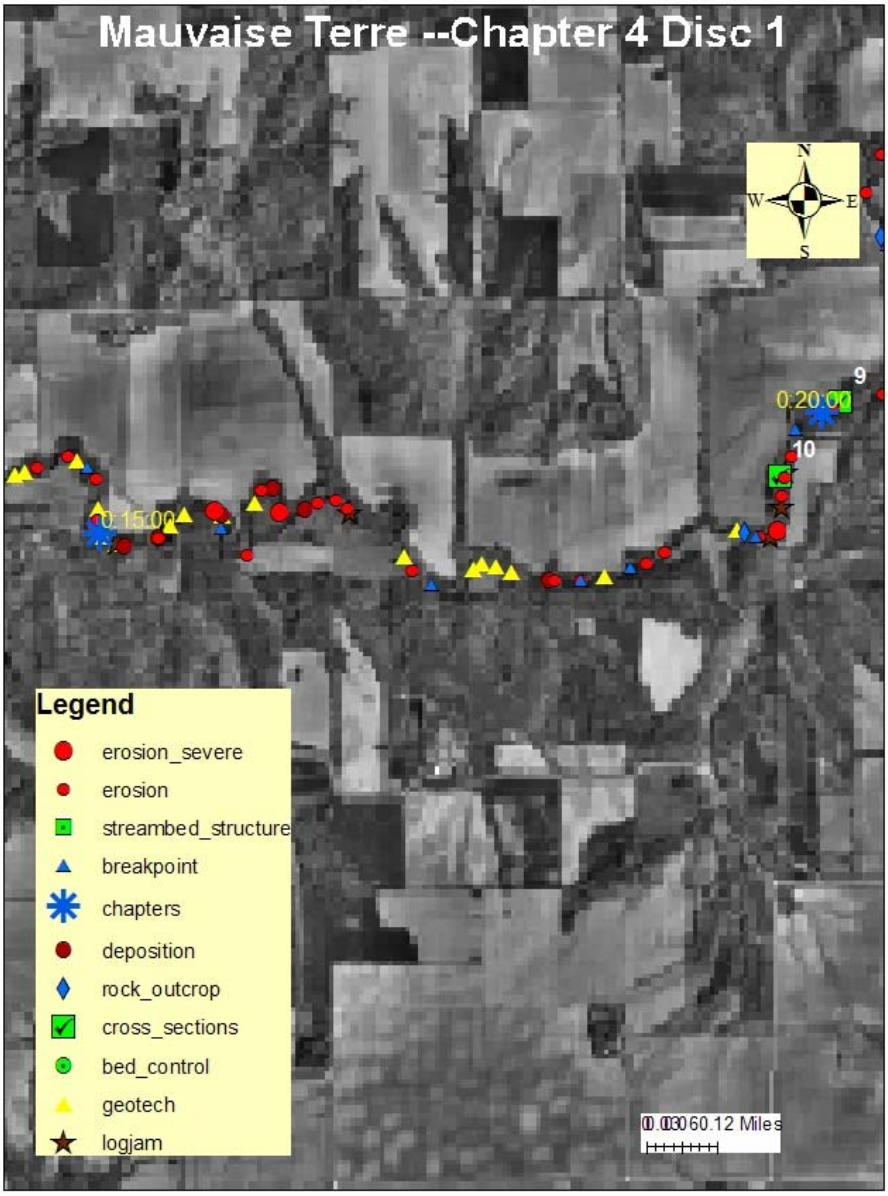
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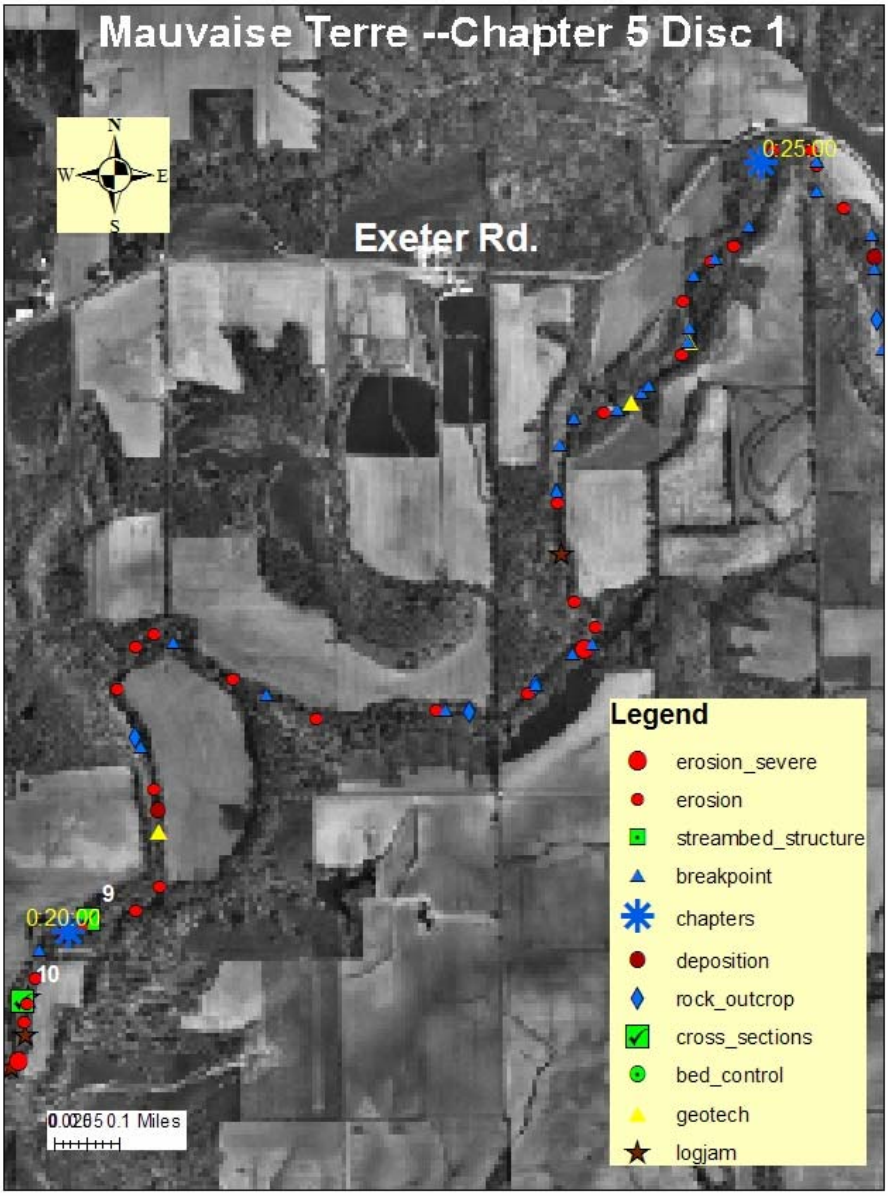
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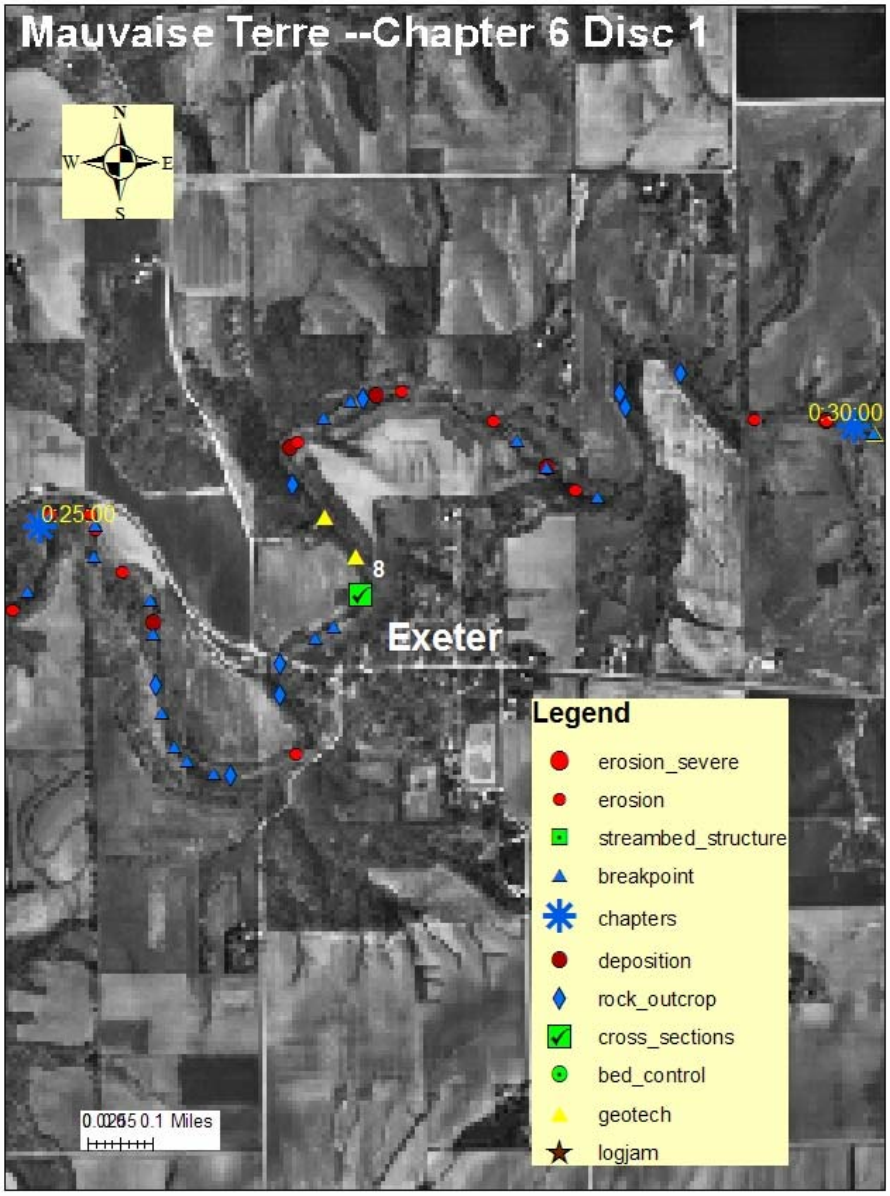
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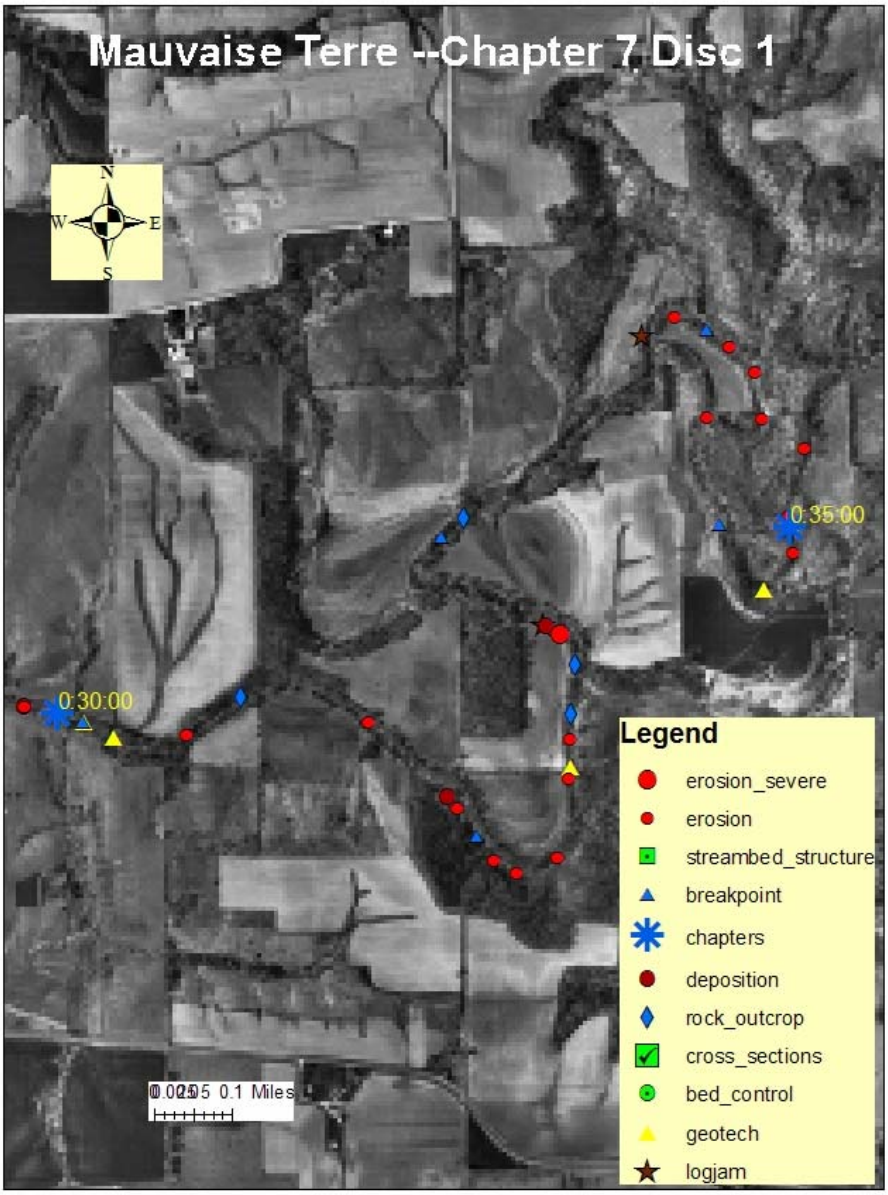
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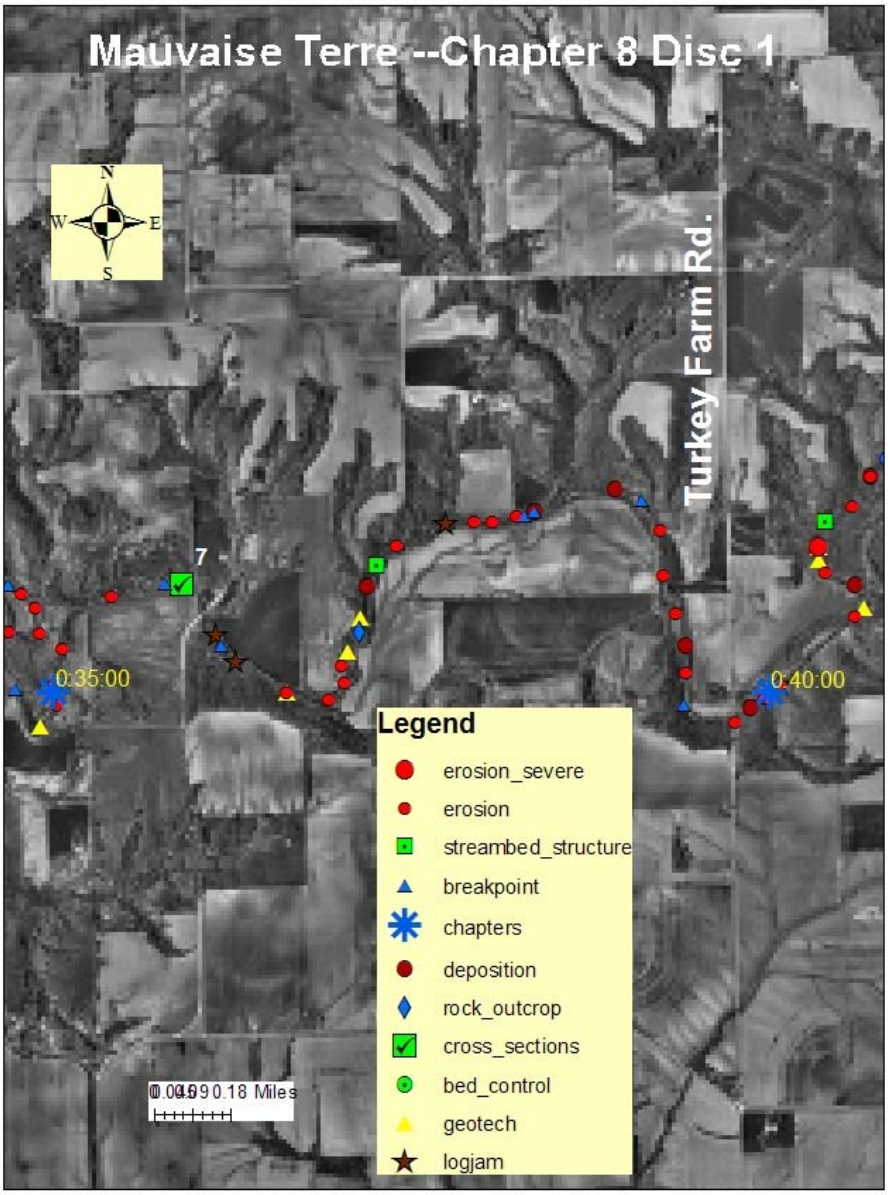
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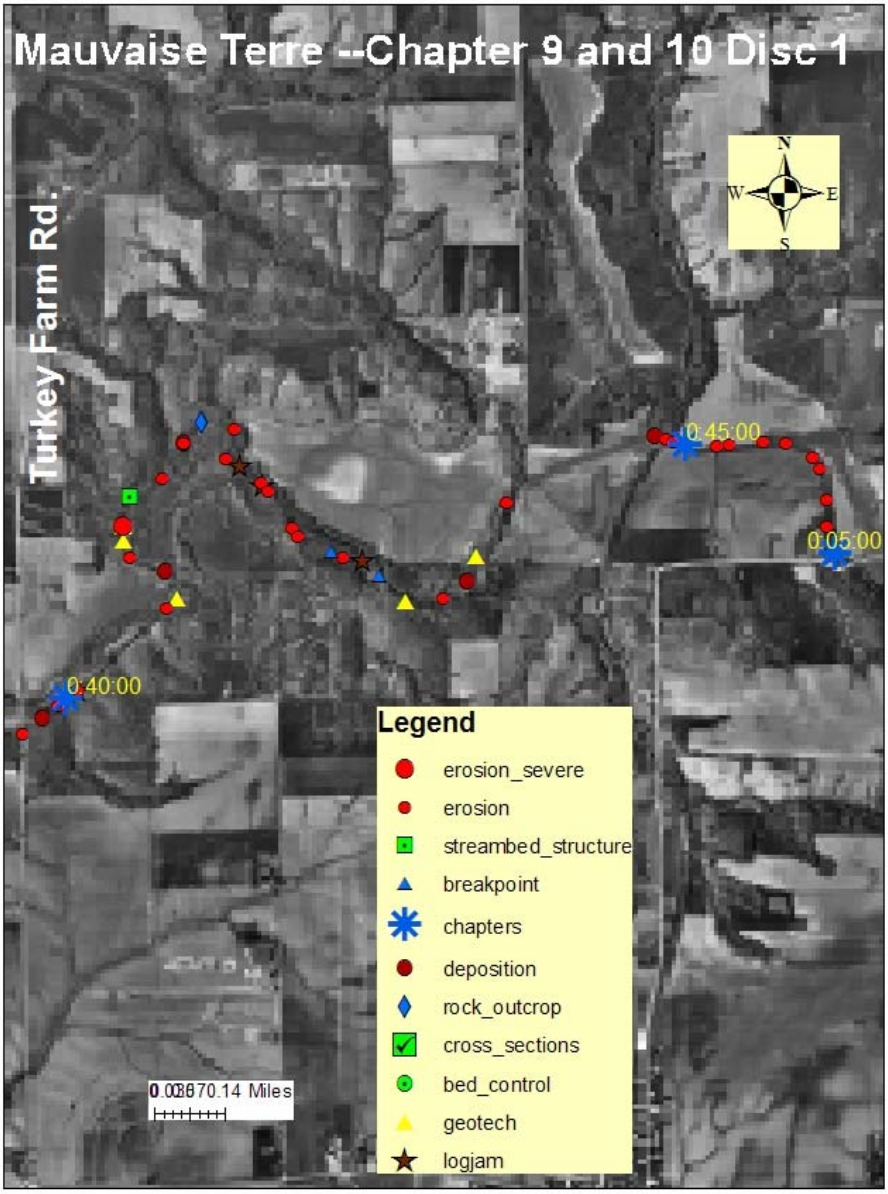
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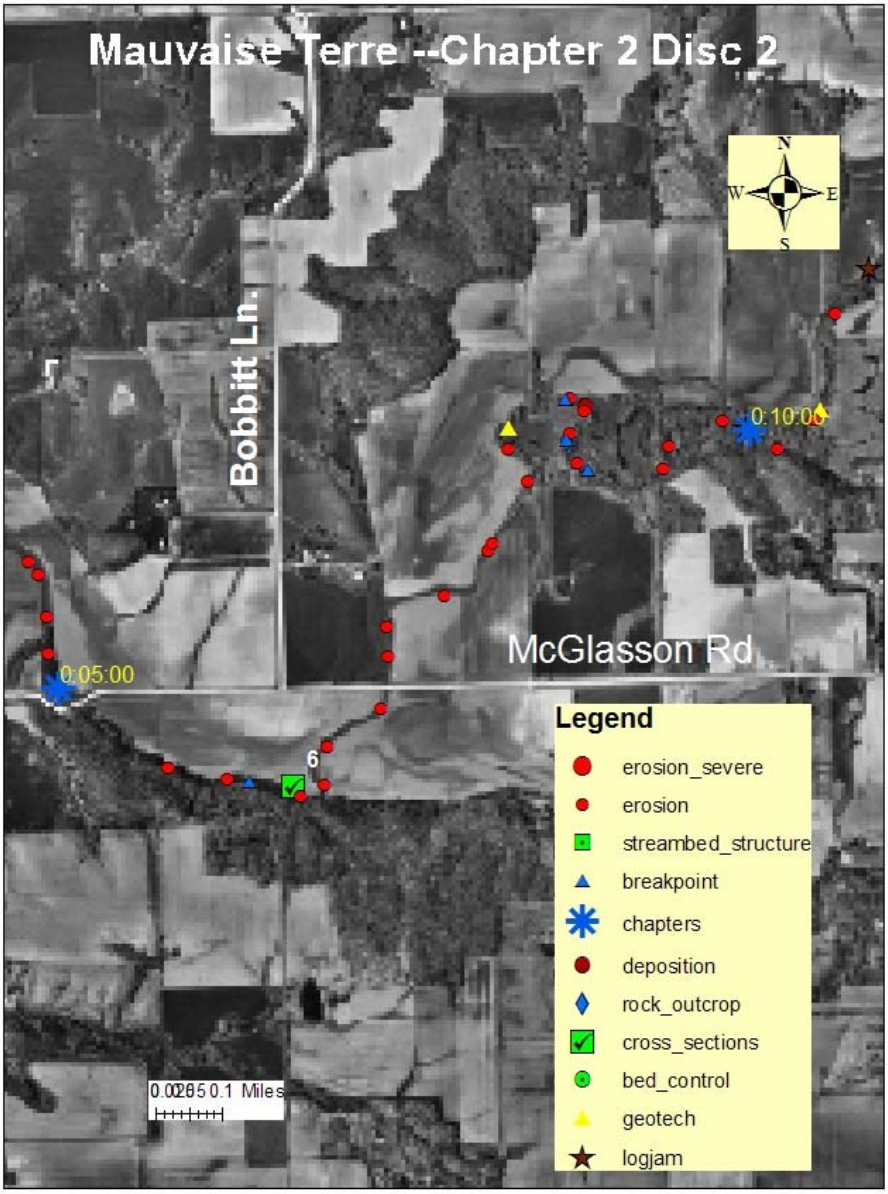
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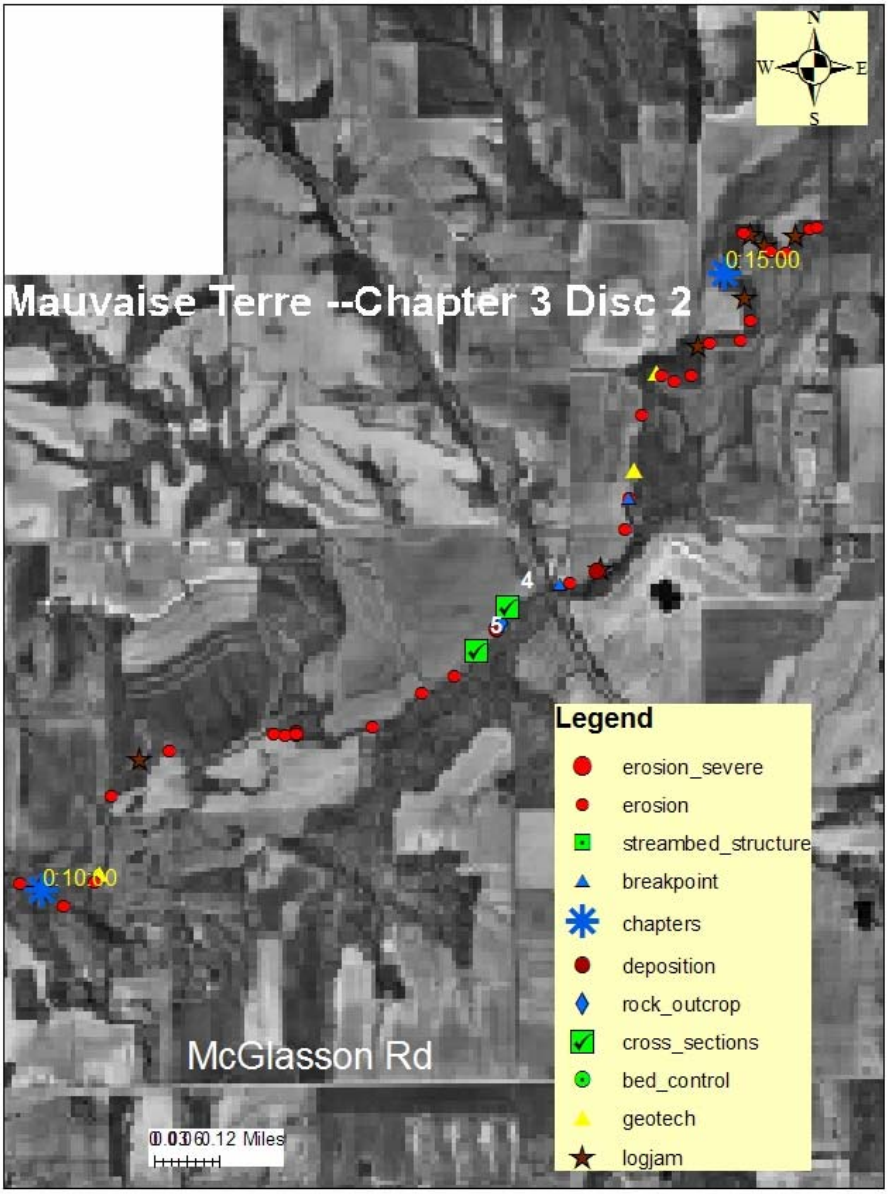
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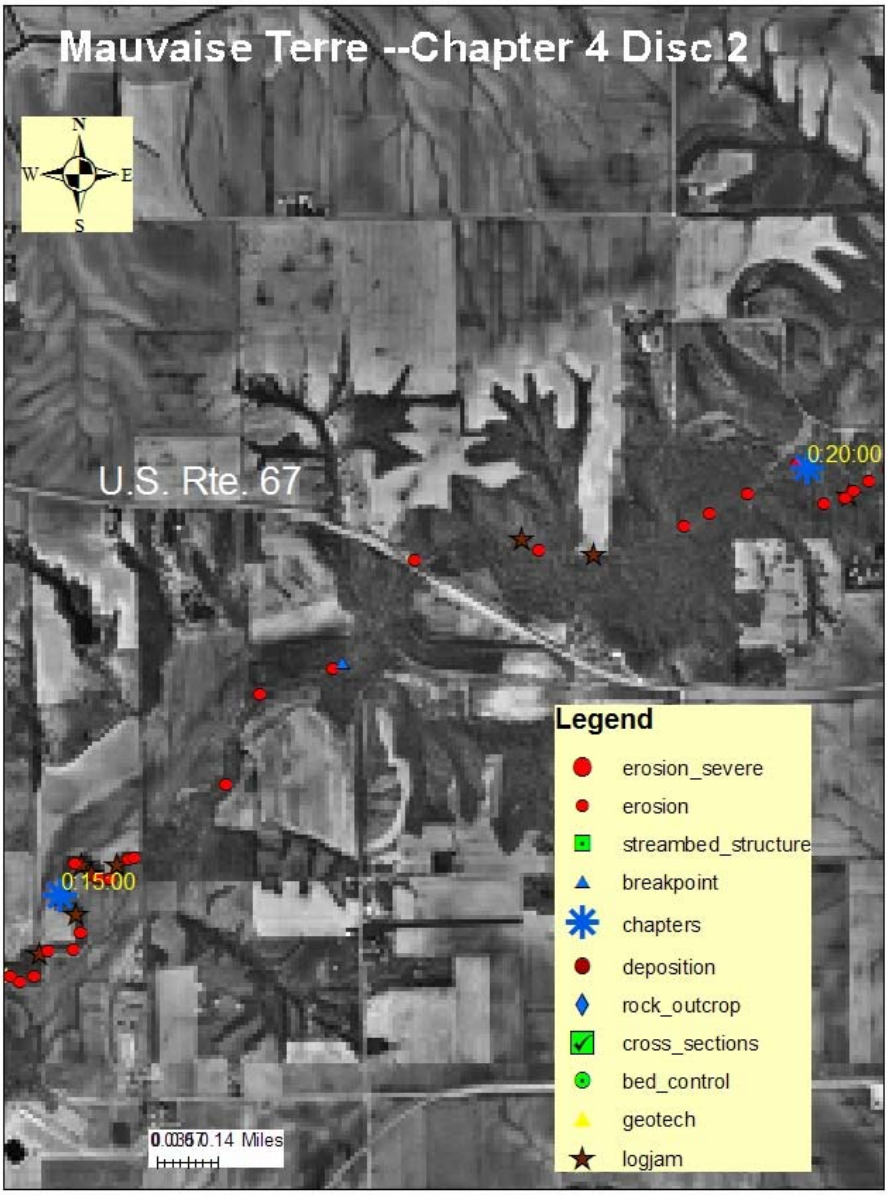
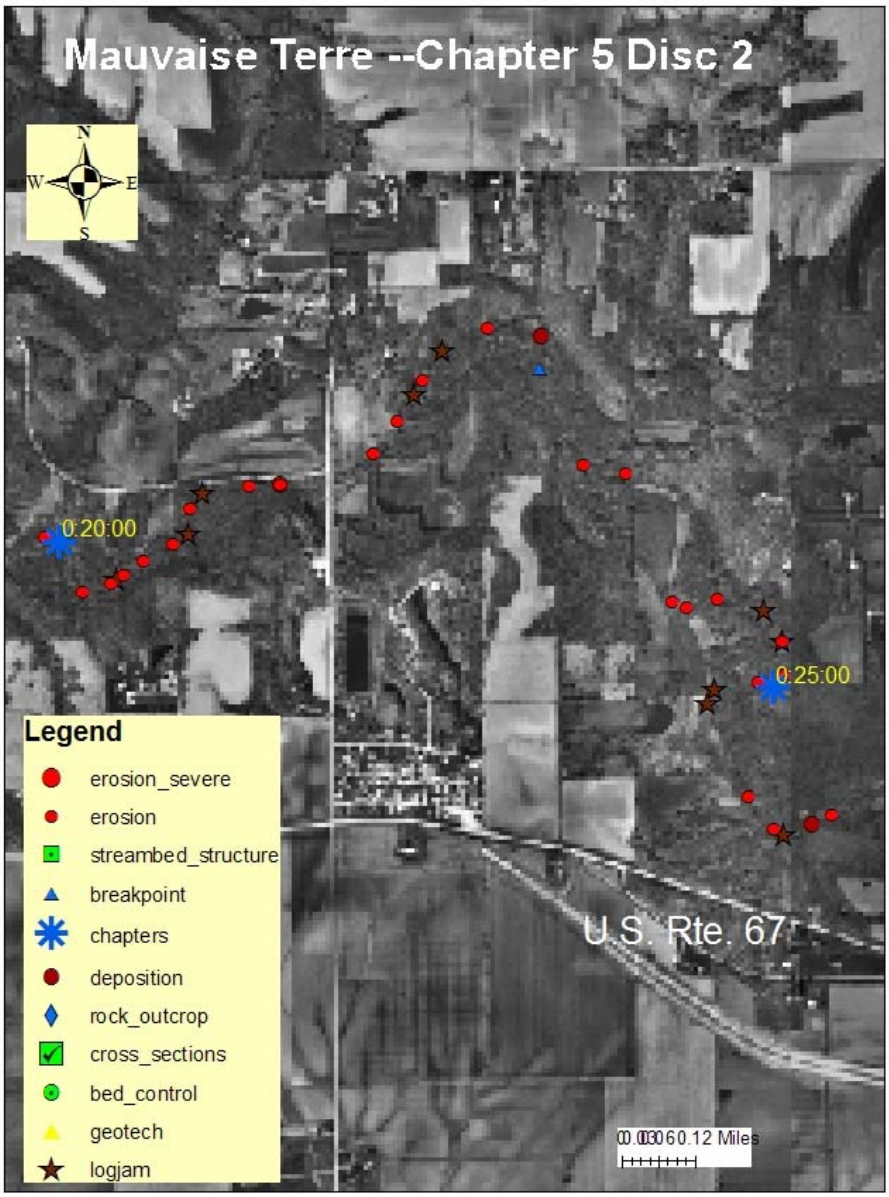
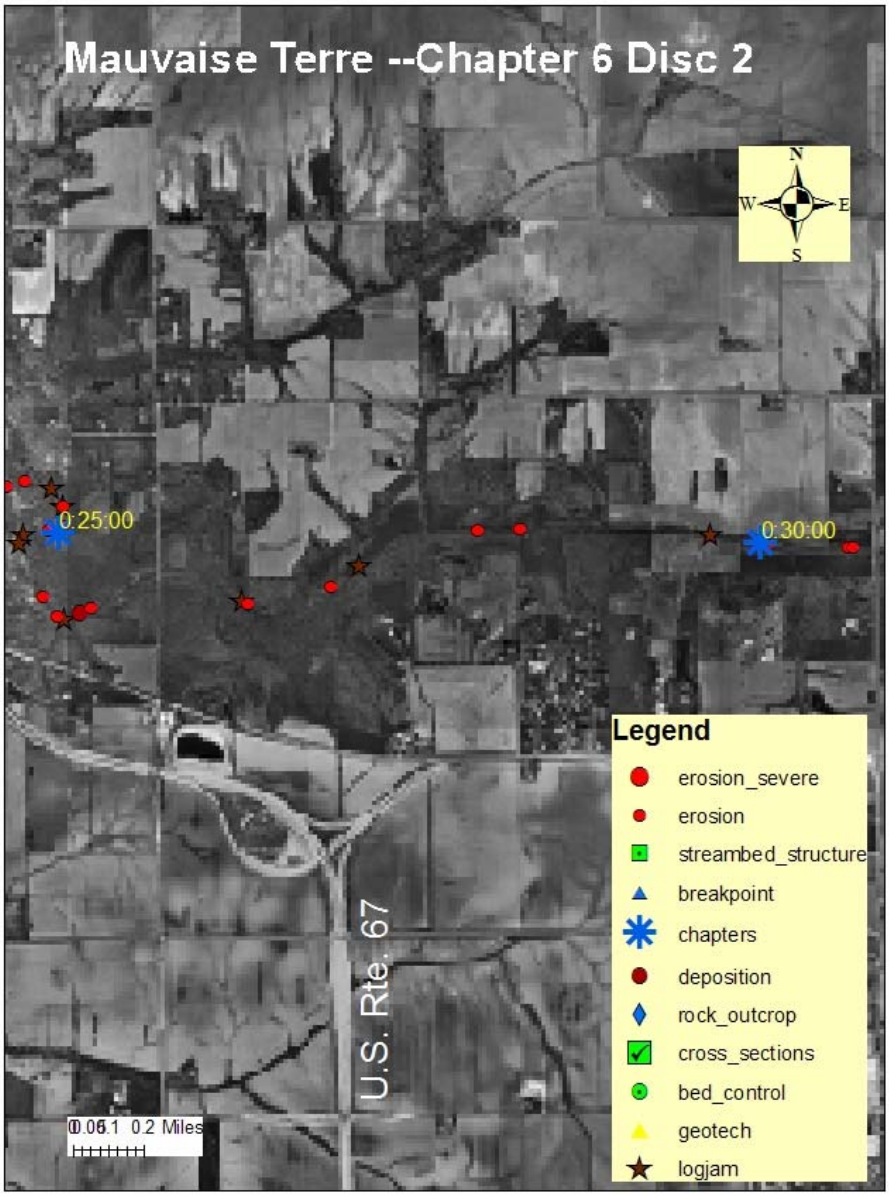
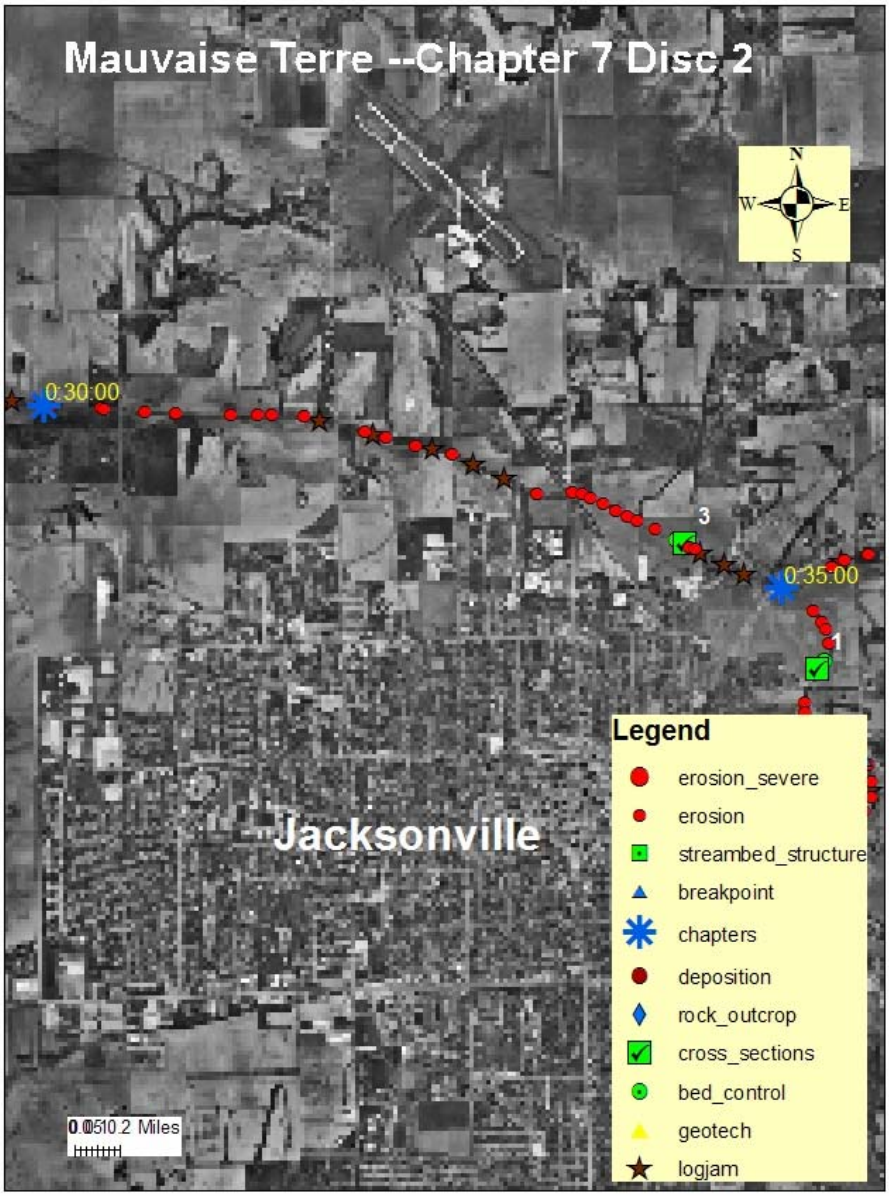
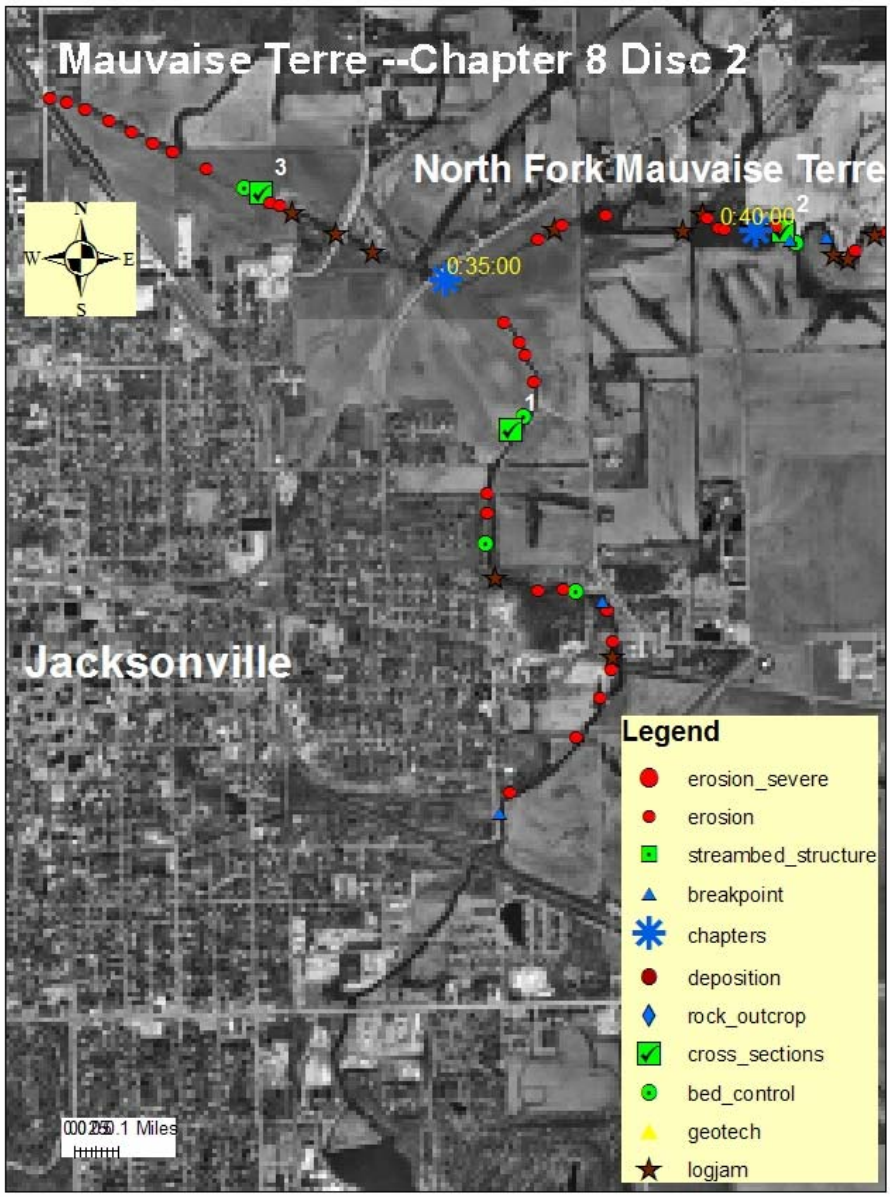
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam

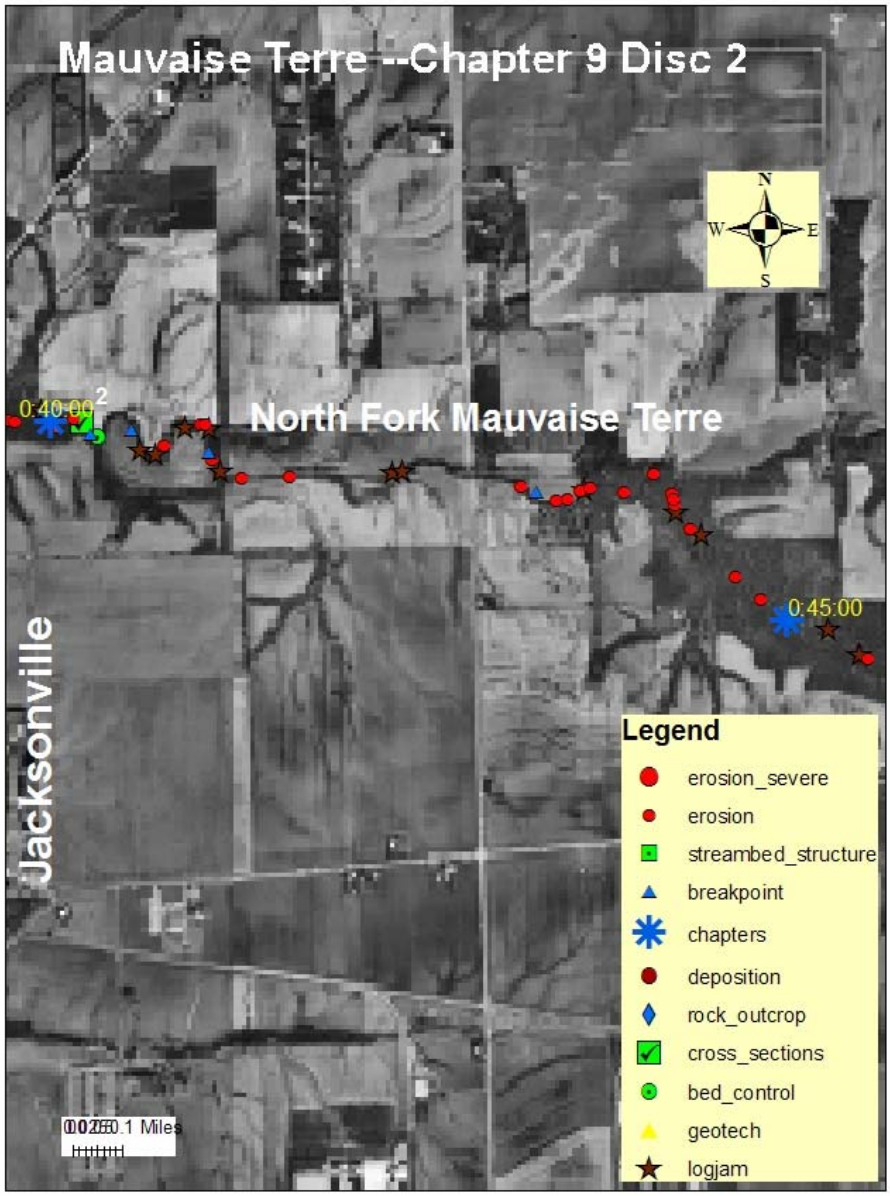

Mauvaise Terre --Chapter 4 Disc 2
N
W
E
S
U.S. Rte. 67
0:20:00
0:15:00
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam
0.0367 0.14 Miles

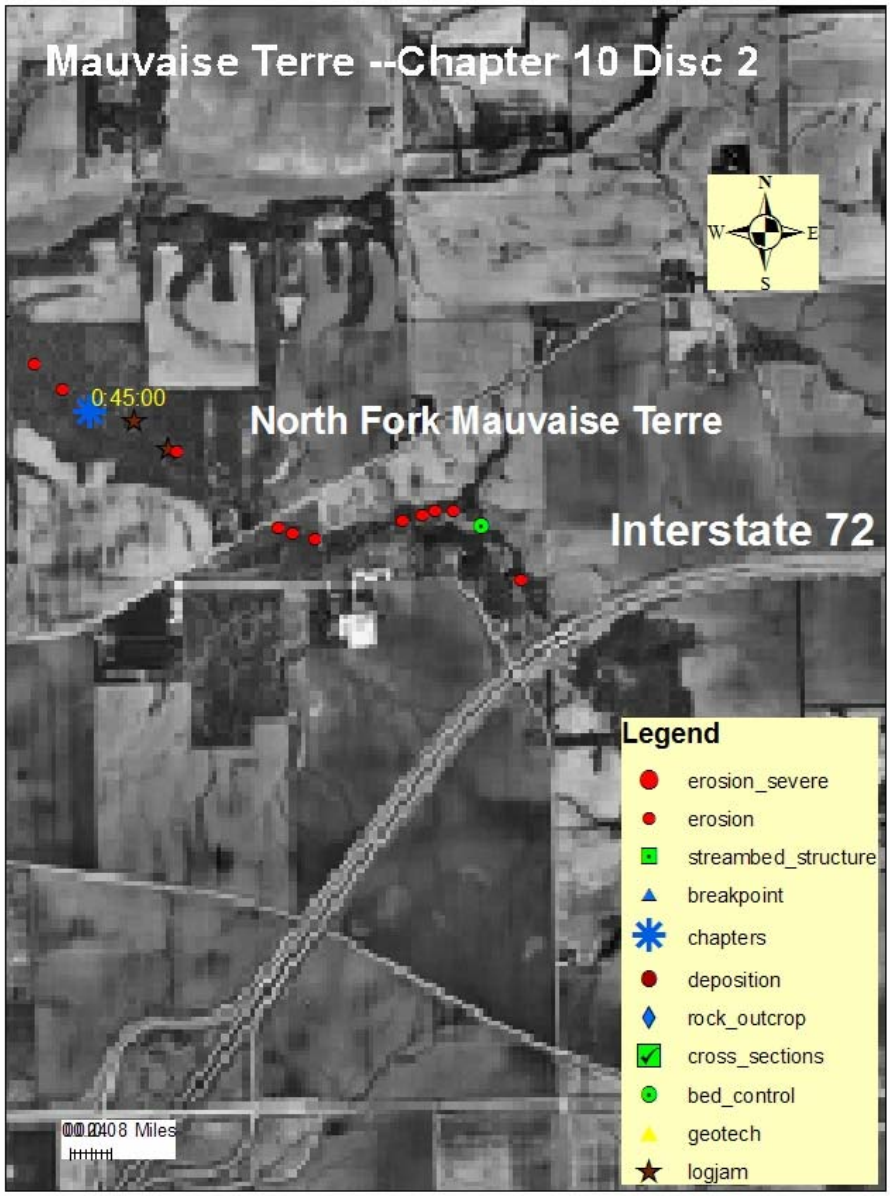

Mauvaise Terre --Chapter 5 Disc 2
N
W
E
S
0:20:00
0:25:00
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam
U.S. Rte. 67
0.00060.12 Miles


Mauvaise Terre --Chapter 6 Disc 2
N
W
E
S
0:25:00
0:30:00
U.S. Rte. 67
0.05 0.1 0.2 Miles
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam


Mauvaise Terre --Chapter 7 Disc 2
N
W
E
S
0:30:00
3
0:35:00
1
Jacksonville
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam
0.0510.2 Miles


Mauvaise Terre --Chapter 8 Disc 2
North Fork Mauvaise Terre
Jacksonville
0:35:00
0:40:00
1
2
3
N
W
E
S
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam


Mauvaise Terre --Chapter 9 Disc 2
N
W
E
S
0:40:00
2
North Fork Mauvaise Terre
0:45:00
Jacksonville
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam
0.1 Miles


Mauvaise Terre --Chapter 10 Disc 2
N
W
E
S
0:45:00
North Fork Mauvaise Terre
Interstate 72
Legend
erosion_severe
erosion
streambed_structure
breakpoint
chapters
deposition
rock_outcrop
cross_sections
bed_control
geotech
logjam
0.0 0.2 0.4 0.8 Miles

APPENDIX “A”

CROSS SECTION DATA