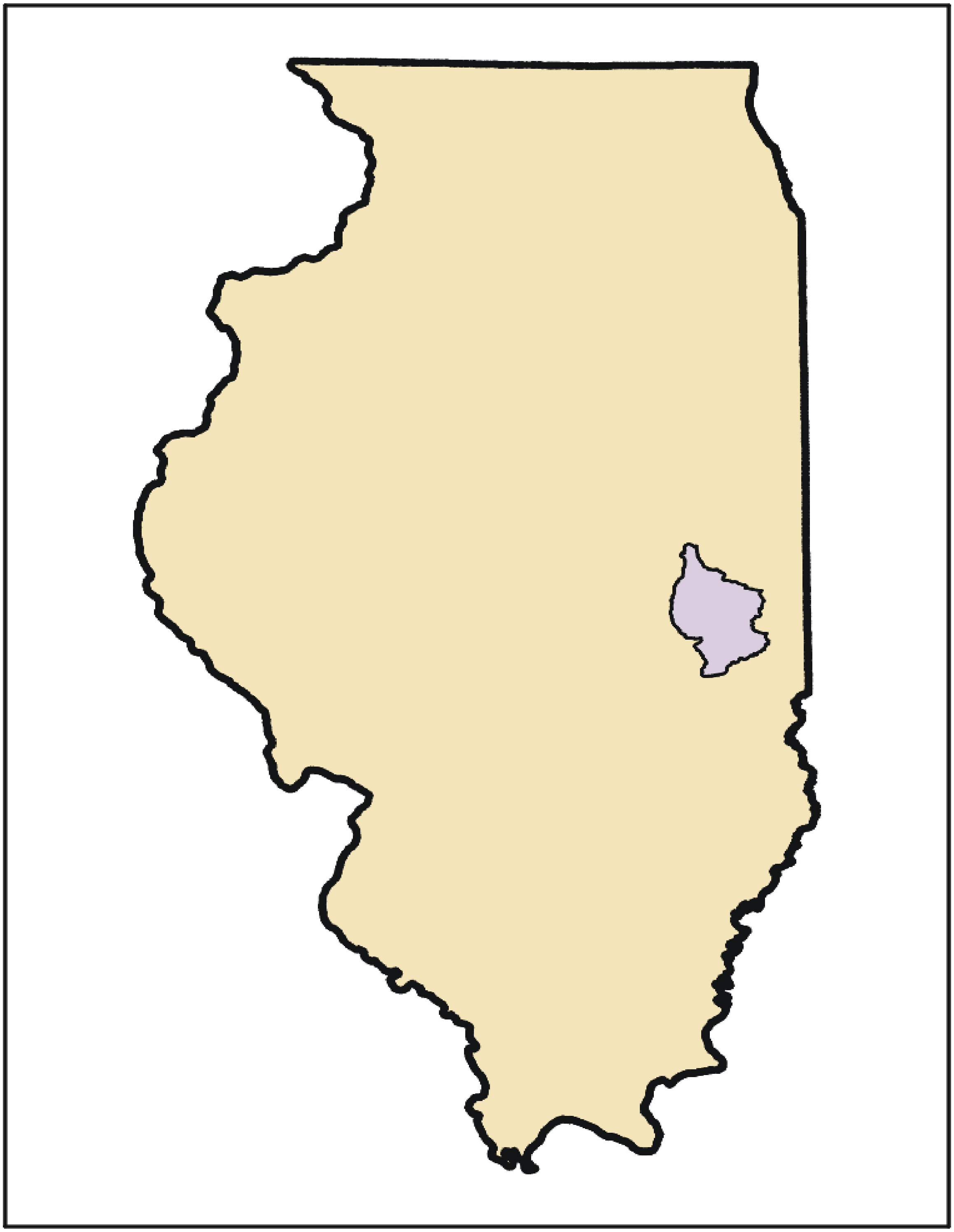

Aerial Assessment of Charleston Side Channel Reservoir (Embarras River) Champaign, Douglas and Coles Counties

July, 2005

Prepared by Wayne Kinney for IL. Dept. of Agriculture

In August 2003, Tetra-Tech, Inc. prepared a Total Maximum Daily Load Report on the Charleston Side Channel Reservoir (CSCR) for the Illinois Environmental Protection Agency. The CSCR is a water supply, recreational reservoir and the sole drinking water source for the city of Charleston, IL. This reservoir has been identified as an impaired water with potential causes of impairment being phosphorus, nitrogen, total suspended solids and excessive algae growth/chlorophyll “a” (Illinois EPA, 2001).
The CSCR TMDL Draft Implementation Plan contained in the August 2003 report indicates that the strategy adopted is to address the “phosphorus impairment which will lead to an overall improvement in water quality due to the interrelated nature of other listed pollutants.
Potential sources of TP to the CSCR include pumping from Lake Charleston, runoff from the direct drainage area, shoreline erosion, septic systems, and precipitation. The bottom sediments are also contributing TP loadings during portions of the year. Loads from these sources were estimated using a variety of means as part of the TMDL analysis, and it was determined that the primary sources are bottom sediments, pumping, and shoreline erosion. The BATHTUB model was used to determine how much the loads must be reduced so that the TP standard for lakes of 0.05 mg/L is achieved and the results indicate that loads must be reduced approximately 90 percent. Please refer to the full TMDL report for details regarding the analysis.”
(Appendix D-1, May 2003 Implementation Plan)

The implementation plan cited suggests several alternative methods of addressing phosphorus in CSCR, one of those options is to reduce upstream loadings in Lake Charleston since an estimated 28.8% of phosphorus loads to CSCR are contributed by pumping from Lake Charleston to CSCR. The report also states that the TMDL analysis indicates that row crop production is the largest source of upstream TP and no mention is made of streambank erosion as a contributing source. The SWAT (Soil Water Assessment Tool, version 2000) developed by the USDA, Agricultural Resource Service was employed to model TP from the Upper Embarras River Watershed, however, this model does not include TP contributions from streambank or gully erosion.
This report will address the potential for contributions of TP from within the mainstem of the Embarras River from Lake Charleston to Villa Grove.

Assessment Procedure

Low level geo-referenced video was taken of the Embarras River 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 just below the Lake Charleston Dam downstream of IL. Rte 130 and progressed upstream to approx. 1 mile above Villa Grove on Jordan Slough. Aerial video of tributaries was not part of the project, regardless of the stream size or vegetation.

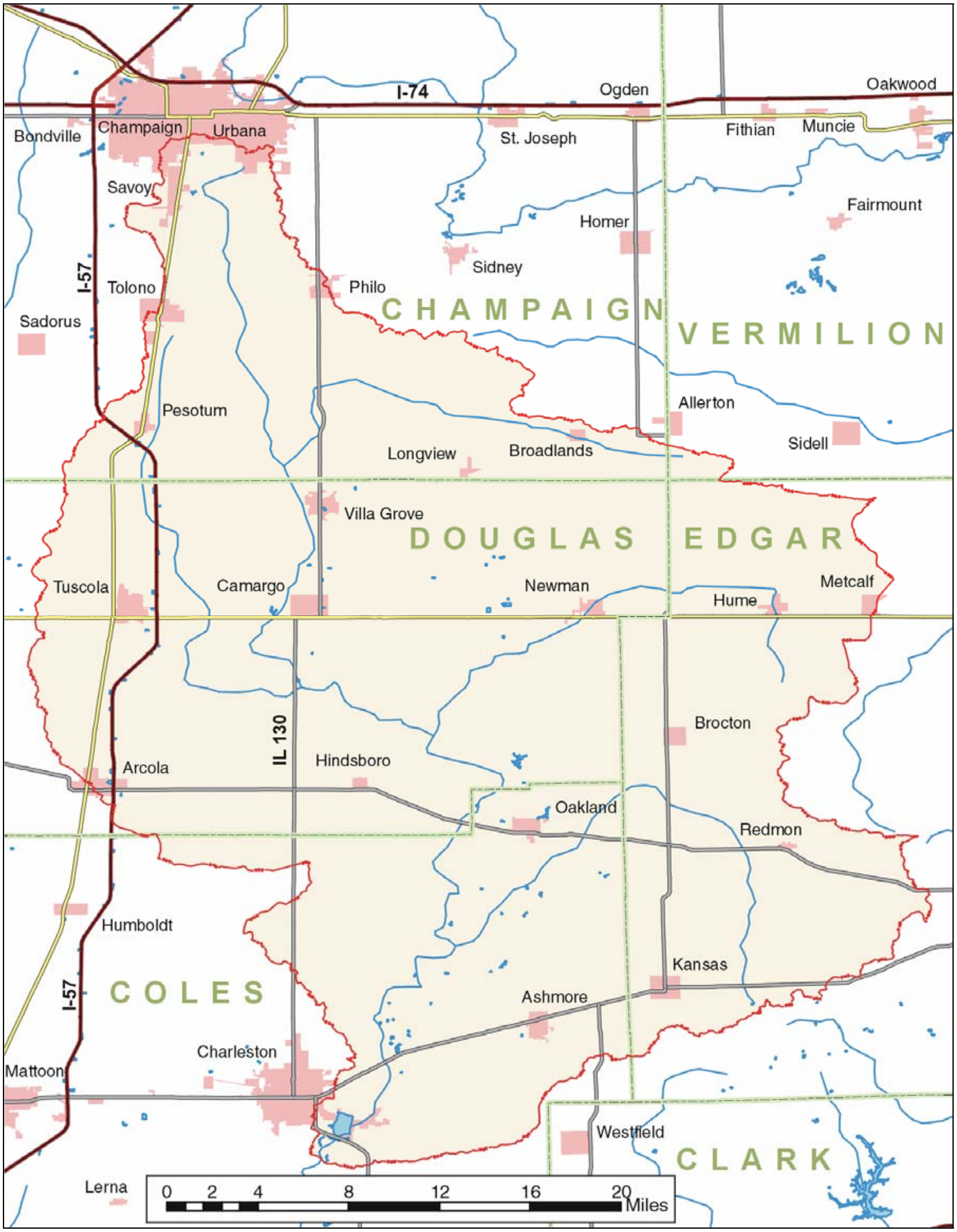

Fig. 1. Charleston Side Channel and Embarras River Watershed

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.

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. 2). 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.

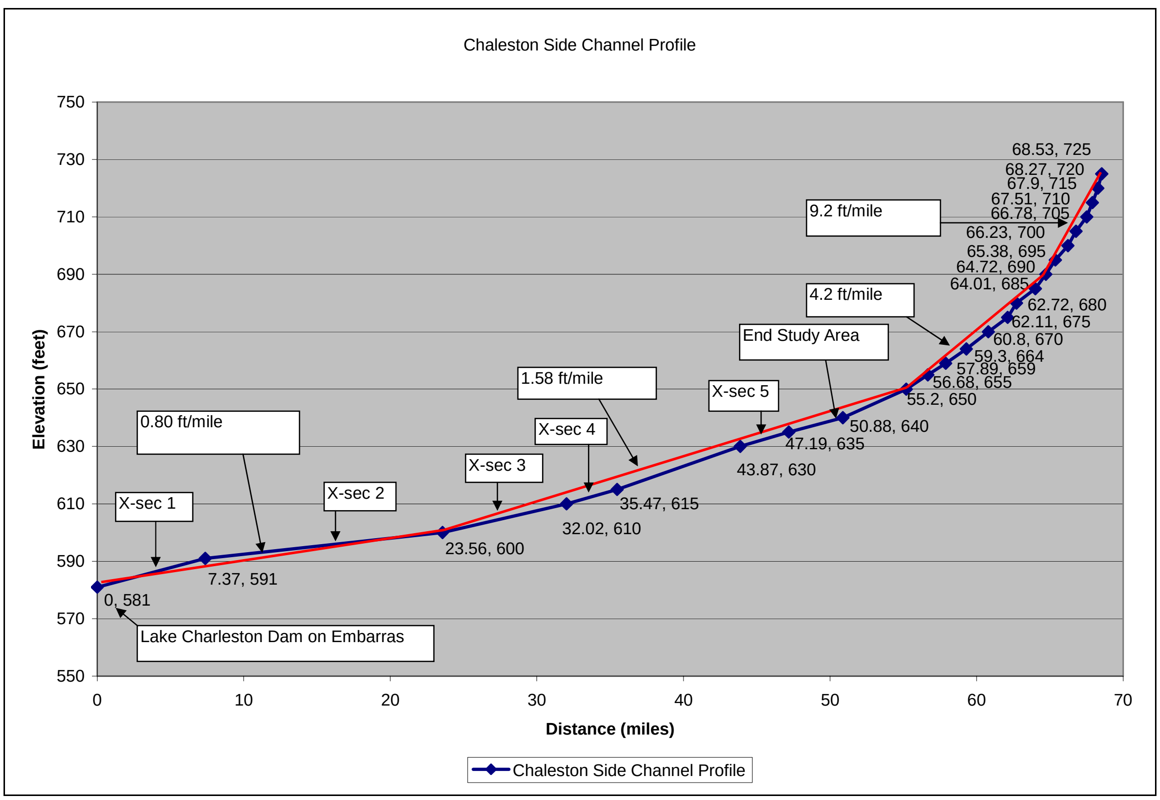

Fig. 2. Valley Profile Embarras River

The DVD has been divided in “chapters” of approximately five 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”. There are 16 chapters on one DVD labeled Chapters 1 thru 16.

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	Divided Channel	Erosion	Severe Erosion
1	1	0	1	1	4	9	0
2	4	0	5	0	1	6	0
3	3	0	2	0	3	17	0
4	1	2	3	0	0	15	0
5	0	2	2	0	1	12	1
6	0	1	2	0	0	10	0
7	0	3	2	0	0	7	1
8	0	1	4	0	0	13	0
9	0	4	2	1	2	6	0
10	0	5	2	0	3	13	0
11	0	5	1	0	2	10	0
12	0	8	2	0	6	7	0
13	0	6	1	0	2	3	0
14	0	6	0	0	0	0	0
15	0	7	0	4	0	5	0
16	0	7	0	7	0	9	0
Totals	**9**	**57**	**29**	**13**	**24**	**142**	**2**

Table 1. Features by Chapter Identified by Aerial Assessment

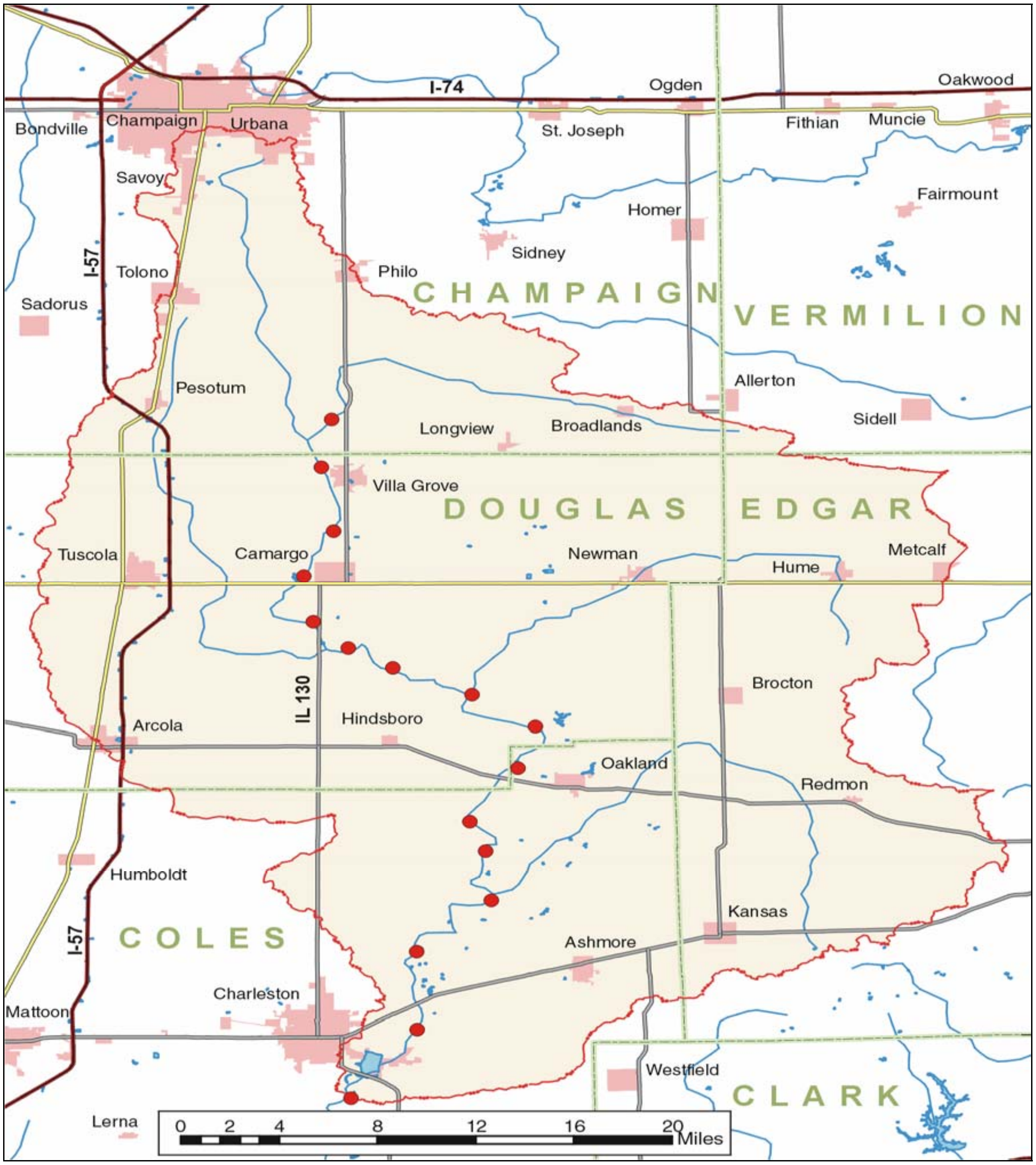

Fig. 3. DVD Chapter Division in Embarras River Study Area

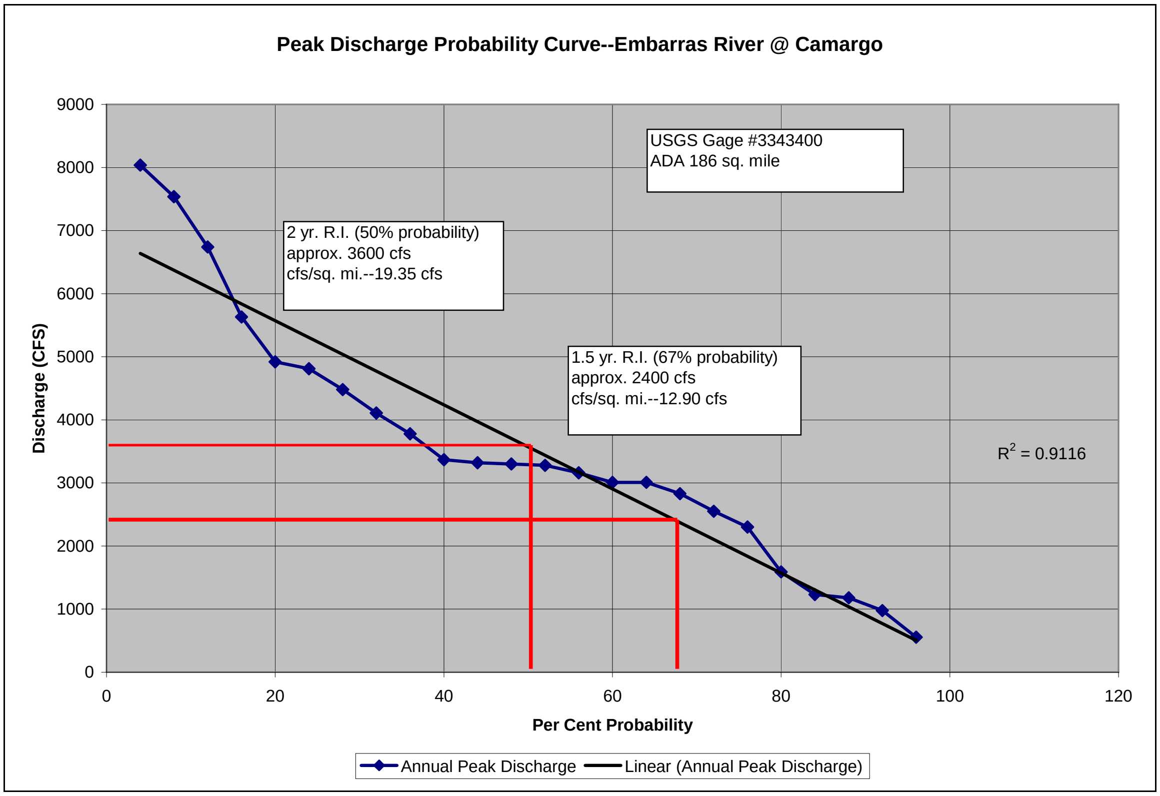

Figure 4. Annual Peak Discharge Probability Curve @ Camargo 1981-2004

The cross section data collected in the Embarras River 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. Appendix A at the end of this report contains the NRCS Streambank Inventory and Evaluation of each cross section.

The probability plot of annual peak discharges for USGS Gage #03343400 has been developed for the period 1981 thru 2004, a more recent rainfall record than was used in WRI Report 87-4207. The more recent analysis shows a slight increase in the 2 yr. discharge from 3160 cfs to approx. 3600 cfs. This increase of 13.9% is not considered significant and may simply reflect increased rainfall during the years analyzed. A trendline of Annual Maximum Peak Discharges from this gage shows only a slight upward trend of 4% over the period 1967-2004. Therefore this report will assume the WRI Report 87-4207 figures to be an accurate reflection of long term peak discharges.

Five cross sections were taken at selected locations on the Embarras River 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 result 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. Cross sections locations are shown in Figs. 5-20 showing aerial views of each chapter. Exact locations as Eastings and Northings can be found in Appendix A

CROSS SECTION SUMMARY – Embarras River

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	719	6431	2205	3.06	235	10.8	1.5	38.27	10.9	1443	1467	0.34	1.02
2	541	5949	1559	2.88	93	11.4	1.9	10.57	11.5	819	828	0.26	1.01
3	513	6249	1500	2.92	106	10.3	2.2	16.43	10.3	684	684	0.24	1.00
4	317	4365	1277	4.02	83	8.7	2.3	12.24	8.8	563	571	0.29	1.01
5	179	3095	396	2.21	74	5.5	1.5	20.56	5.6	267	275	0.13	1.03

Table 2 Cross Section Summary

General Observations

1. Streambank erosion on the Upper Embarras above Lake Charleston is minimal with 173 sites identified in 56 miles of channel including the geotech failures. The average is about 3 sites per mile.
2. Both sides of the channel have mature woody vegetation on nearly the entire length with little to no point bar accumulation, suggesting very minimal lateral migration.
3. Lack of bar accumulations indicates sediment is primarily silt and clay with a high affinity for nutrients in a channel able to transport the sediment delivered from upland sources.
4. Mature woody vegetation on banks is sloughing off into channel at erosion sites contributing to the woody debris creating 57 identified logjams.
5. The channel x-sections taken show the Embarras to be very well connected to the floodplain with channel capacity only 13 to 34% of the predicted Q2. These discharges would equate to a range of "out-of-bank" frequencies of 1.04 yr. R.I to a 1.2 yr. R.I.
6. With no recent rains and the channel well within banks at the lower end of study area, the upper end near Villa Grove was near flood stage substantiating the findings at X-sec 5 of a channel only capable of carrying 13% of the 2 yr. discharge.

Conclusion and Recommendations

No assessment by chapter is being made for the Embarras River. Reviews of the aerial DVD's and field investigations indicate there is no downcutting, the channel is well connected to floodplain and channel erosion appears to be minimal. There are 29 geotechnical failures where trees have slid vertically into the channel and the accumulation of woody debris and logjams in a major factor in many other erosion sites.

The recommendation is therefore to actively remove major logjams and large woody debris that is likely to form a logjam. The current erosion sites not associated with woody debris could be successfully treated with stream barbs to stop the bank erosion and prevent additional trees from entering the channel through bank failure. It is estimated from the DVD that 40 to 50% of the erosion sites would be candidates for stabilization. The stone required for the average barb in the Embarras is estimated to be 150 tons at a cost of $4500 each. Each outside bend treated will require 4 to 5 barbs at an estimated cost of $18,000 to $22,500 per site. The total cost of treatment with streambarbs would then be approx. 70 sites at $20,000 each for a total of $1,400,000.

Figures 5 thru 20 show the location of eroding sites needing potential treatment, but no distinction is made for individual sites between those needing woody debris management only and those needing bank stabilization. No other treatment is recommended.

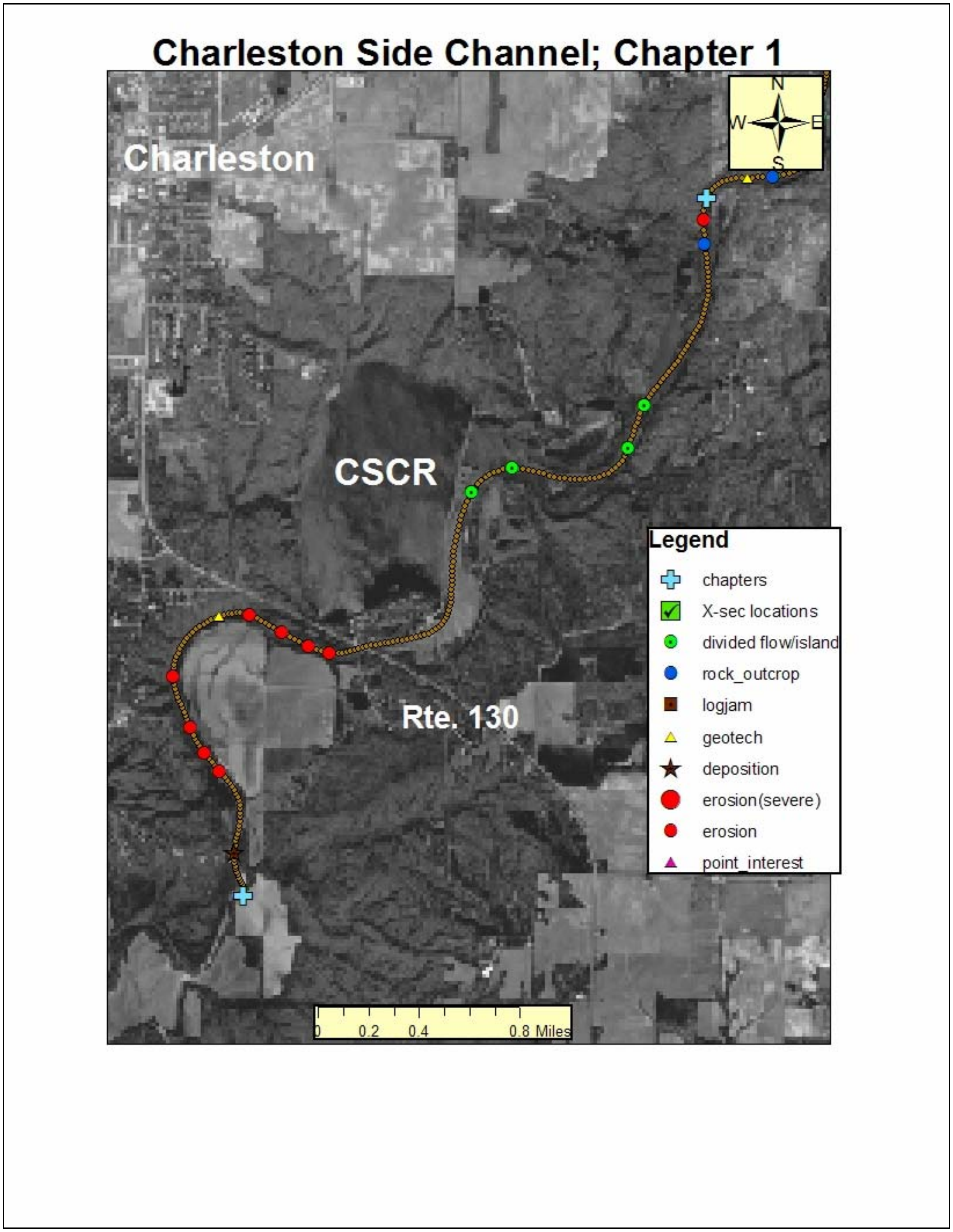

Fig. 5. Chapter 1 Aerial View

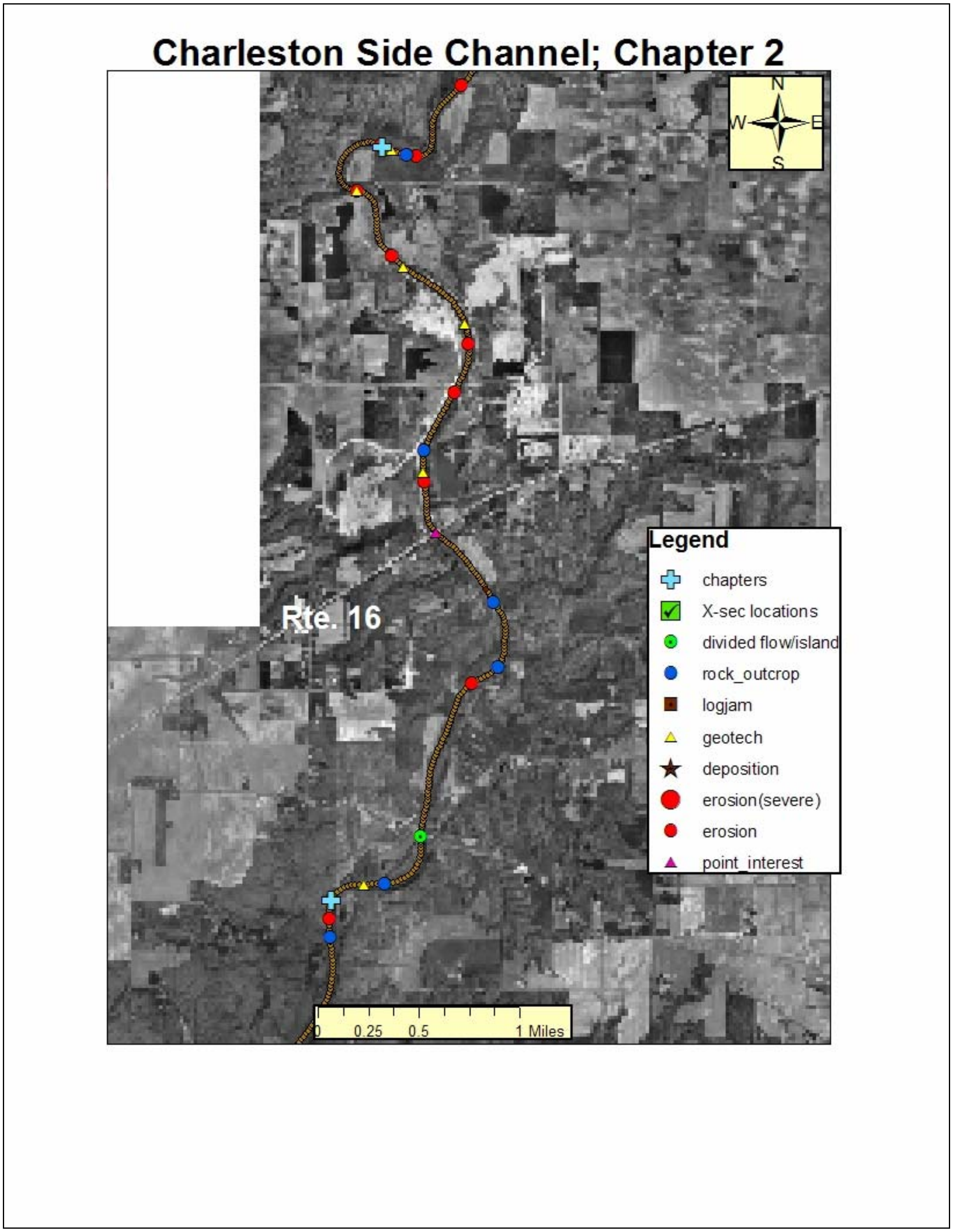

Fig. 6. Chapter 2 Aerial View

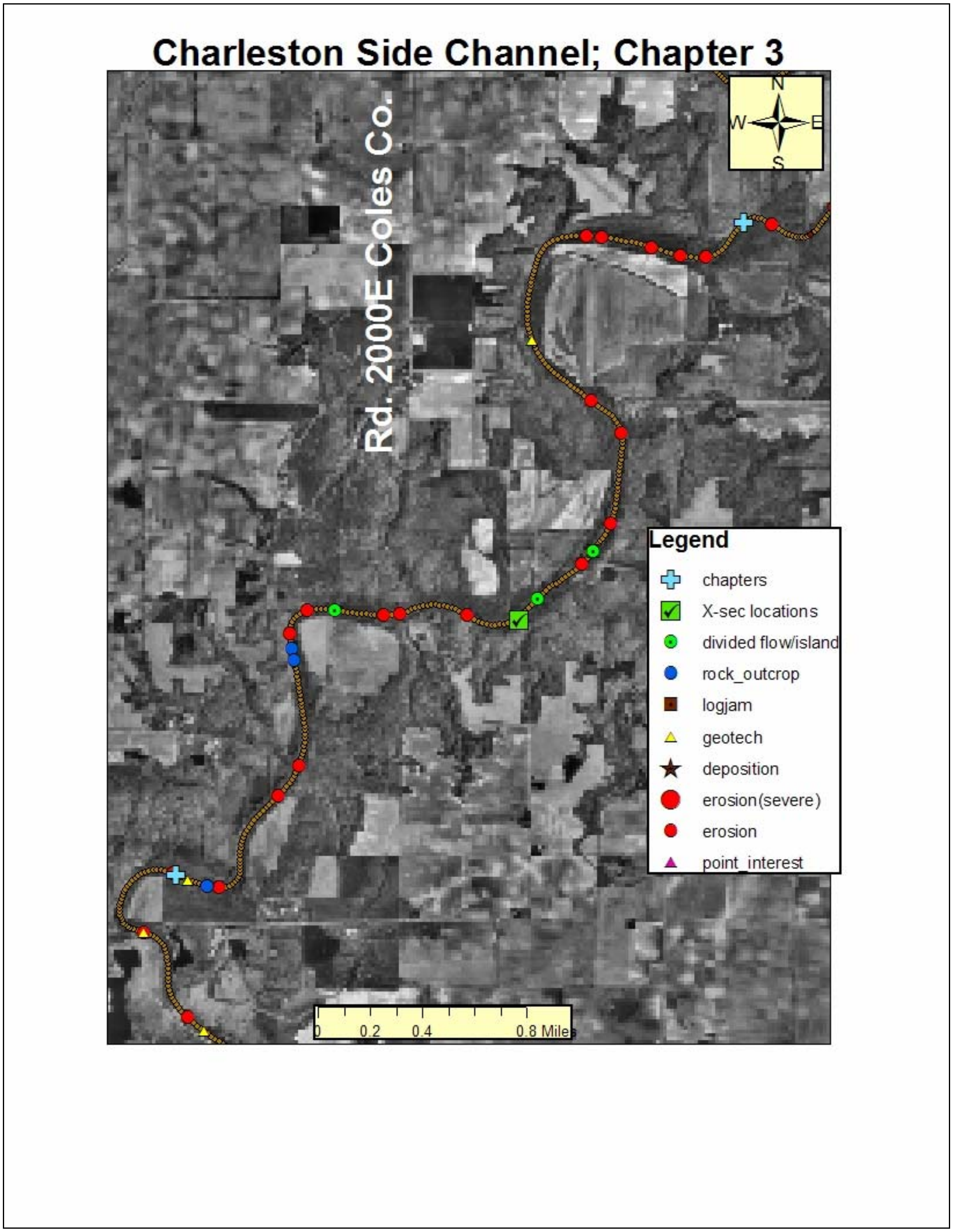

Fig. 7. Chapter 3 Aerial View

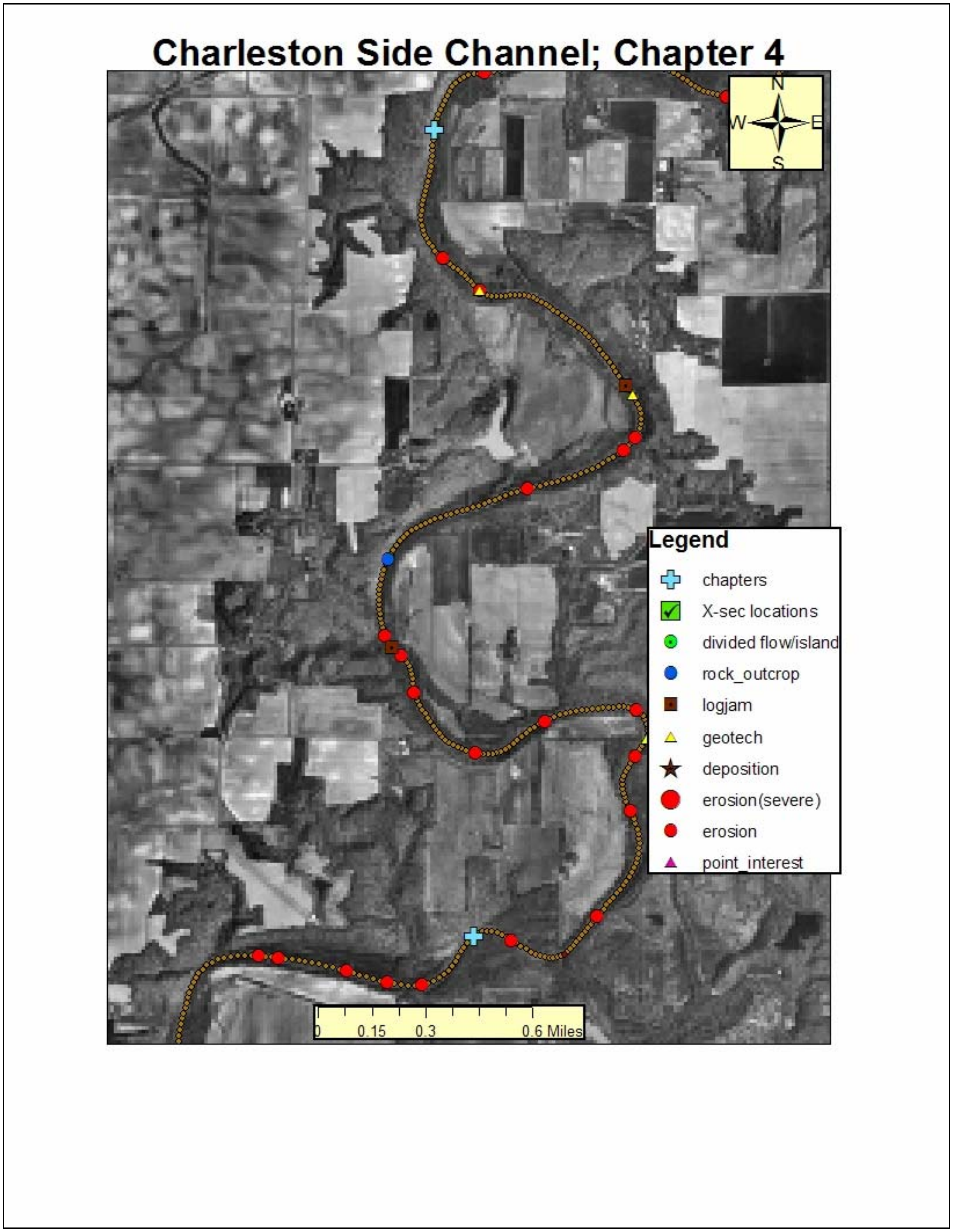

Fig. 8. Chapter 4 Aerial View

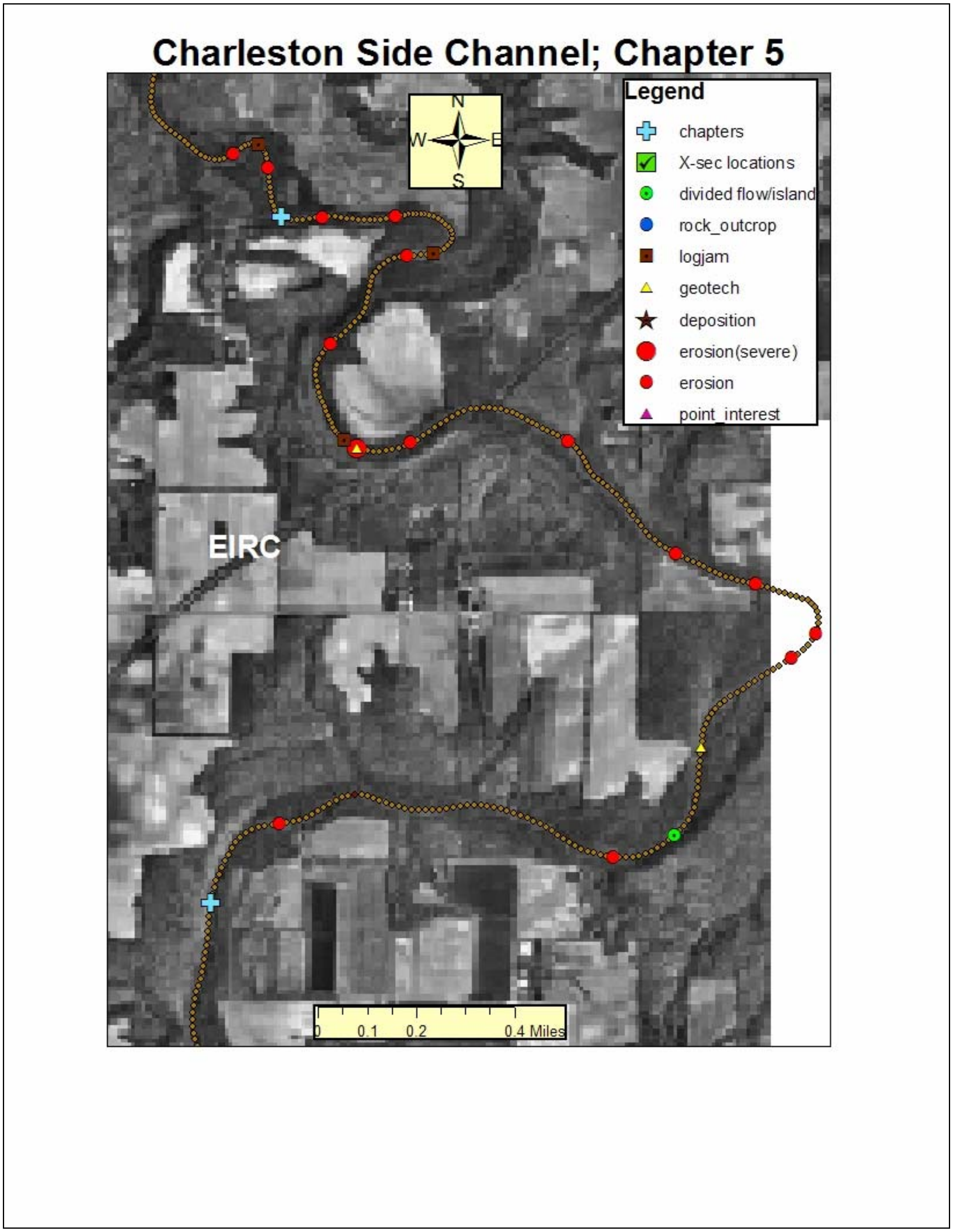

Fig. 9. Chapter 5 Aerial View

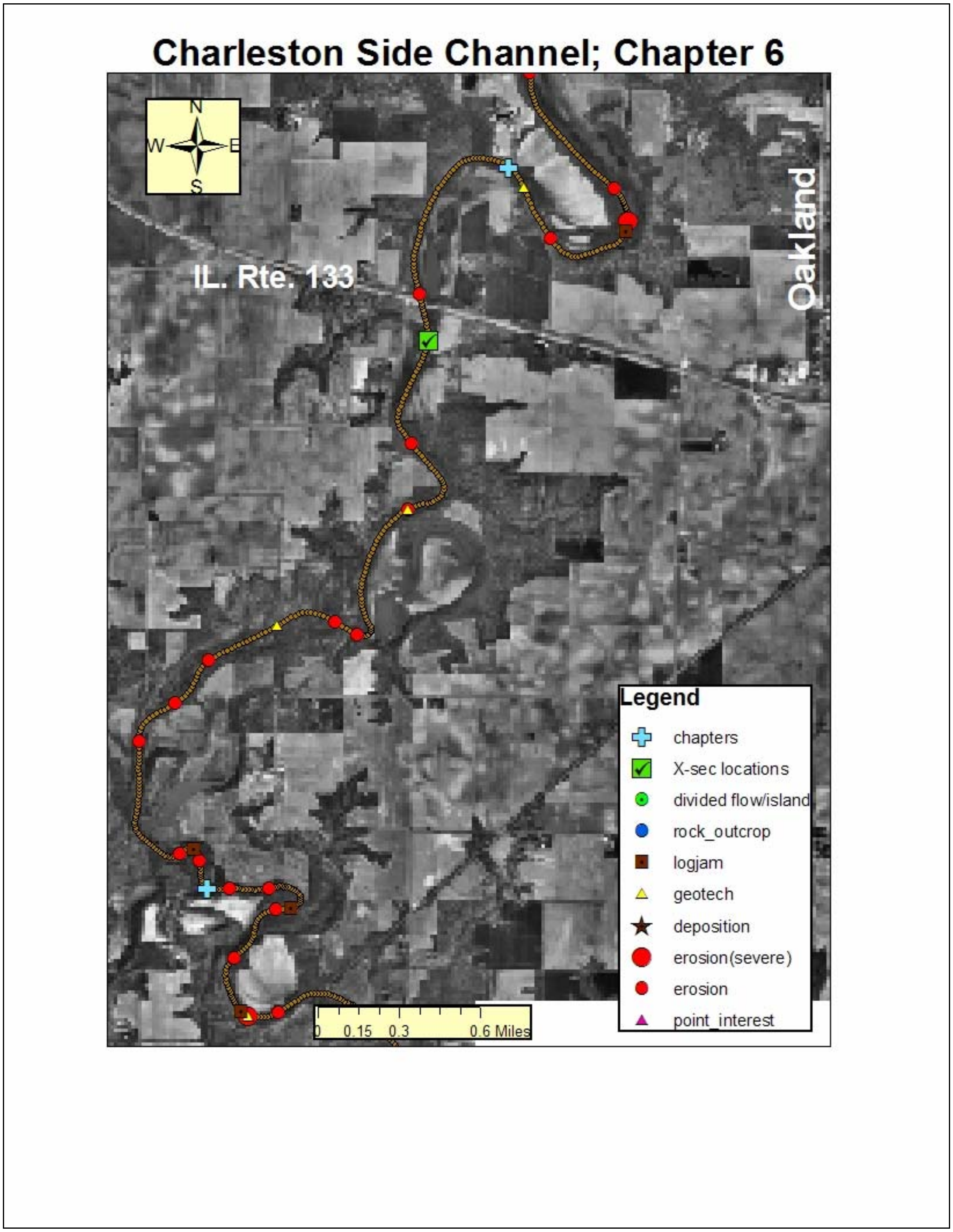

Fig. 10. Chapter 6 Aerial View

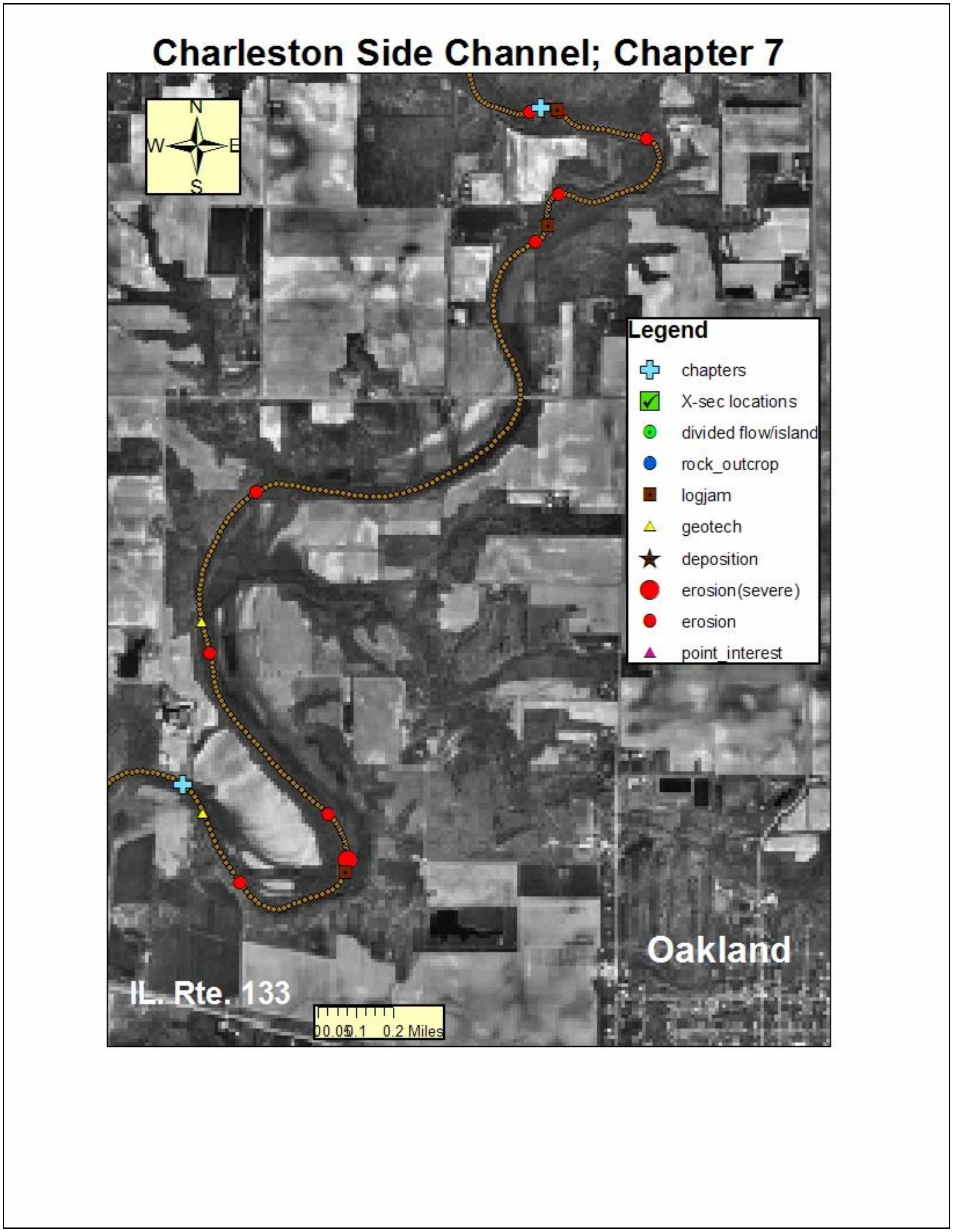

Fig. 11. Chapter 7 Aerial View

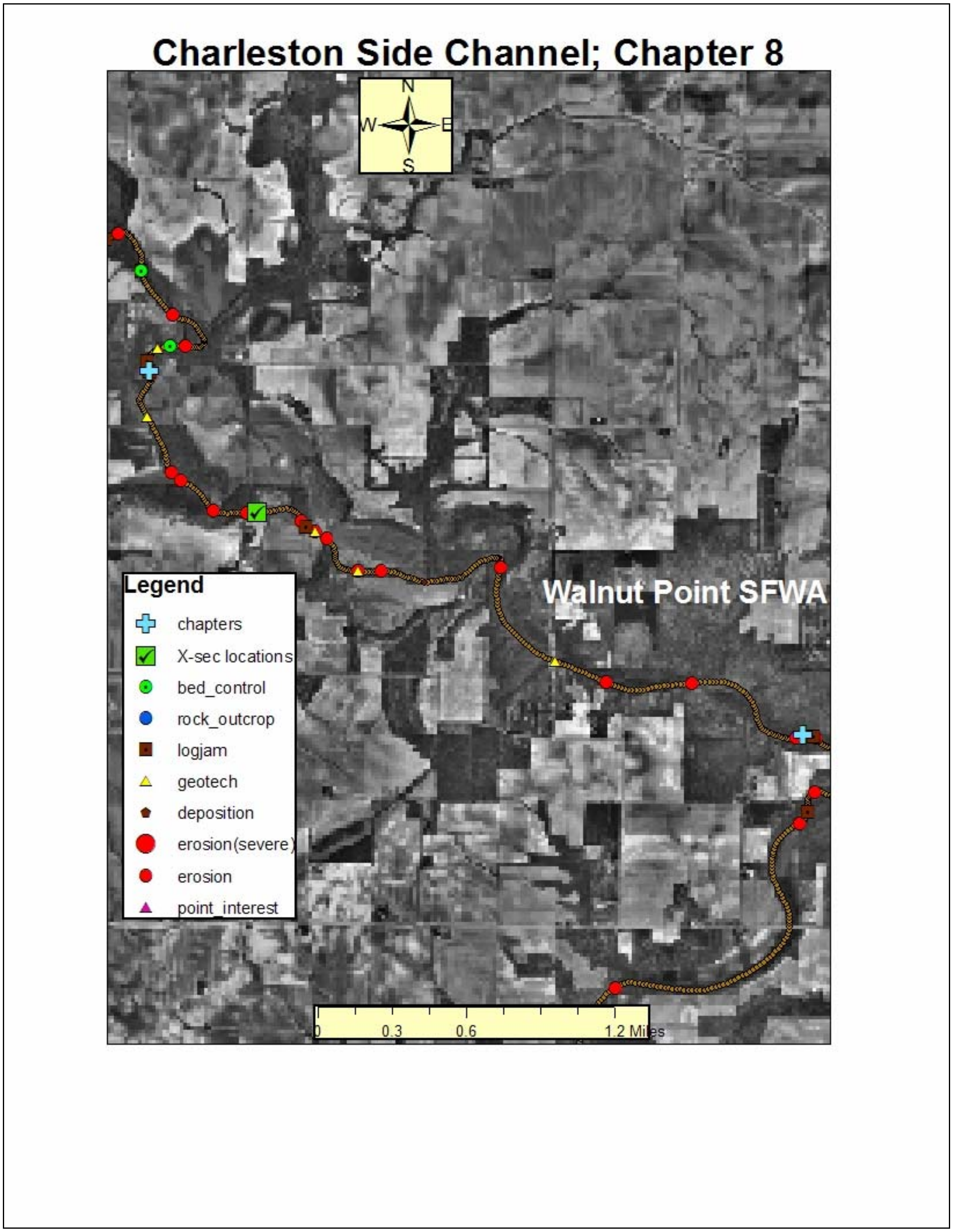

Fig. 12. Chapter 8 Aerial View

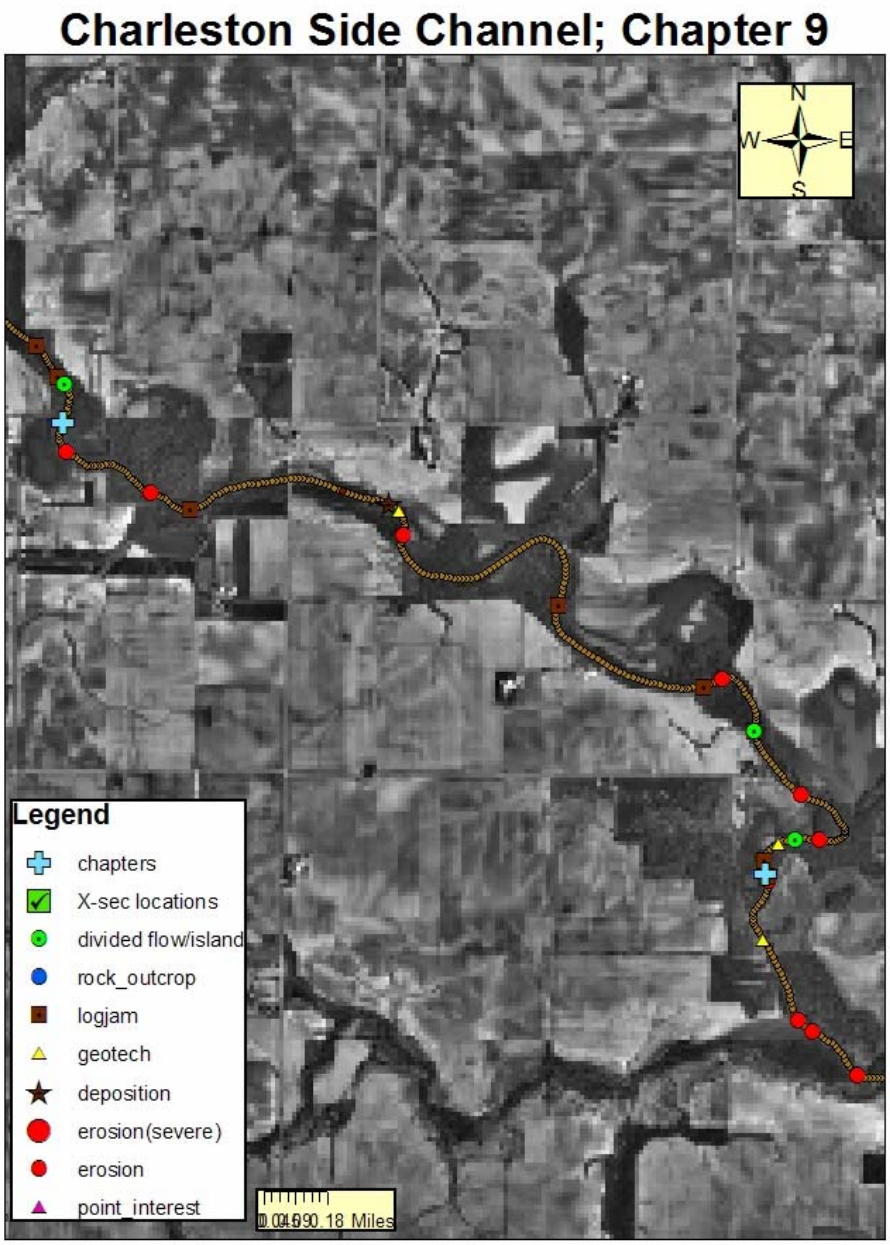

Fig. 13. Chapter 9 Aerial View

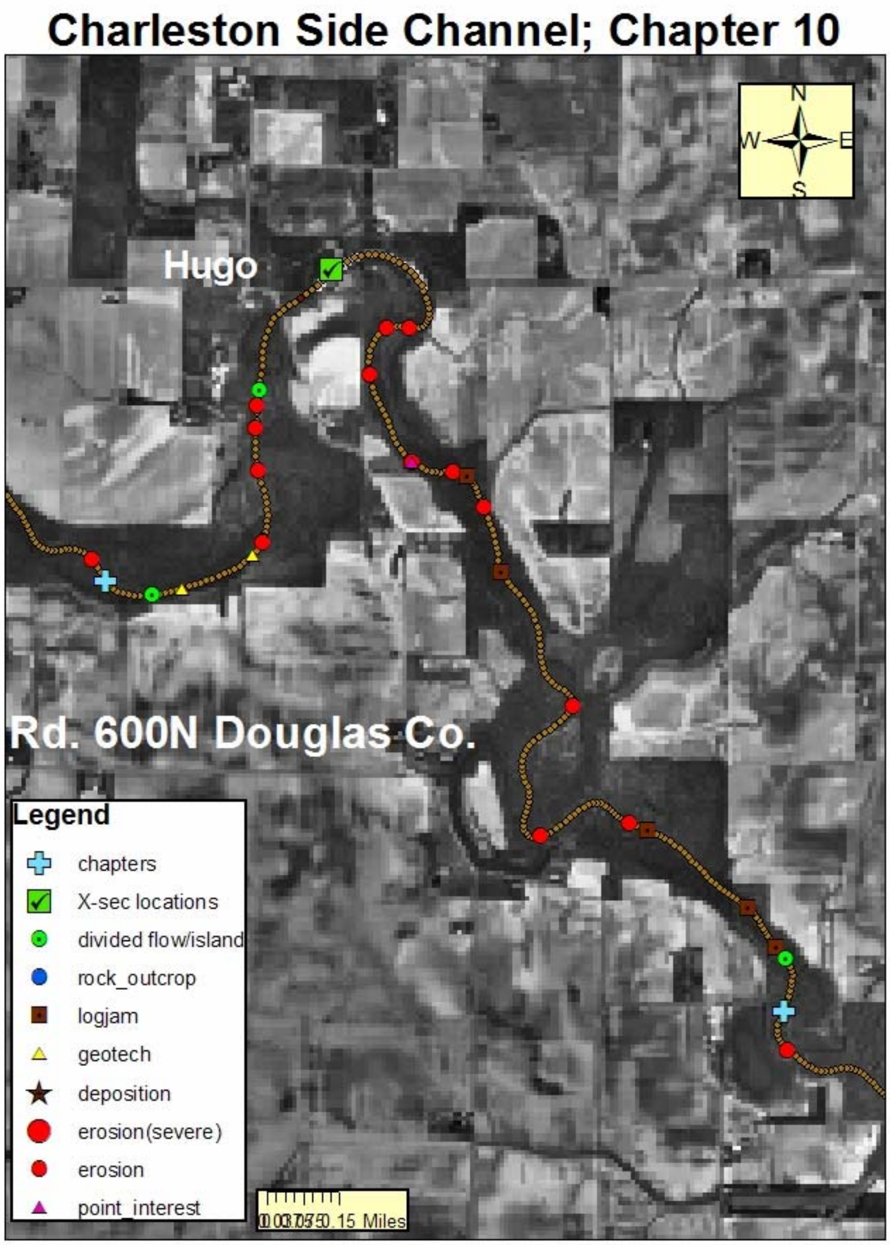

Fig. 14. Chapter 10 Aerial View

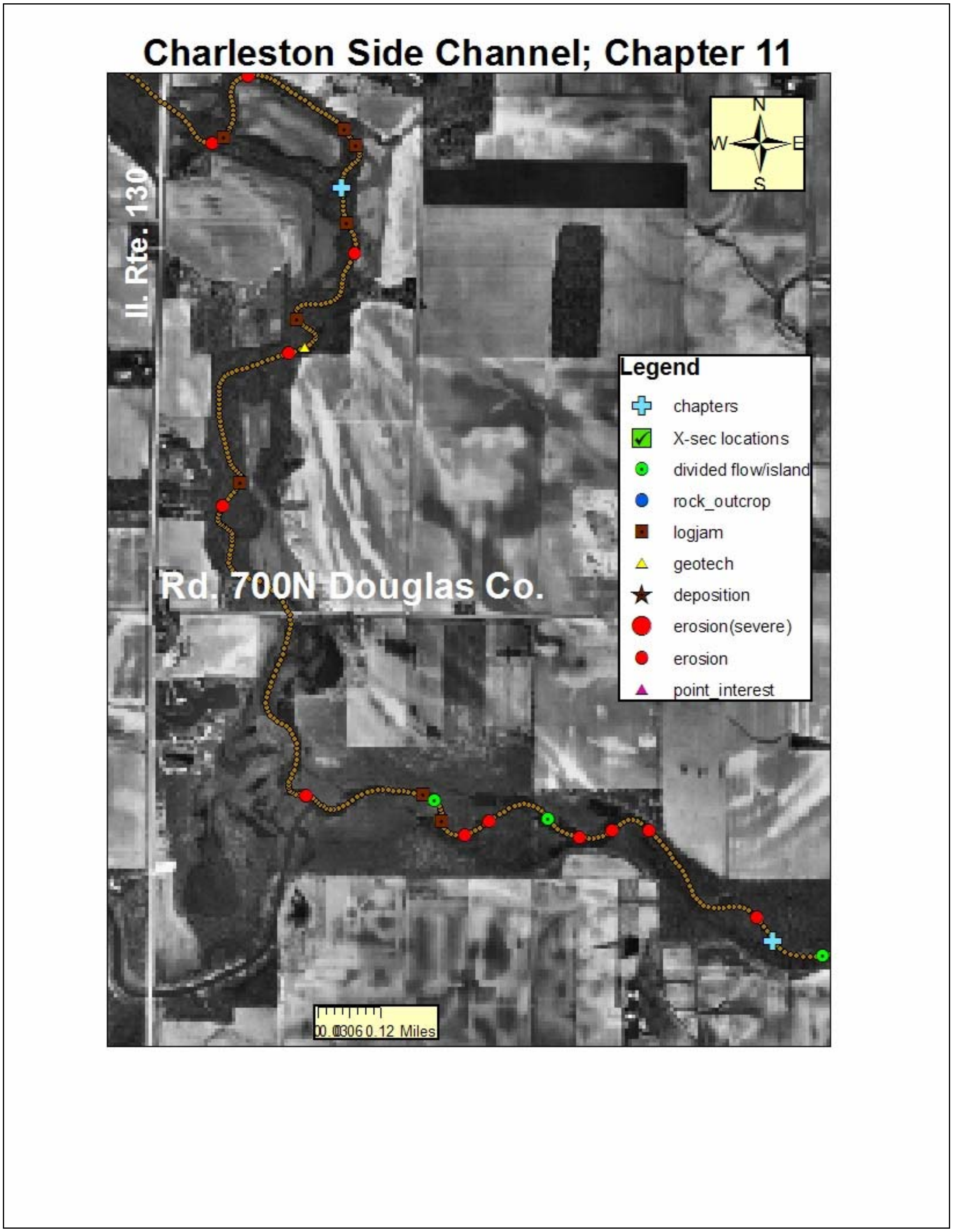

Fig. 15. Chapter 11 Aerial View

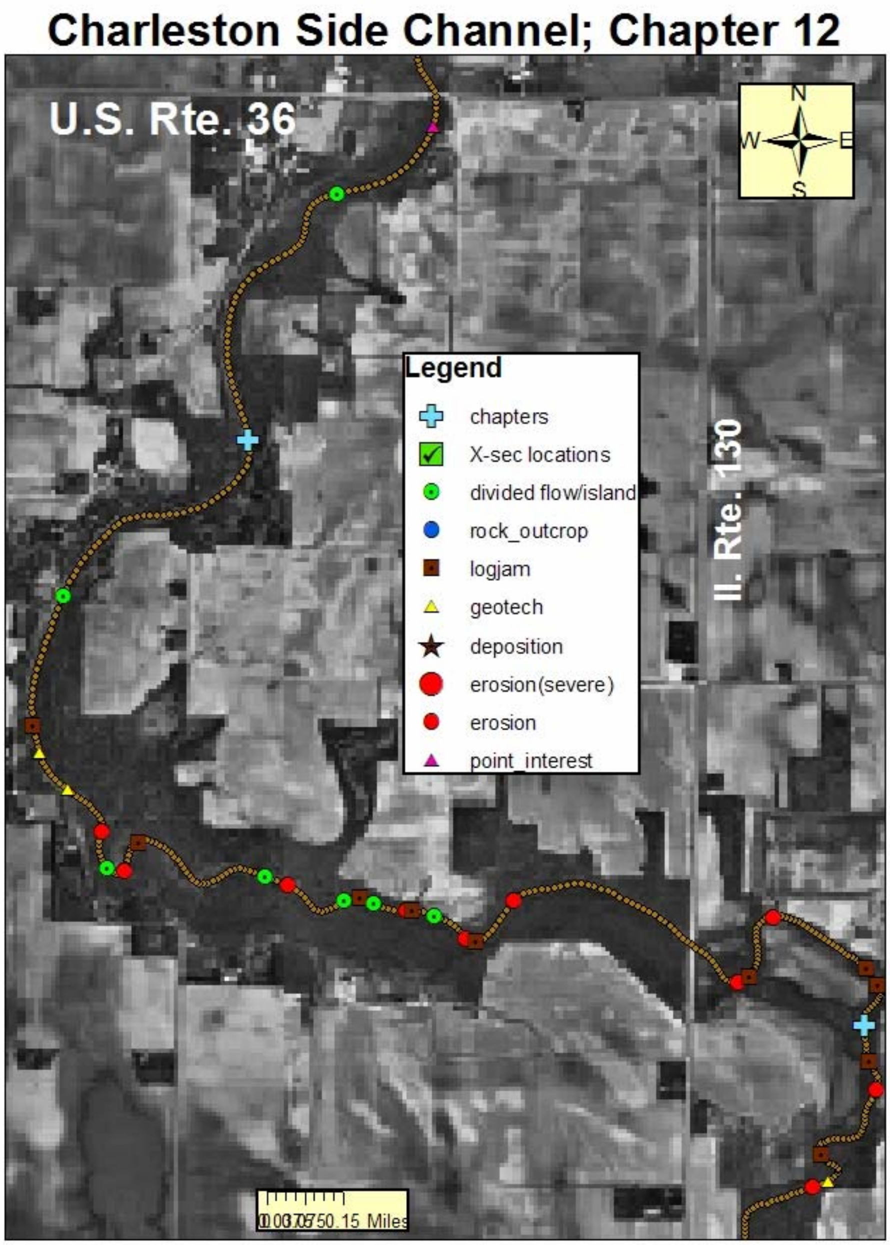

Fig. 16. Chapter 12 Aerial View

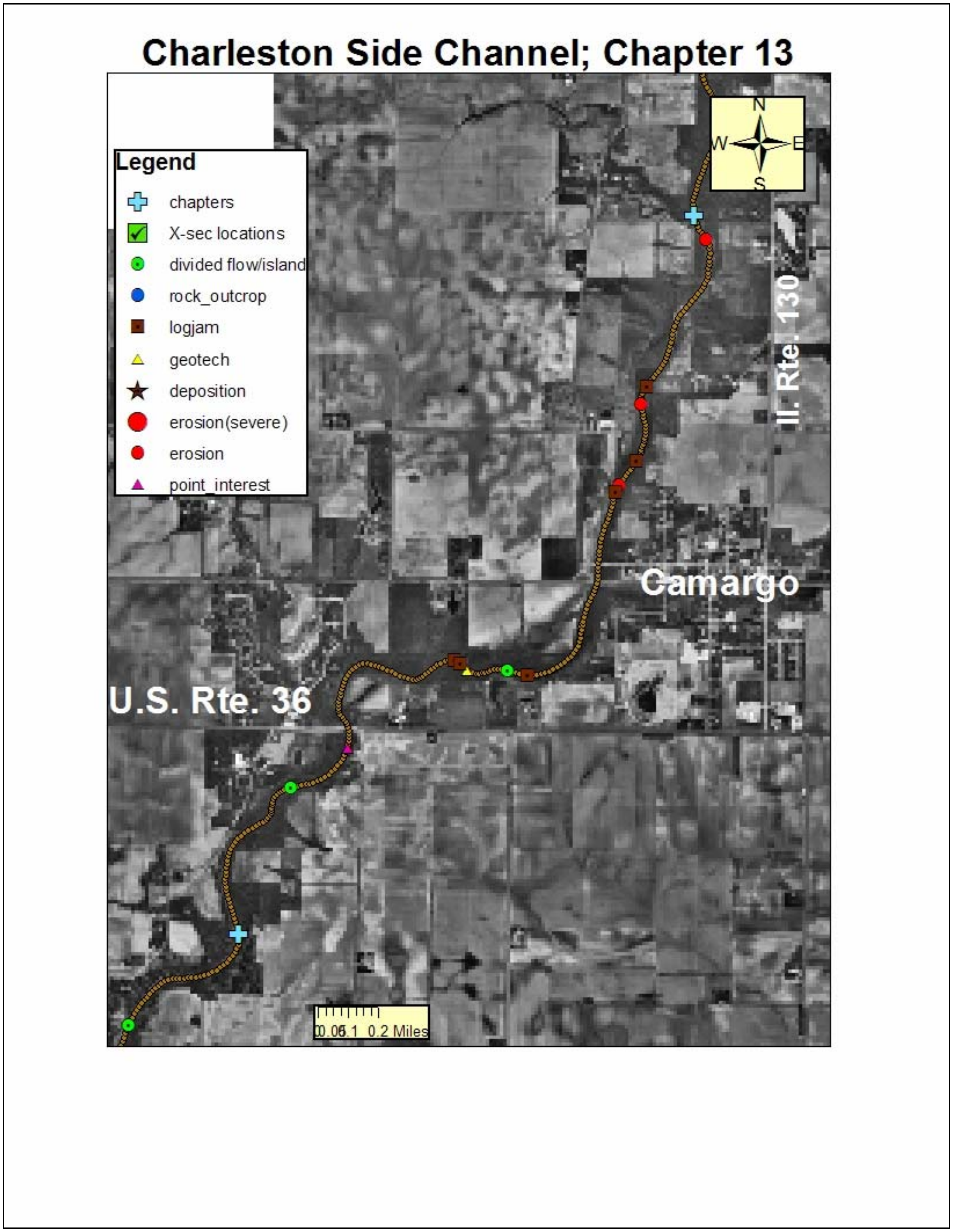

Fig. 17. Chapter 13 Aerial View

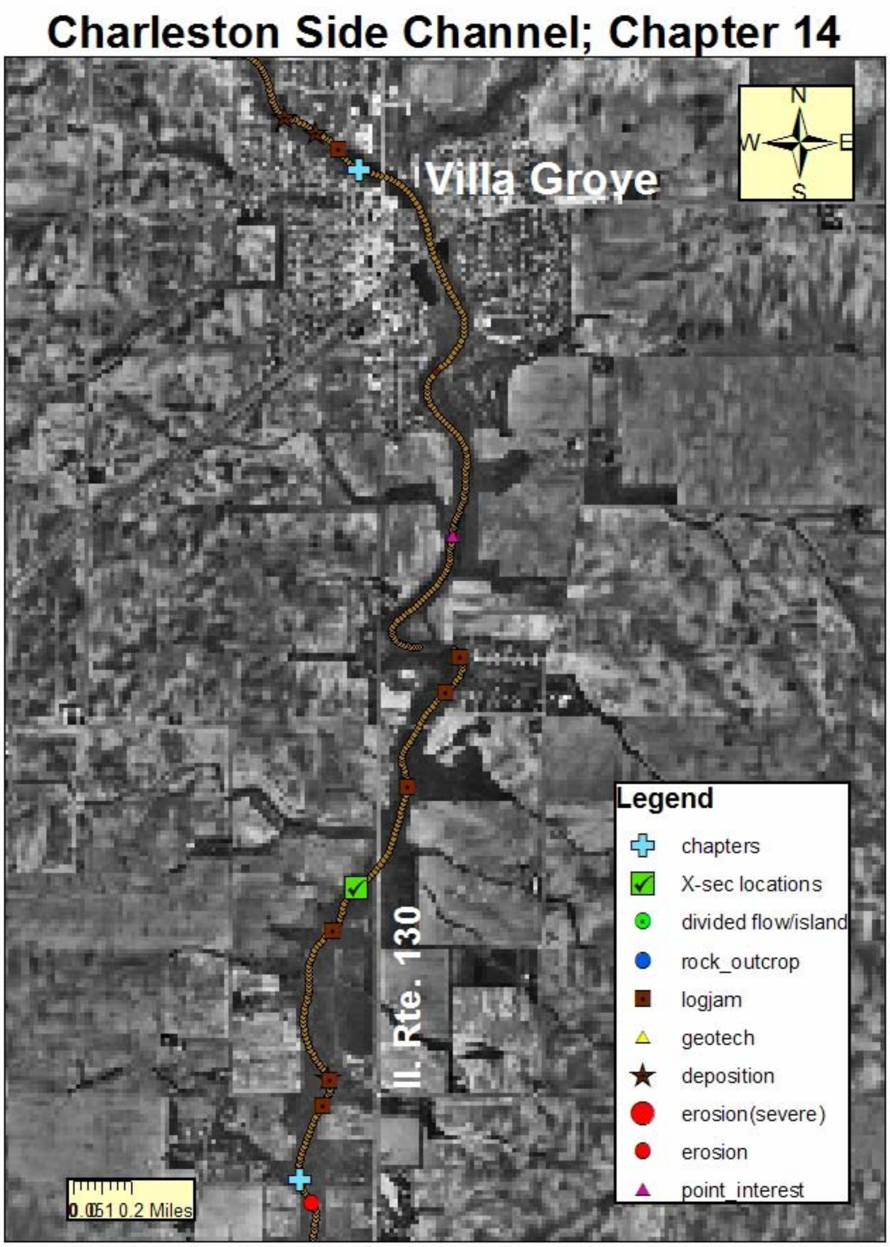

Fig. 18. Chapter 14 Aerial View

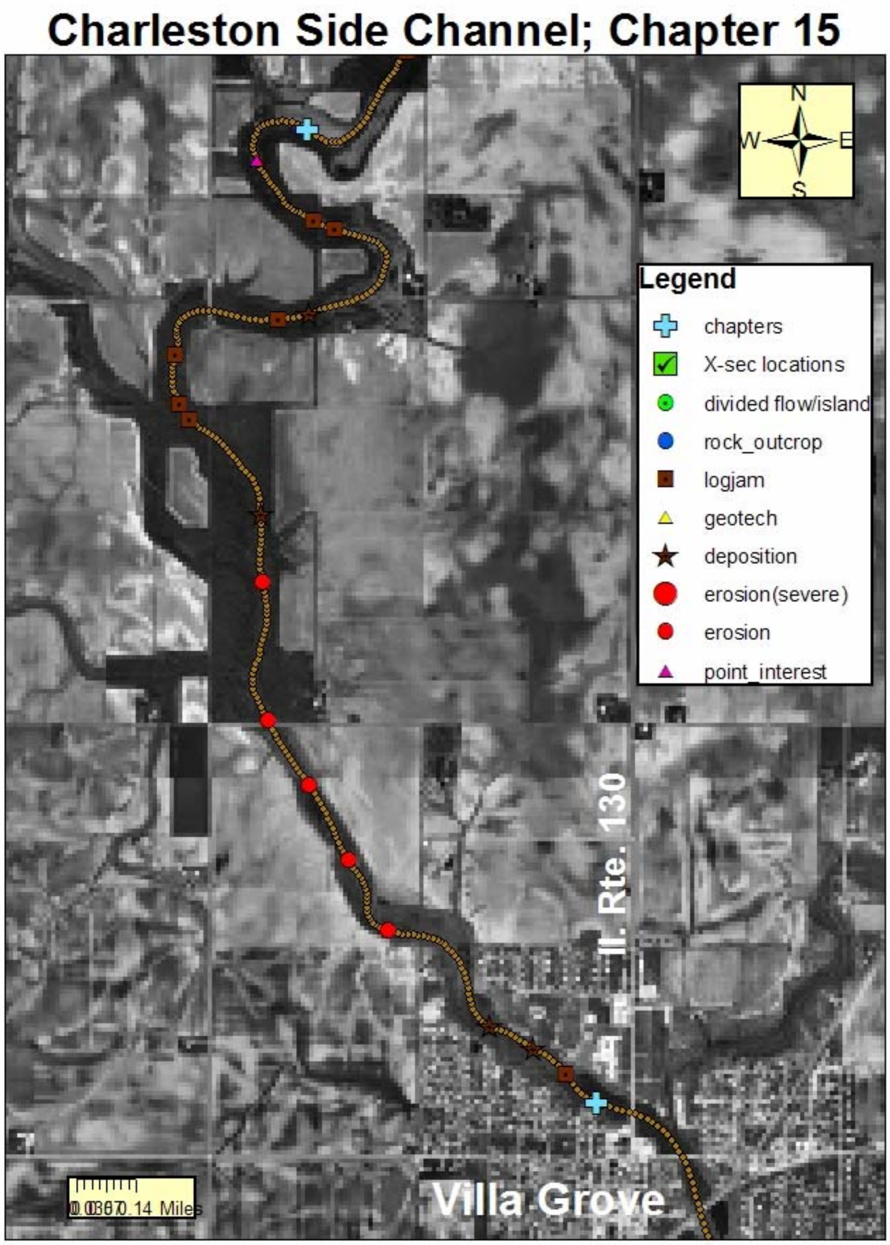

Fig. 19. Chapter 15 Aerial View

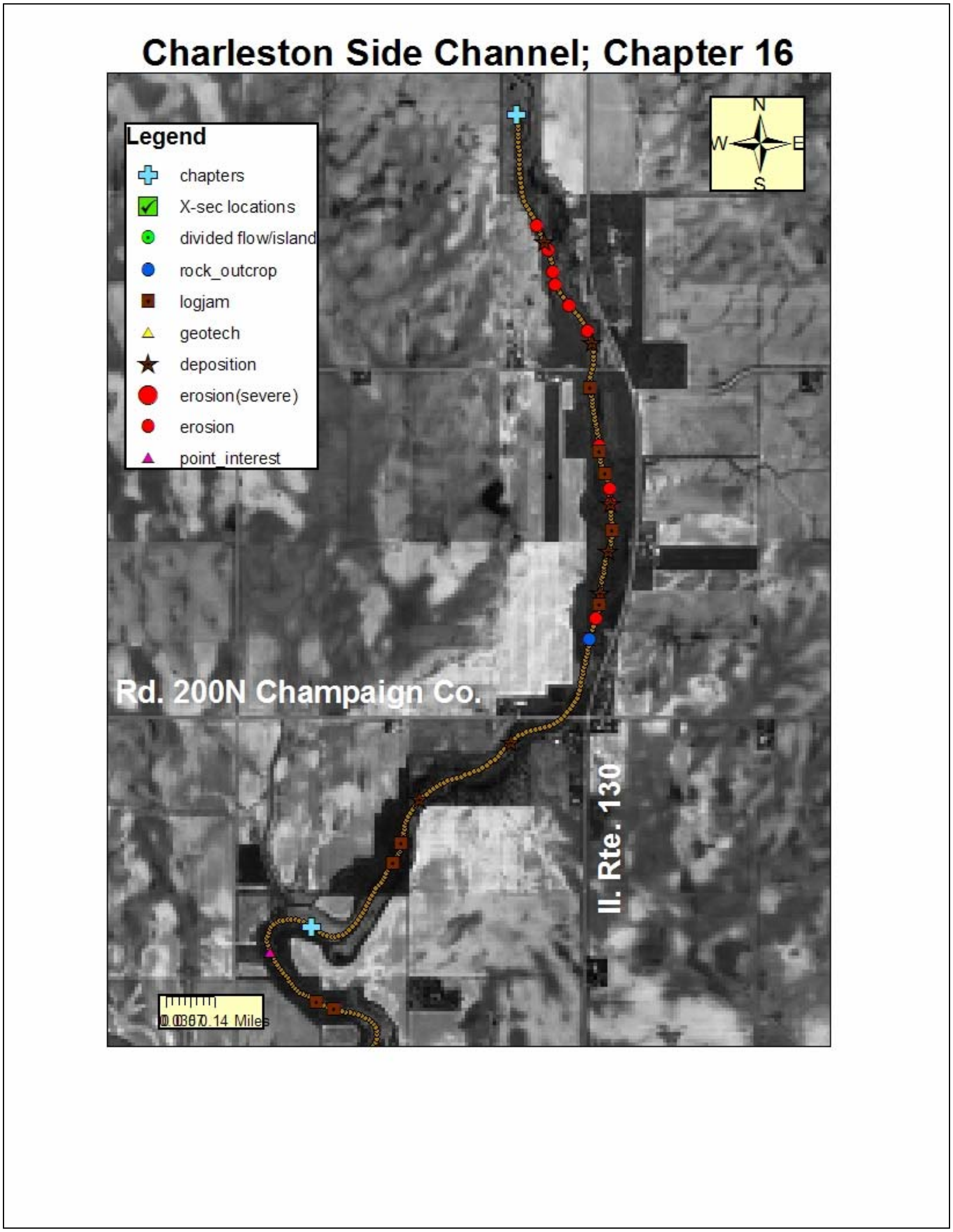

Fig. 20. Chapter 16 Aerial View

APPENDIX A

CROSS SECTION DATA