

# **AERIAL ASSESSMENT REPORT FOR Hodges and Otter Creek**

**Macoupin County**

**December 2005**

**Prepared by Wayne Kinney for IL. Dept. of Agriculture**

The DRAFT TMDL study of Hodge's Creek completed by Limno-Tech, Inc in July 2005. The report lists Otter Lake, a 765 acre water supply reservoir, as impaired by manganese, however Hodges Creek watershed is yet to be addressed in a TMDL report. Hodges Creek has been identified by IEPA as a waterbody impaired by Dissolved Oxygen (DO).

### Assessment Procedure

Low level geo-referenced video was taken of Hodges and Otter 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 the upper reaches of Otter Creek just above the Macoupin-Sangamon County line and preceded downstream to the confluence of Hodges Creek with Macoupin Creek near Rockbridge, IL. Aerial video of tributaries was not part of the project, regardless of the stream size or vegetation.

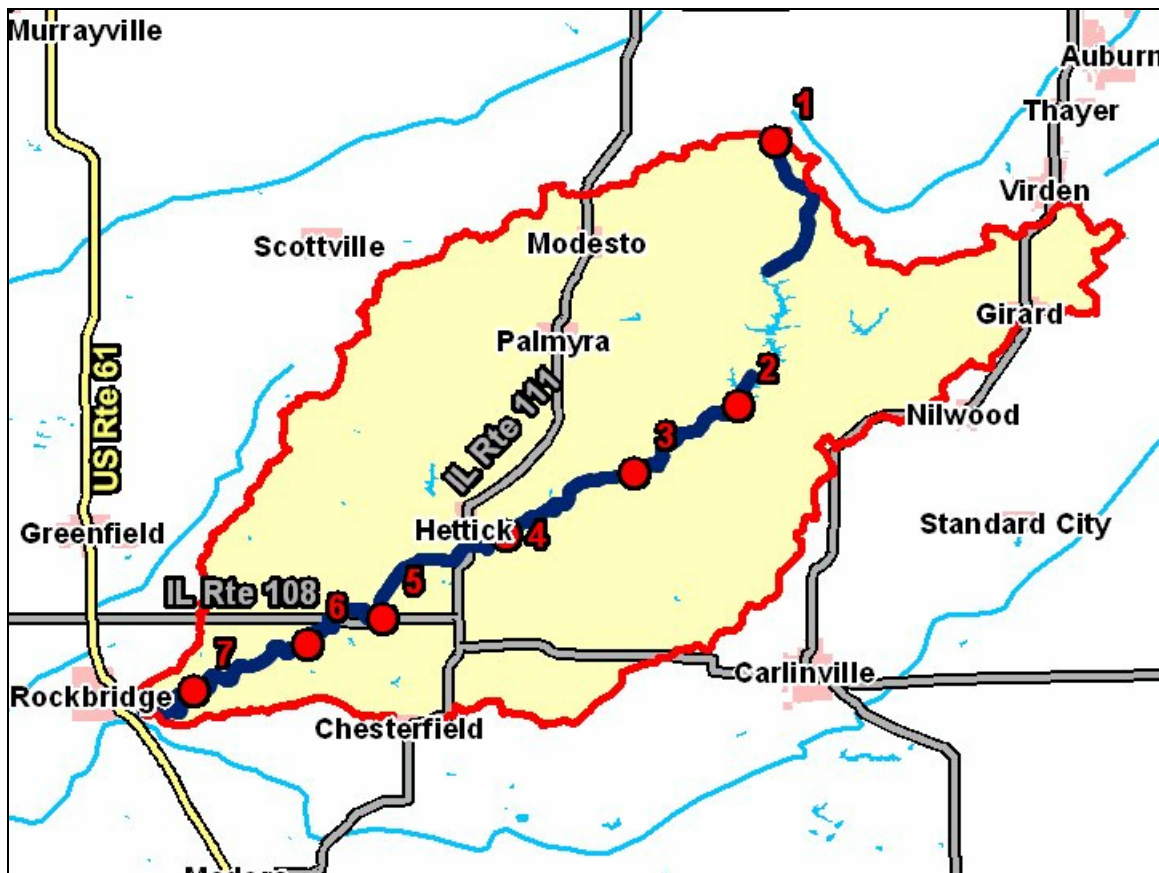
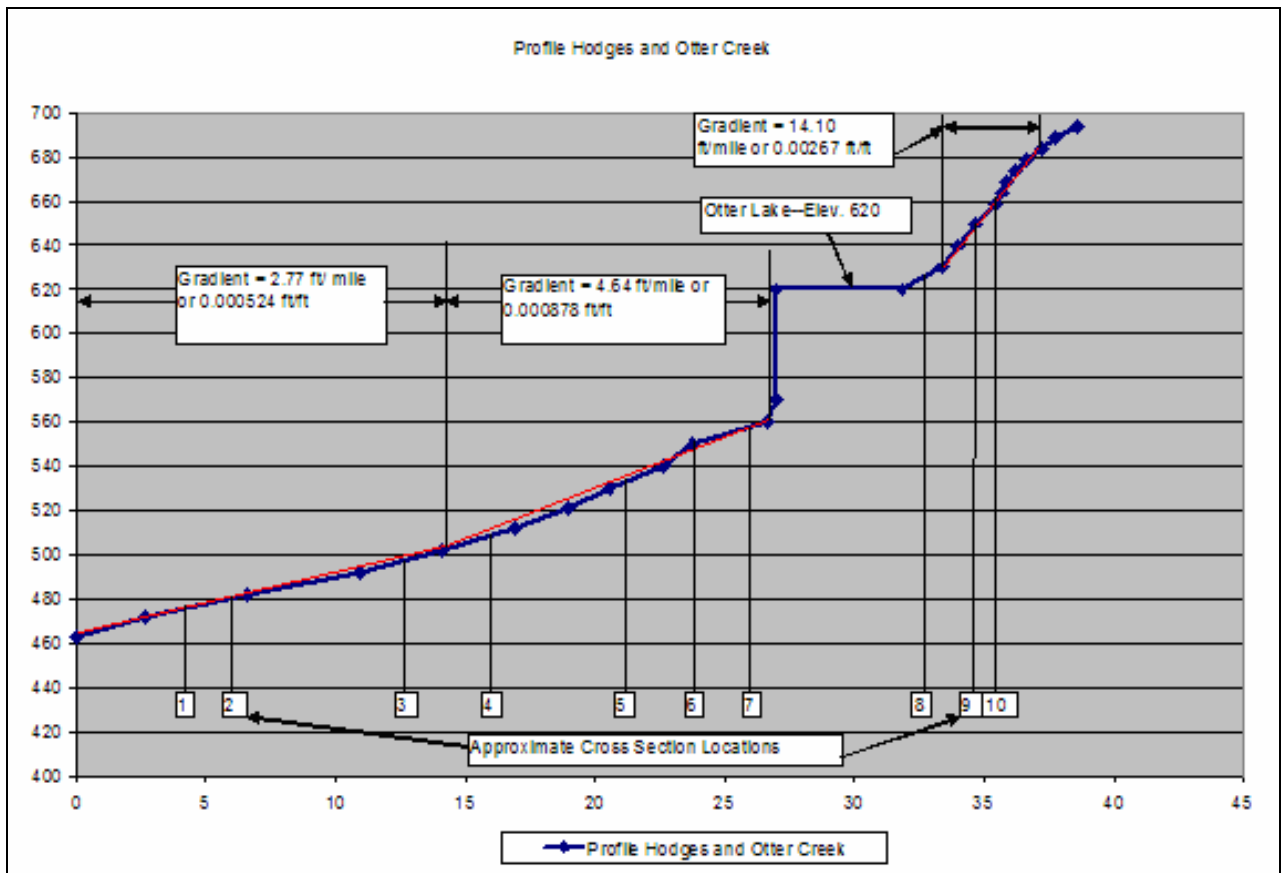


Fig. 1 Aerial Assessment Map of Hodges Creek

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.



**Fig. 2 Channel Profile Hodges and Otter 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.

| CHAPTERS ON DVD AND ASSESSMENT REPORT<br>Otter Creek |             |                |                |               |
|--|-------------|----------------|----------------|---------------|
| DVD Disc   | DVD chapter | Beginning Time | Report Chapter | Cross Section |
| 1  | 2           | 10:00          | 1              | 8,9,10        |
| 1  | 3           | 20:00          | 2              | 6,7           |
| 1  | 4           | 30:00:00       | 3              | 5             |
| 1  | 5           | 40:00:00       | 4              | *             |
| 2  | 2           | 10:00          | 4              | 3,4           |
| 2  | 3           | 20:00          | 5              | *             |
| 2  | 4           | 30:00:00       | 6              | 1,2           |
| 2  | 5           | 40:00:00       | 7              | *             |

Note: Flight path is from upstream to downstream

**Fig. 3 DVD Chapters and Report Guide**

The DVD has been divided into “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 or group of chapters. 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”.

### **Chapter Division and Cross Section locations**

Figures 4 thru 10 below show the locations of the seven (7) chapters and the ten (10) cross sections used to develop the analysis of Hodges and Otter Creeks.

# Otter Creek--Chapter 1

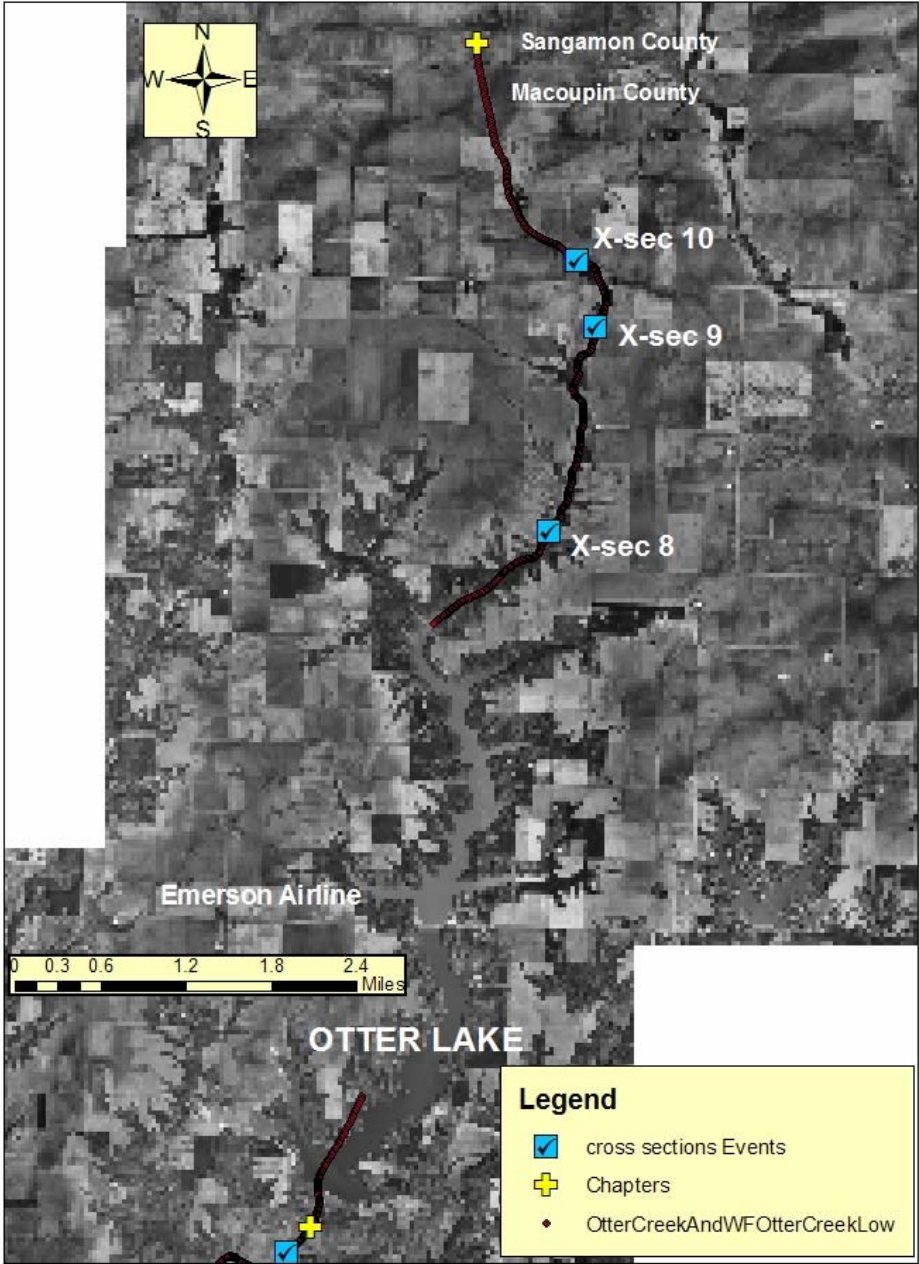


Figure 4

## Otter Creek--Chapter 2

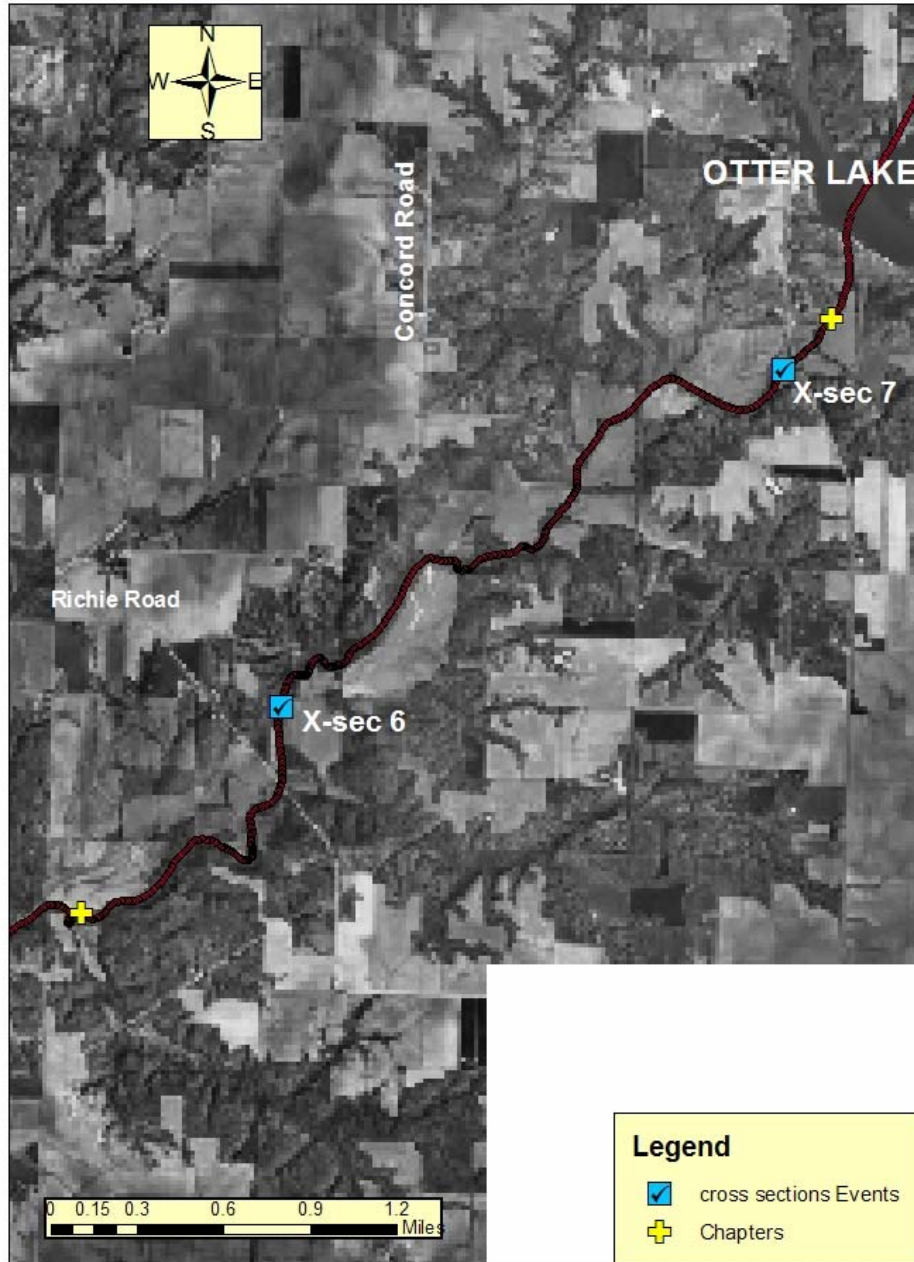


Figure 5

# Otter Creek--Chapter 3

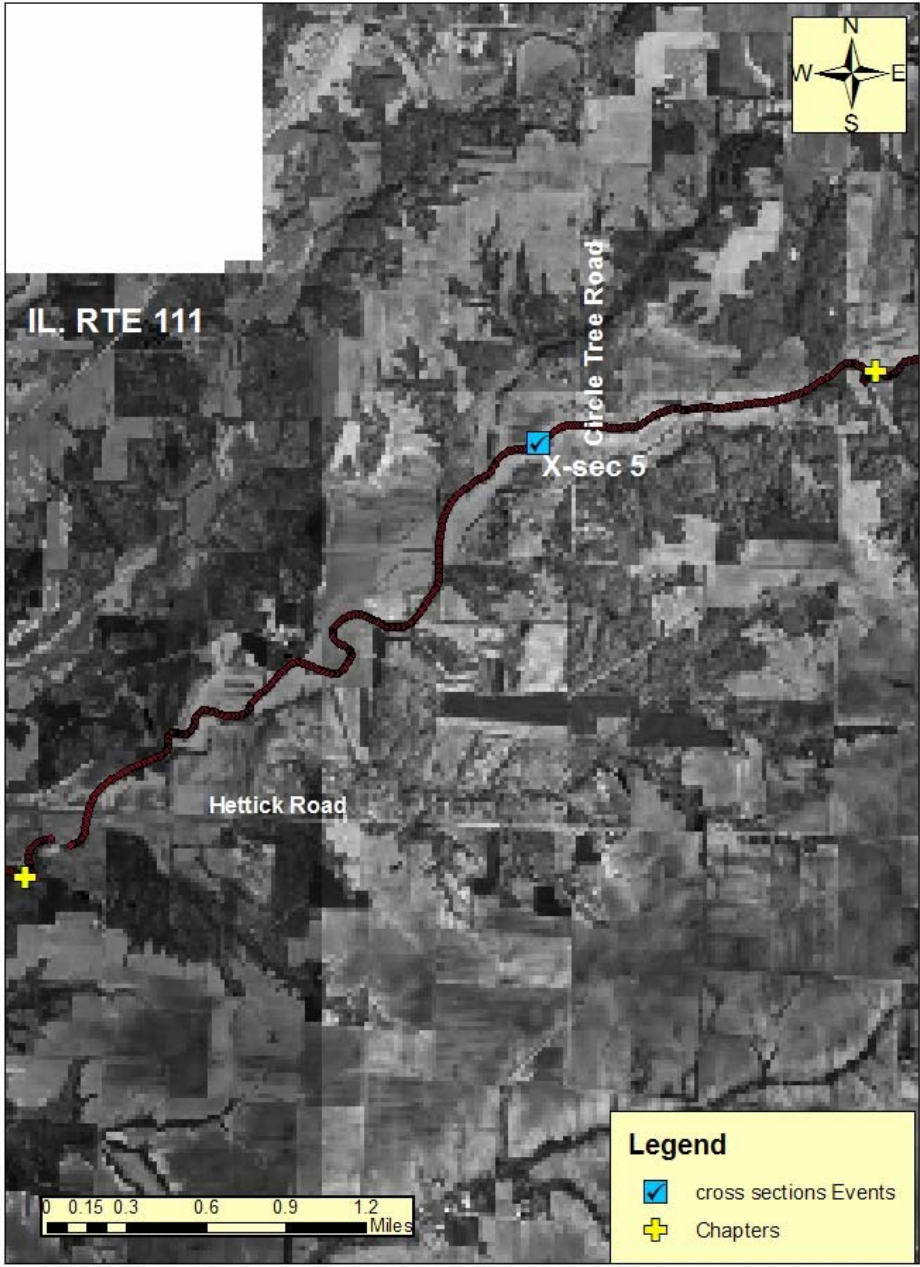


Figure 6

# Otter Creek--Chapter 4

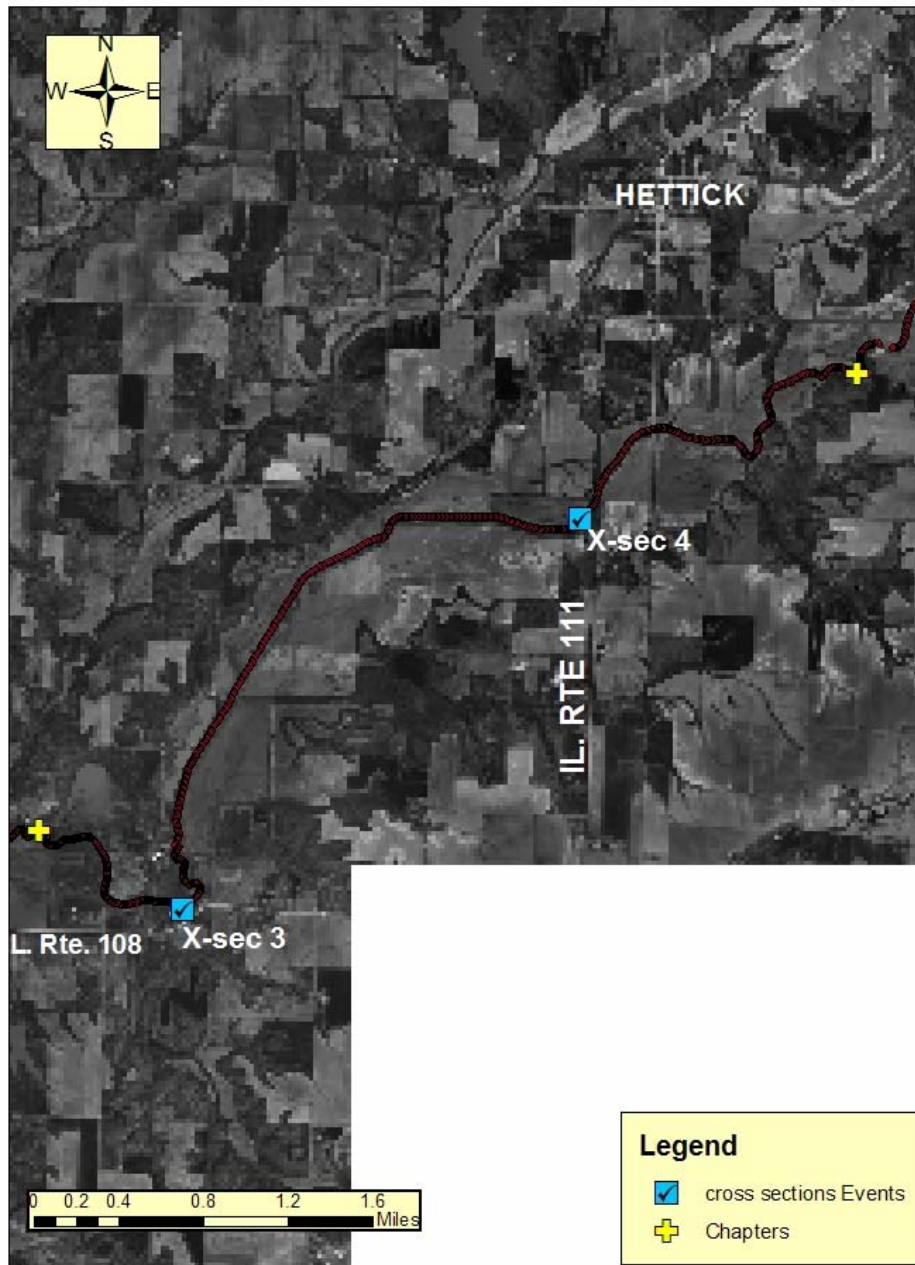


Figure 7



## Otter Creek--Chapter 5



Figure 8

# Otter Creek--Chapter 6



Figure 9

## Otter Creek--Chapter 7



**Figure 10**

The major factors indicating channel conditions 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 |                 |                   |         |            |                  |                |                 |                |                   |         |
|--------------------------------|-----------------|-------------------|---------|------------|------------------|----------------|-----------------|----------------|-------------------|---------|
| Otter Creek                    |                 |                   |         |            |                  |                |                 |                |                   |         |
| CHAPTER                        | ROCK<br>OUTCROP | GEOTECH<br>LOGJAM | FAILURE | DEPOSITION | BED<br>STRUCTURE | BED<br>CONTROL | BANK<br>CONTROL | BREAK<br>POINT | SEVERE<br>EROSION | EROSION |
| 1                              | 0               | 3                 | 0       | 1          | 0                | 0              | 0               | 16             | 23                | 0       |
| 2                              | 1               | 11                | 20      | 1          | 1                | 1              | 0               | 29             | 30                | 1       |
| 3                              | 1               | 3                 | 19      | 1          | 1                | 1              | 1               | 26             | 35                | 10      |
| 4                              | 0               | 10                | 16      | 1          | 0                | 0              | 0               | 16             | 44                | 0       |
| 5                              | 0               | 6                 | 16      | 0          | 0                | 0              | 0               | 6              | 47                | 1       |
| 6                              | 1               | 8                 | 18      | 2          | 0                | 0              | 0               | 3              | 40                | 2       |
| 7                              | 0               | 1                 | 18      | 0          | 0                | 0              | 0               | 0              | 2                 | 0       |
| TOTALS                         | 3               | 42                | 107     | 6          | 2                | 2              | 1               | 96             | 221               | 14      |

**Table 1 Features by Chapter Identified with Aerial Assessment**

Ten cross sections were taken at selected locations on Hodges and Otter Creeks 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 the approximate location of each cross section along the channel profile is found in Fig. 2. Exact locations as Eastings and Northings and more detail can be found in Appendix A.

| CROSS SECTION SUMMARY – OTTER CREEK |        |        |         |            |       |       |             |      |                  |                |                   |                    |                     |
|-------------------------------------|--------|--------|---------|------------|-------|-------|-------------|------|------------------|----------------|-------------------|--------------------|---------------------|
| X-sec                               | ADA    | Q2 cfs | BKF cfs | BKF/sq.mi. | Width | Max D | Vel.<br>FPS | WD   | Top Bk.<br>Depth | BKF<br>X- Area | Top Bk<br>X- Area | BKF cfs/<br>Q2 cfs | Top Bk/<br>BKF area |
| 1                                   | 229.92 | 5190   | 3185    | 13.90      | 80    | 15.7  | 3.9         | 10.3 | 17               | 821            | 941               | 0.61               | 1.15                |
| 2                                   | 187.81 | 4649   | 2777    | 14.80      | 85    | 12.6  | 3.6         | 9.4  | 13.7             | 769            | 867               | 0.60               | 1.13                |
| 3                                   | 112.38 | 3356   | 962     | 8.60       | 61    | 9.2   | 2.7         | 10.5 | 9.3              | 355            | 361               | 0.29               | 1.02                |
| 4                                   | 105.72 | 3444   | 1800    | 17.00      | 59    | 9.4   | 4.1         | 7.9  | 11.2             | 442            | 564               | 0.52               | 1.28                |
| 5                                   | 65.38  | 2537   | 1303    | 19.90      | 44    | 10.4  | 4           | 5.9  | 12.8             | 328            | 463               | 0.51               | 1.41                |
| 6                                   | 58.99  | 2568   | 1157    | 19.61      | 53    | 8     | 3.6         | 8.7  | 8.7              | 324            | 370               | 0.45               | 1.14                |
| 7                                   | 52.67  | 2291   | 975     | 18.50      | 53    | 8.1   | 3.4         | 9.7  | 9.2              | 291            | 355               | 0.43               | 1.22                |
| 8                                   | 6.84   | 496    | 164     | 24.00      | 22    | 4     | 2.6         | 7.5  | 6                | 64             | 120               | 0.33               | 1.88                |
| 9                                   | 3.41   | 280    | 102     | 29.90      | 15    | 3     | 3.1         | 6.8  | 5.9              | 33             | 104               | 0.36               | 3.15                |
| 10                                  | 3.09   | 252    | 87      | 28.20      | 15    | 2.9   | 2.9         | 7.5  | 5.3              | 30             | 109               | 0.35               | 3.63                |

**Table 2 Cross Section Summary**

### General Observations

1. No USGS flow data is available for Hodges or Otter Creeks. The flow data from Macoupin Creek would appear to be the best available showing a 1.5 yr. R.I discharge of approximately 9.2 cfs/sq. mile of drainage area. Hodges Creek discharge appears to be somewhat higher at 14 to 20 cfs/sq. mile below Otter Lake. This discharge determined from field indicators appears to be consistent given drainage on Hodges Creek is much smaller (50 to 230 sq. miles compared to 868 sq. miles at the Macoupin gage site) and smaller watersheds tend to have higher per unit discharge rates.

2. Width/Depth ratios throughout Hodges and Otter Creeks are narrow with the largest ratio being 10.5 and 5 of 10 cross sections have a W/D ratio of less than 8.0. Combined with the incision that has already occurred and the presence of active downcutting these low ratios indicate a very unstable channel dimension.
3. Previously identified degradation on the receiving waters of Macoupin Creek will continue to drive the degradation process in spite of treatment applied to the Hodges Creek watershed.
4. Gradient below Otter Lake drops to 4.6 ft/mile from 14 ft/mile above Otter Lake. The steeper gradient above Otter Lake is degrading also although Otter Lake obviously acts as a grade control to prevent any degradation below Otter Lake from impacting the area above the dam.
5. Larger cobble founding the bed above Otter Lake may be armoring the bed and reducing or halting degradation, however the channel has already incised approximately 3 times its bankfull flow depth and will continue to cause the channel to widen as predicted by the Channel Evolution Model (CEM).
6. The low Width/Depth ratios make use of redirection techniques for lateral migration very limited. Therefore all lateral migration will be assumed to need Stone Toe Protection.
7. Rock Riffle Grade Control Structures are being recommended throughout this study reach. As the gradient decreases below Otter Lake and continues to decrease downstream the riffle heights can be increased without negatively impacting flooding or backwater conditions. Riffle heights can reach 4.0 ft. or more in the lower reaches which impact the cost but also are more effective in dissipating energy and providing better aquatic habitat.

## **Recommendations**

### **Chapter 1**

Chapter 1 is the very upper end of the aerial assessment and represents the only portion inventoried above Otter Lake. Cross section 8, 9 and 10 are in this segment. Cross sections 9 and 10 show incision to a depth of over 3 times the bankfull depth. Section 8 is nearer to Otter Lake and influenced by its backwater effects limiting incision to slightly less than twice the bankfull depth. Cross section 8 is depositional in CEM stage 5 while 9 and 10 are degrading although they are partially armored by the heavy cobble eroded from the glacial till exposed in this reach. There are 16 breakpoints and 23 erosion sites identified in chapter 1.

The recommendation is to install Rock Riffle Grade Control structures above cross section 8 to a point about one half mile above cross section 10. While preliminary analysis shows that riffle more than 0.6 ft. in height will increase the water surface profile significantly this segment is incised approximately 2.5 to 3.0 ft. and therefore riffles 2.0 ft. high can be safely installed without increasing out of bank flow. Lateral bank treatment is recommended using Stone Toe Protection at the 23 identified sites. Table 3 shows the estimated treatment costs and quantities required for this segment.

| <b>TREATMENT --CHAPTER 1</b>     |                       |                           |                         |                          |                     |
|----------------------------------|-----------------------|---------------------------|-------------------------|--------------------------|---------------------|
| <b>Lateral Bank Treatment</b>    |                       |                           |                         |                          |                     |
| <b>Chapter</b>                   | <b>Erosion Sites</b>  | <b>Average Length(ft)</b> | <b>Total Length</b>     | <b>Average Cost/foot</b> | <b>Total Cost</b>   |
| 1                                | 23                    | 75                        | 1725                    | \$25.00                  | \$43,125.00         |
| <b>Total</b>                     | <b>23</b>             |                           | <b>1725</b>             |                          | <b>\$43,125.00</b>  |
| <b>Rock Riffle Grade Control</b> |                       |                           |                         |                          |                     |
| <b>Chapter</b>                   | <b>Number Riffles</b> | <b>Average Tons Stone</b> | <b>Total Tons Stone</b> | <b>Average Cost/ton</b>  | <b>Total Cost</b>   |
| 1                                | 125                   | 90                        | 11250                   | \$30.00                  | \$337,500.00        |
| <b>Total</b>                     | <b>125</b>            |                           | <b>11250</b>            |                          | <b>\$337,500.00</b> |

**Table 3. Treatment for Otter Creek Chapter 1**

# Otter Creek--Chapter 1

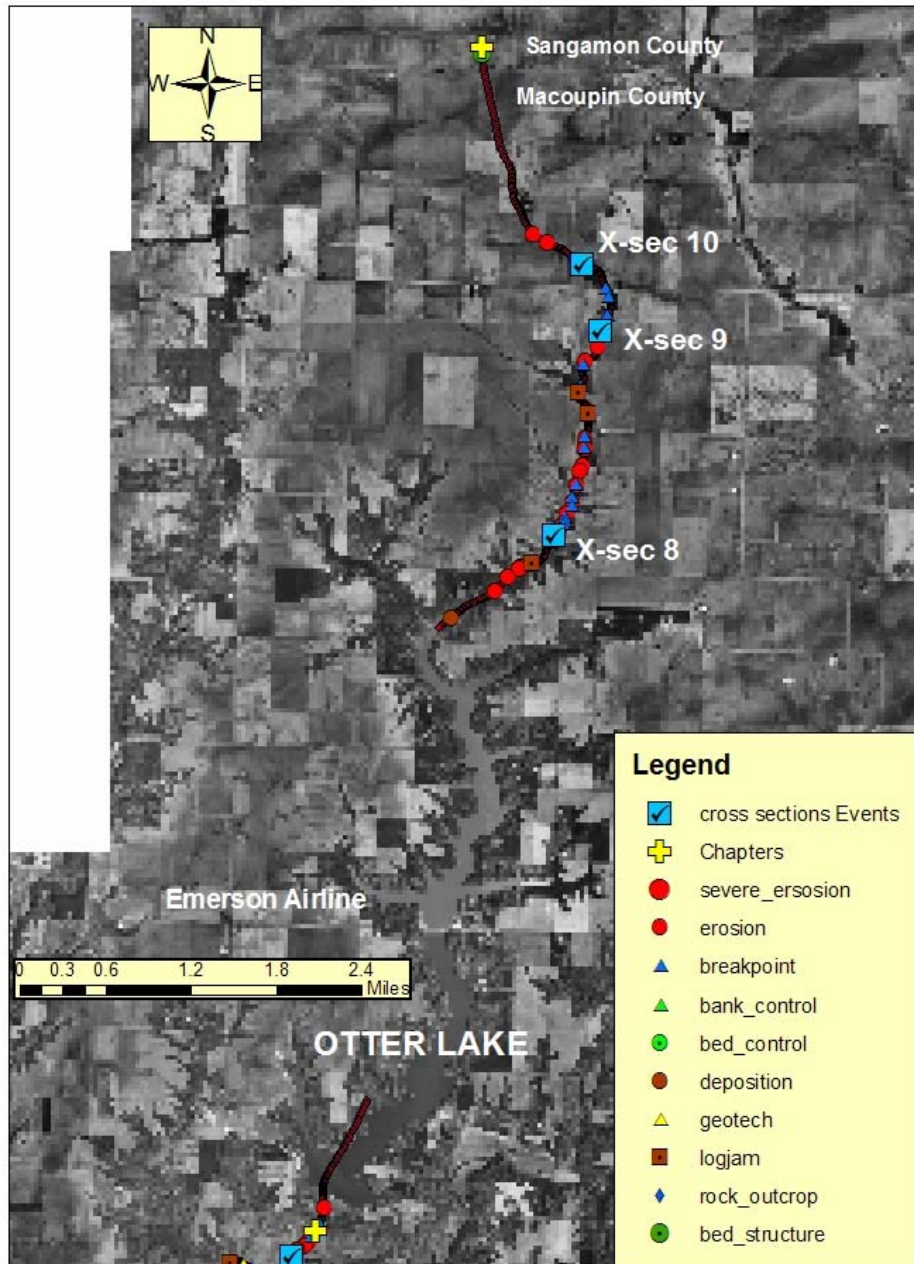


Figure 11. Chapter 1 Features

## Chapter 2

This segment begins below Otter Lake and extends downstream approximately 4 miles. Cross sections 6 and 7 are located in chapter 2. There are 30 erosion sites, 20 geotechnical failures and 11 logjams identified in this reach as well as 29 breakpoints. The identification of such a large number of problems indicate a very unstable channel in this segment, although the cross sections do not indicate significant degradation. Cross sections 6 and 7 have bankfull elevations within one foot of the floodplain elevations and the diameter of the bedload is less than 1 inch however no exposed residual material was found in the “breakpoints” identified.

This segment is in CEM stage 4 where the channel is both degrading and widening resulting in the multiple problems of bank failure through lateral erosion and geotechnical failures.

The recommended treatment is to install Rock Riffle Grade control structures approximately 2.5 ft. above the riffle (breakpoint) elevations. The increased pool depths created will dissipate energy, halt downcutting and improve aquatic habitat. Lateral bank erosion is severe and will require additional treatment with Stone Toe protection. The estimated treatment needs and cost are presented in Table 4 below.

| <b>TREATMENT --CHAPTER 2</b>     |                      |                           |                      |                            |                     |
|----------------------------------|----------------------|---------------------------|----------------------|----------------------------|---------------------|
| <b>Lateral Bank Treatment</b>    |                      |                           |                      |                            |                     |
| <b>Chapter</b>                   | <b>Erosion Sites</b> | <b>Average Length(ft)</b> | <b>Total Length</b>  | <b>Average Cost/foot</b>   | <b>Total Cost</b>   |
| 2                                | 50                   | 300                       | 15000                | \$25.00                    | \$375,000.00        |
| <b>Total</b>                     | <b>50</b>            |                           | <b>15000</b>         |                            | <b>\$375,000.00</b> |
| <b>Rock Riffle Grade Control</b> |                      |                           |                      |                            |                     |
|                                  | <b>Rock Riffles</b>  | <b>Average Tonnage</b>    | <b>Ave. Cost Ton</b> | <b>Average Cost/Riffle</b> |                     |
| 3                                | 70                   | 300                       | \$30.00              | \$9,000.00                 | \$630,000.00        |
| <b>Total</b>                     | <b>70</b>            |                           |                      | <b>9,000</b>               | <b>\$630,000.00</b> |

**Table 4. Treatment for Otter Creek Chapter 2**



## Otter Creek--Chapter 2

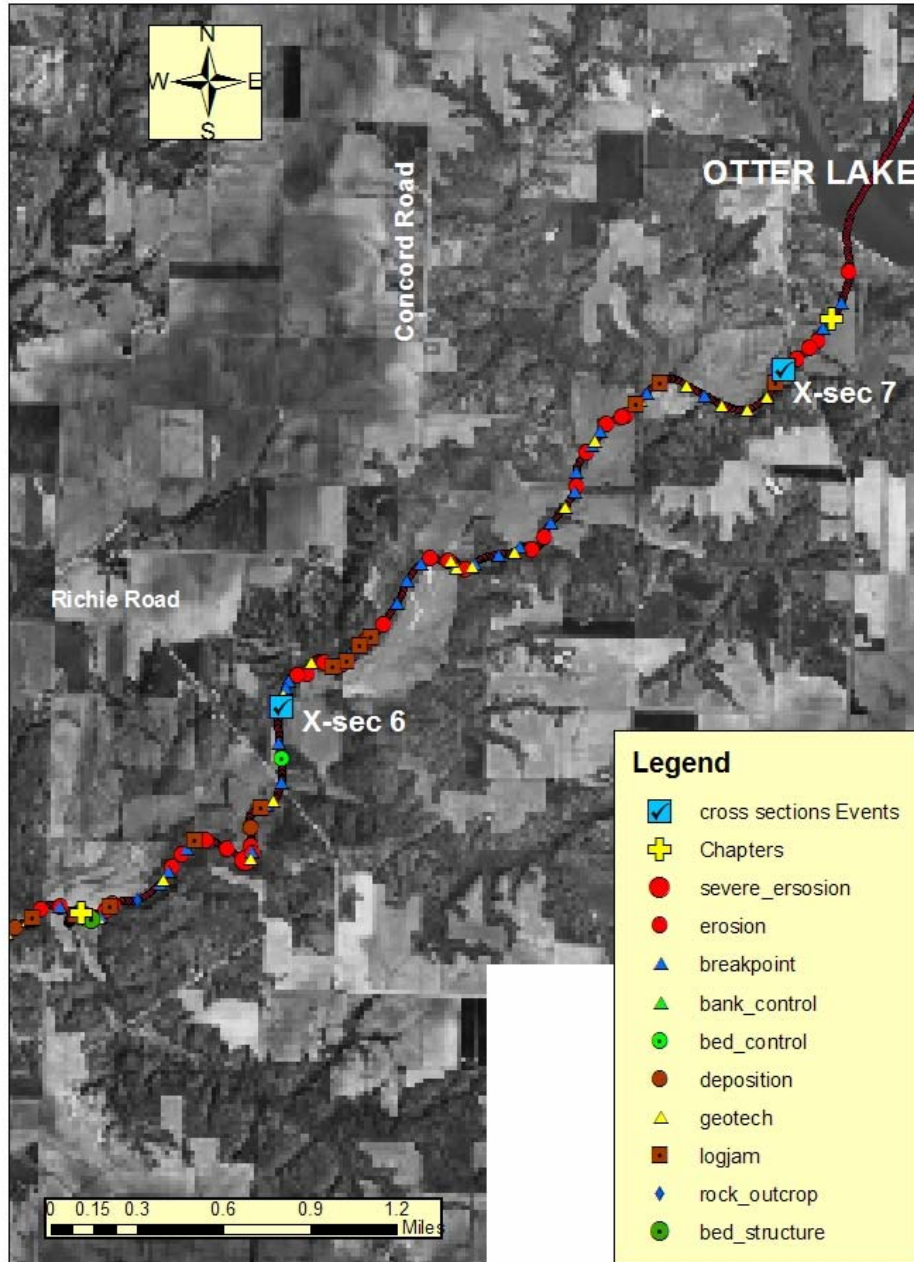


Figure 12. Chapter 2 Features



**Logjam in Chapter 2 caused by failing banks**

### **Chapter 3**

This reach is about 4.5 miles long and extends downstream approximately one half mile below Hettick Road. Chapter 3 contains cross section 5 which is located below Circle Tree Road and is located in a definite “knickzone” where degradation is severe. The channel is incised approximately 2 feet at this location and has a very narrow width/depth ratio of 5.9 indicating a very unstable channel. Chapter 3 has 35 erosion sites, plus 10 additional sites identified with severe erosion, 19 geotechnical failures and 26 breakpoints identified by the aerial assessment.

This reach is extremely unstable and will require use of Rock Riffle Grade control structures and lateral bank treatment to achieve any stability in the near future. The preliminary analysis indicates that riffles may be built to a height of 3.0 feet with no impact on out of bank flow or backwater. Given the incision that has already occurred even greater riffle heights would be feasible and perhaps desirable. For this report a riffle height of 3.0 ft. will be used to determine estimated cost.

Table 5 provides the estimated treatment needs for Chapter 3.

| TREATMENT --CHAPTER 3     |               |                    |               |                     |                     |
|---------------------------|---------------|--------------------|---------------|---------------------|---------------------|
| Lateral Bank Protection   |               |                    |               |                     |                     |
| Chapter                   | Erosion Sites | Average Length(ft) | Total Length  | Average Cost/foot   | Total Cost          |
| 3                         | 64            | 300                | 19200         | \$25.00             | \$480,000.00        |
| <b>Total</b>              | <b>64</b>     |                    | <b>19200</b>  |                     | <b>\$480,000.00</b> |
| Rock Riffle Grade Control |               |                    |               |                     |                     |
| Chapter                   | Rock Riffles  | Average Tonnage    | Ave. Cost Ton | Average Cost/Riffle | Total Cost          |
| 3                         | 79            | 350                | \$30.00       | \$10,500.00         | \$829,500.00        |
| <b>Total</b>              | <b>79</b>     |                    |               | <b>10,500</b>       | <b>\$829,500.00</b> |

Table 5. Treatment needs for Chapter 3



Failing banks in Chapter 3 causing mature trees to collapse into channel

### Otter Creek--Chapter 3

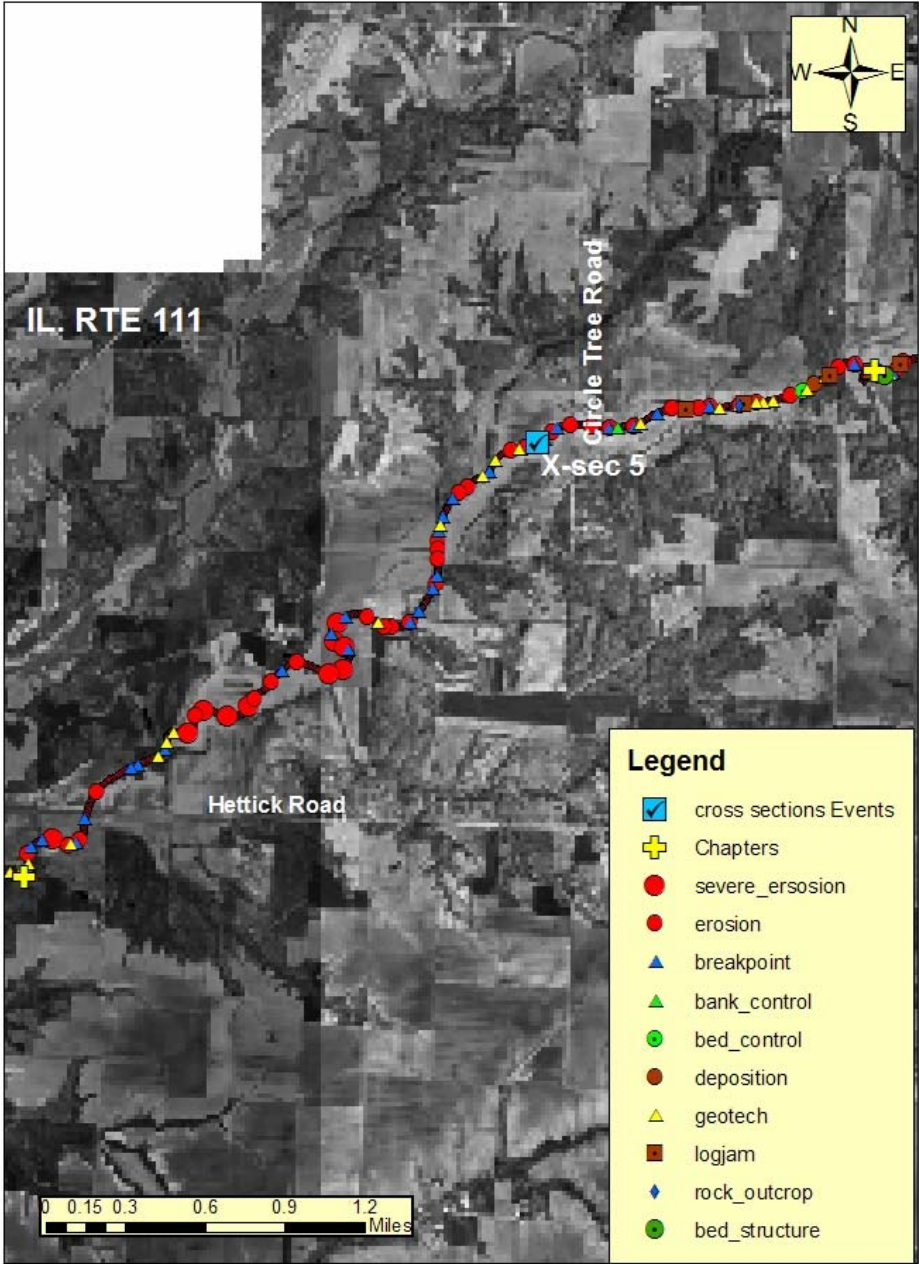


Figure 13. Chapter 3 Features



**Severe Erosion in Chapter 3**

#### **Chapter 4**

This chapter is approximately 6 miles in length ending about a mile above the IL. Rte. 108 bridge. Cross sections 3 and 4 are located in this chapter. This segment has been extensively channelized and no doubt contributes significantly to the problems identified in chapters 2 and 3. However, the same problems of degradation and widening are occurring below this site as well, but at a reduced intensity and are thought to be impacted by the extensive channelization and downcutting found downstream in Macoupin Creek. Cross section 3 near the end of chapter 4 appears to be well connected to the floodplain, however there is a knickpoint at this location on residual soil material indicating active downcutting is beginning to occur and will migrate upstream if left untreated.

This chapter has 44 erosion sites, 16 geotechnical failures and 16 breakpoints identified by the aerial assessment. Treatment recommendations for this segment remain the same with a need for Rock Riffle Grade control structures approximately 3.0 ft. high and lateral bank protection with Stone Toe Protection. Table 6 provides the estimated treatment needs.

| <b>TREATMENT --CHAPTER 4</b>     |                       |                           |                         |                          |                       |
|----------------------------------|-----------------------|---------------------------|-------------------------|--------------------------|-----------------------|
| <b>Lateral Bank Treatment</b>    |                       |                           |                         |                          |                       |
| <b>Chapter</b>                   | <b>Erosion Sites</b>  | <b>Average Length(ft)</b> | <b>Total Length</b>     | <b>Average Cost/foot</b> | <b>Total Cost</b>     |
| 4                                | 60                    | 300                       | 18000                   | \$25.00                  | \$450,000.00          |
| <b>Total</b>                     | <b>60</b>             |                           | <b>18000</b>            |                          | <b>\$450,000.00</b>   |
| <b>Rock Riffle Grade Control</b> |                       |                           |                         |                          |                       |
| <b>Chapter</b>                   | <b>Number Riffles</b> | <b>Average Tons Stone</b> | <b>Total Tons Stone</b> | <b>Average Cost/ton</b>  | <b>Total Cost</b>     |
| 4                                | 80                    | 500                       | 40000                   | \$30.00                  | \$1,200,000.00        |
| <b>Total</b>                     | <b>80</b>             |                           | <b>40000</b>            |                          | <b>\$1,200,000.00</b> |

**Table 6. Treatment needs for Chapter 4**

# Otter Creek--Chapter 4

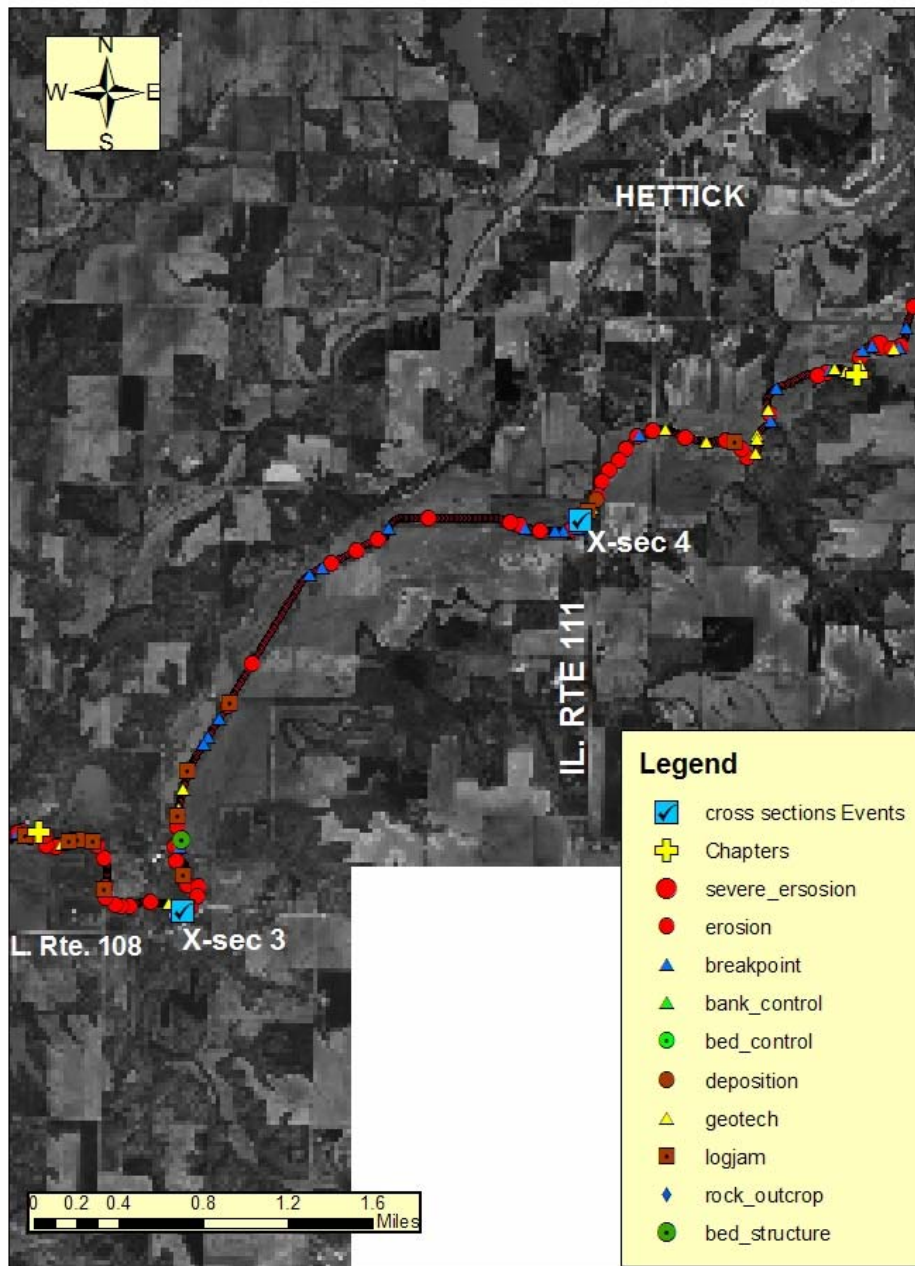


Figure 14. Chapter 4 Features

## Chapter 5 through 7

These chapters represent the remaining length of Otter and Hodges Creeks ending at the confluence with Macoupin Creek. The total length of these segments is approximately 10 miles. In this segment there is a marked decrease in breakpoints although the number of erosion sites and geotechnical failures remains fairly consistent with the upper chapters.

Given present knowledge about the downcutting occurring in Macoupin Creek and the continued stream instability it seems highly likely that even this lower reach of Hodges Creek is degrading. Cross sections 1 and 2 located in Chapter 6 would tend to support that conclusion as the floodplain is at least 1 foot above the bankfull elevation.

Therefore, evening the absence of obvious “breakpoints” the recommendation is to continue with the installation of Rock Riffle Grade control structures to halt any current downcutting masked by low flow conditions re-depositing bedload and to prevent additional degradation on Macoupin Creek from migrating up Hodges Creek.

Rock Riffle Grade control structures can be at least 4.0 ft. high in this segment with no impact on out of bank flow (flooding) or backwater.

Table 7 provides the estimated treatment needs for this reach.

| <b>TREATMENT --CHAPTER 5-7</b>   |                      |                           |                      |                            |                       |
|----------------------------------|----------------------|---------------------------|----------------------|----------------------------|-----------------------|
| <b>Lateral Bank Protection</b>   |                      |                           |                      |                            |                       |
| <b>Chapter</b>                   | <b>Erosion Sites</b> | <b>Average Length(ft)</b> | <b>Total Length</b>  | <b>Average Cost/foot</b>   | <b>Total Cost</b>     |
| 5                                | 63                   | 400                       | 25200                | \$25.00                    | \$630,000.00          |
| 6                                | 58                   | 400                       | 23200                | \$25.00                    | \$580,000.00          |
| 7                                | 20                   | 400                       | 8000                 | \$25.00                    | \$200,000.00          |
| <b>Total</b>                     | <b>141</b>           |                           | <b>56400</b>         |                            | <b>\$1,410,000.00</b> |
| <b>Rock Riffle Grade Control</b> |                      |                           |                      |                            |                       |
| <b>Chapter</b>                   | <b>Rock Riffles</b>  | <b>Average Tonnage</b>    | <b>Ave. Cost Ton</b> | <b>Average Cost/Riffle</b> | <b>Total Cost</b>     |
| 5                                | 40                   | 800                       | \$30.00              | \$24,000.00                | \$960,000.00          |
| 6                                | 52                   | 800                       | \$30.00              | \$24,000.00                | \$1,248,000.00        |
| 7                                | 14                   | 800                       | \$30.00              | \$24,000.00                | \$336,000.00          |
| <b>Total</b>                     | <b>106</b>           |                           |                      | <b>\$24,000.00</b>         | <b>\$2,544,000.00</b> |

**Table 7. Treatment needs for Chapter 5 through 7**



## Otter Creek--Chapter 5

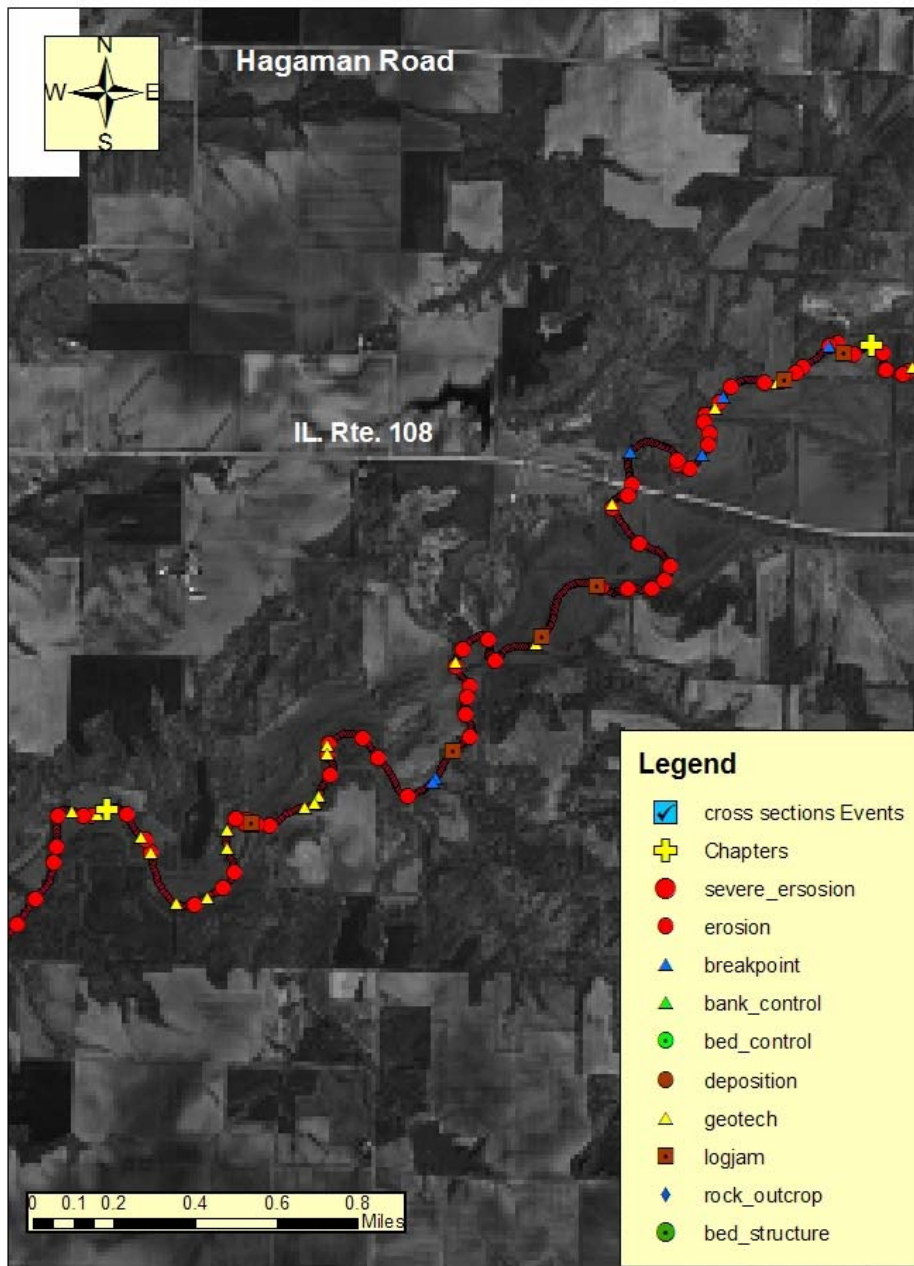


Figure 15. Chapter 5 Features

# Otter Creek--Chapter 6

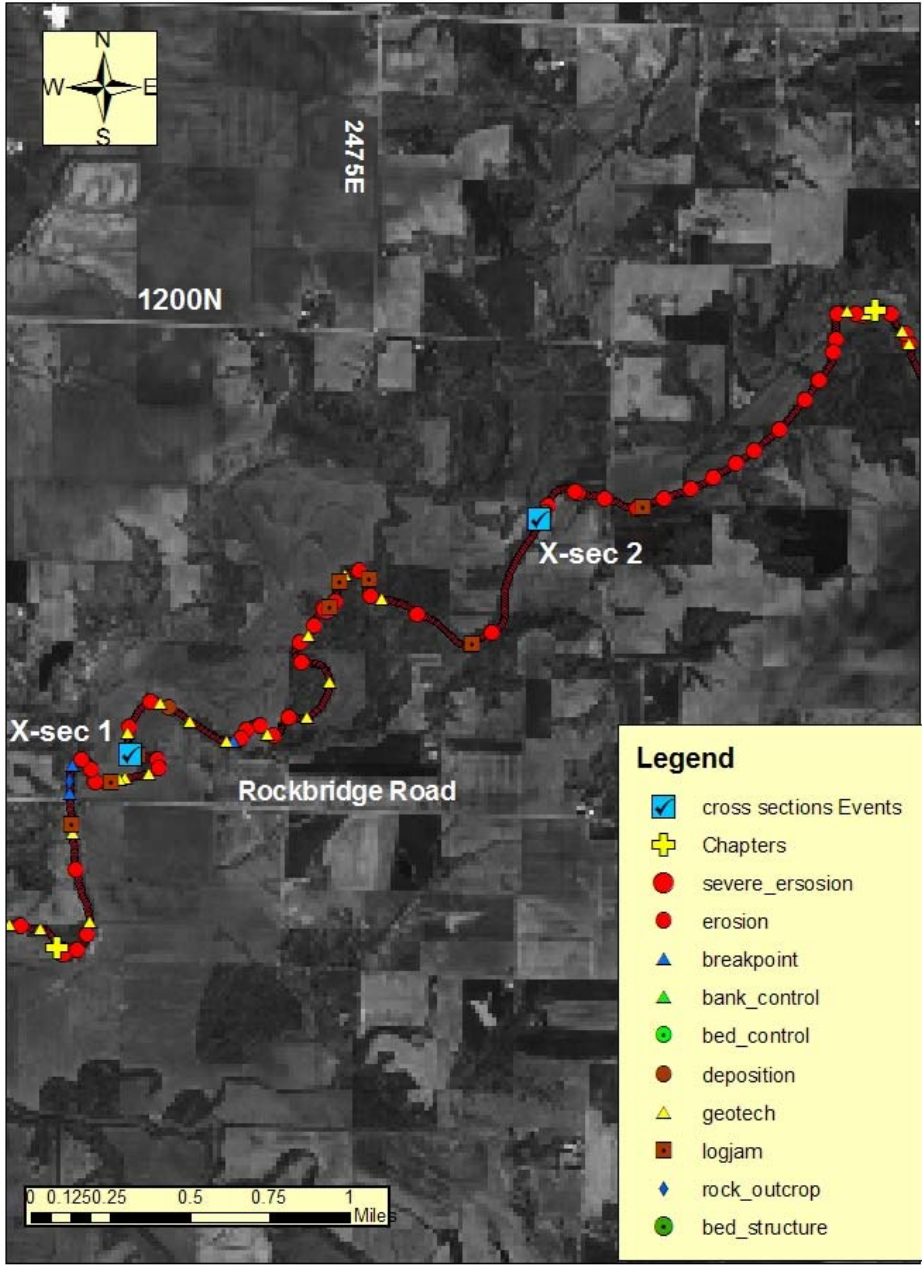


Figure 16. Chapter 6 Features



Logjam in Chapter 6



**Geotechnical failure just above the confluence of Hodges and Macoupin Creek**

## Otter Creek--Chapter 7

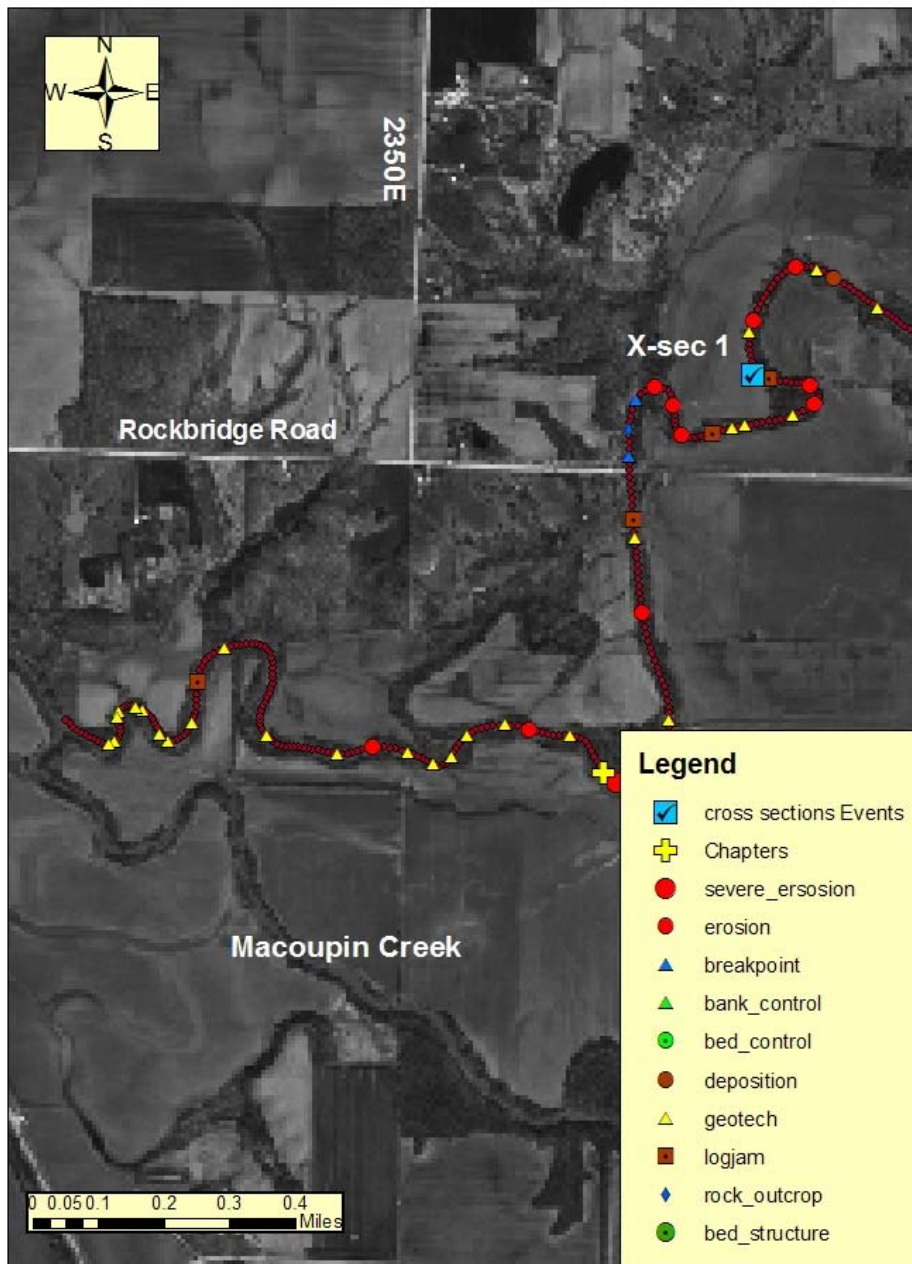


Figure 17. Chapter 7 Features

**APPENDIX A**

**CROSS SECTION DATA**

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
**Date** 12/23/2005 **By** Wayne Kinney  
**Stream Name** Otter Creek **UTM Coord.** E744431 N4350725  
**Landowner Name** X sec 1  
**Drainage Area** 229.92 sq. mi.

*Regional Curve Predictions:*

|                     |       |         |                      |             |
|---------------------|-------|---------|----------------------|-------------|
| Bankfull dimensions | Width | 124 ft. | Cross Sectional Area | 898 sq. ft. |
|                     | Depth | 7.2 ft. |                      |             |

*Reference Stream Gage:*

|                          |               |           |                        |           |
|--------------------------|---------------|-----------|------------------------|-----------|
| Macoupin Creek near Kane | Station No.   | 05587000  | Gage Q <sub>2</sub>    | 9790 cfs  |
| Greene County, IL        | Drainage Area | 868 sq.mi | Regression Coefficient | 11800 cfs |

**REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

|  |                           |                       |
|--|---------------------------|-----------------------|
| <b>Valley Slope:</b> 5.5 ft./mi. (user-entered)        | Regression Q <sub>2</sub> | 6255 cfs              |
| ft./mi (from worksheet)                                | Rainfall                  | 3.40 in (2 yr, 24 hr) |
| Adjusted Q <sub>2</sub>                                | 5190 cfs                  |                       |
| 0.0010 ft./ft.   | Regional Factor           | 1.057                 |
| Typical Range for Bankfull Discharge: 2070 to 4160 cfs |                           |                       |

*Local Stream Morphology:*

**Channel Description:** (c) Clean, winding, some pools and shoals

**Manning's "n"** 0.04

|                          |                     |  |
|--------------------------|---------------------|--|
| <i>Basic Field Data:</i> | Stream Length       | <input type="text"/> ft.                       |
| Bankfull Width           | Valley Length       | <input type="text"/> ft.                       |
| Mean Bankfull Depth      | Contour Interval    | <input type="text"/> feet <input type="text"/> |
| Width/Depth Ratio        | Estimated Sinuosity | <input type="text"/>                           |
| 80 ft.                   |                     |  |
| 10.26 ft.                |                     |  |
| 7.80                     |                     |  |

|   |                           |
|---|---------------------------|
| <i>Channel Slope:</i>                   | Bankfull Q from:          |
| Surveyed: 0.000524 ft./ft.              | Cross-Section 3063 cfs    |
| Estimated: <input type="text"/> ft./ft. | Basic field data 3307 cfs |
|   | Selected Q 3185 cfs       |

Max. Bankfull Depth 15.7 ft.  
 Width at twice max. depth 1500 ft. (31.4 ft.)  
 Entrenchment Ratio 18.75  
 Radius of Curvature (Rc)  ft.  
 Rc/Bankfull width: 0.00

*Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

|  |   |               |
|--|---|---------------|
| Bedload: D <sub>90</sub> 1 <input type="text"/> in.                            | Velocity required to move D <sub>90</sub> : | 2.1 ft./sec.  |
| D <sub>50</sub> <input type="text"/> in.                                       | Velocity from Cross-Section data:           | 3.73 ft./sec. |
| <b>GOAL: Develop confidence by matching velocities from different sources.</b> | Velocity from basic field data:             | 4.03 ft./sec. |
|  | Velocity from selected Q:                   | 3.9 ft./sec.  |

**Channel Evolution Stage** IV  **Stream Type (Rosgen)**

**Notes**

13.9 cfs/sq. mi.





# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date 12/20/2005 By Wayne Kinney  
 Stream Name Otter Creek UTM Coord. E746415 N4352051  
 Landowner Name X sec 2  
 Drainage Area 187.81 sq. mi.

*Regional Curve Predictions:*  
 Bankfull dimensions Width 115 ft. Cross Sectional Area 783 sq. ft.  
 Depth 6.8 ft.

*Reference Stream Gage:*  
 Macoupin Creek near Kane  Station No. 05587000 Gage Q<sub>2</sub> 9790 cfs  
 Drainage Area 868 sq.mi. Regression 11800 cfs  
 Greene County, IL **REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*  
Valley Slope: 6.1 ft./mi. (user-entered) Regression Q<sub>2</sub> 5604 cfs  
 ft./mi (from worksheet) Rainfall 3.40 in (2 yr, 24 hr) Adjusted Q<sub>2</sub> 4649 cfs  
0.0012 ft./ft. Regional Factor 1.057 Typical Range for Bankfull Discharge: 1850 to 3720 cfs

*Local Stream Morphology:*  
**Channel Description:** (c) Clean, winding, some pools and shoals   
 Manning's "n" 0.04  
 Stream Length  ft.  
 Valley Length  ft.  
 Contour Interval  feet   
 Estimated Sinuosity   
*Basic Field Data:*  
 Bankfull Width 85 ft.  
 Mean Bankfull Depth 9.05 ft.  
 Width/Depth Ratio 9.39  
 Max. Bankfull Depth 12.6 ft.  
 Width at twice max. depth 1500 ft.  
 (25.2 ft.)  
 Entrenchment Ratio 17.65  
 Channel Slope: Surveyed: 0.000524 ft./ft. Bankfull Q from: Cross-Section 2703 cfs  
 Estimated:  ft./ft. Basic field data 2851 cfs  
 Selected Q 2777 cfs  
 Radius of Curvature (Rc)  ft.  
 Rc/Bankfull width: 0.00

*Bankfull Velocity Check:* (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)  
 Bedload: D<sub>90</sub> 1 in. Velocity required to move D<sub>90</sub>: 2.1 ft./sec.  
 D<sub>50</sub>  in. Velocity from Cross-Section data: 3.51 ft./sec.  
 GOAL: Develop confidence by matching velocities from different sources. Velocity from basic field data: 3.71 ft./sec.  
 Velocity from selected Q: 3.6 ft./sec.

Channel Evolution Stage IV  Stream Type (Rosgen)

**Notes**  
 14.8 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 2  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (**S**): 0.000524 ft/ft  
 Manning's **n**: 0.040  
 Flow Depth: 12.6 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

*assuming uniform, steady flow*

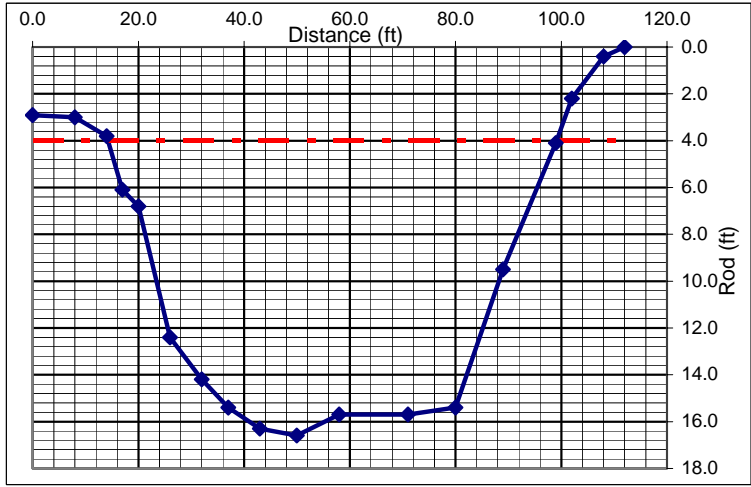
[back to I&E form](#)

Clear Cells

### Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 2.9      | 0.0           |
| 3.0      | 8.0           |
| 3.8      | 14.0          |
| 6.1      | 17.0          |
| 6.8      | 20.0          |
| 12.4     | 26.0          |
| 14.2     | 32.0          |
| 15.4     | 37.0          |
| 16.3     | 43.0          |
| 16.60    | 50            |
| 15.70    | 58            |
| 15.70    | 71            |
| 15.40    | 80            |
| 9.50     | 89            |
| 4.10     | 99            |
| 2.2      | 102           |
| 0.4      | 108           |
| 0.0      | 112           |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 12.6 ft       | 13.7          |
| Channel Flow (Q):         | 2,702.6 cfs   | 2,956.6       |
| Channel Velocity:         | 3.5 ft/sec    | 3.4           |
| Cross-Sectional Area (A): | 769.2 sq.ft.  | 867.2         |
| Hydraulic Radius (R):     | 8.4 ft        | 8.0           |



COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date  By   
 Stream Name  UTM Coord.   
 Landowner Name   
 Drainage Area  sq. mi.

**Regional Curve Predictions:**

|                     |       |                                      |                      |  |
|---------------------|-------|--------------------------------------|----------------------|--|
| Bankfull dimensions | Width | <input type="text" value="94"/> ft.  | Cross Sectional Area | <input type="text" value="553"/> sq. ft. |
|                     | Depth | <input type="text" value="5.9"/> ft. |                      |  |

**Reference Stream Gage:**

|                          |               |  |                     |  |
|--------------------------|---------------|--|---------------------|--|
| Macoupin Creek near Kane | Station No.   | <input type="text" value="05587000"/>  | Gage Q <sub>2</sub> | <input type="text" value="9790"/> cfs  |
| Greene County, IL        | Drainage Area | <input type="text" value="868"/> sq.mi | Regression          | <input type="text" value="11800"/> cfs |

**REFERENCE STREAM DATA ONLY**

**USGS Flood-Peak Discharge Predictions:**

|  |                                       |  |
|--|---------------------------------------|--|
| <b>Valley Slope:</b> <input type="text" value="7.2"/> ft./mi. (user-entered) | Regression Q <sub>2</sub>             | <input type="text" value="4045"/> cfs                                      |
| <input type="text" value="0.0014"/> ft./ft.                                  | Adjusted Q <sub>2</sub>               | <input type="text" value="3356"/> cfs                                      |
| Rainfall <input type="text" value="3.40"/> in (2 yr, 24 hr)                  | Typical Range for Bankfull Discharge: | <input type="text" value="1340"/> to <input type="text" value="2690"/> cfs |
| Regional Factor <input type="text" value="1.057"/>                           |                                       |  |

**Local Stream Morphology:**

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n"

|  |   |                      |                                      |
|--|---|----------------------|--------------------------------------|
| <b>Basic Field Data:</b>   | Stream Length   | <input type="text"/> | ft.                                  |
| Bankfull Width <input type="text" value="61"/> ft.                         | Valley Length   | <input type="text"/> | ft.                                  |
| Mean Bankfull Depth <input type="text" value="5.82"/> ft.                  | Contour Interval  | <input type="text"/> | feet <input type="text"/>            |
| Width/Depth Ratio <input type="text" value="10.48"/>                       | Estimated Sinuosity                                     | <input type="text"/> |                                      |
| Max. Bankfull Depth <input type="text" value="9.2"/> ft.                   | <b>Channel Slope:</b>                                   | Bankfull Q from:     |                                      |
| Width at twice max. depth <input type="text" value="1000"/> ft. (18.4 ft.) | Surveyed: <input type="text" value="0.000524"/> ft./ft. | Cross-Section        | <input type="text" value="944"/> cfs |
| Entrenchment Ratio <input type="text" value="16.39"/>                      | Estimated: <input type="text"/>                         | Basic field data     | <input type="text" value="980"/> cfs |
|  | Radius of Curvature (Rc) <input type="text"/>           | Selected Q           | <input type="text" value="962"/> cfs |
|  | Rc/Bankfull width: <input type="text" value="0.00"/>    |                      |                                      |

**Bankfull Velocity Check:** (typical Illinois streams will have average bankfull velocity between 3 and 5 ft./sec.)

|  |   |  |
|--|---|--|
| Bedload: D <sub>90</sub> <input type="text" value="2"/> in.                    | Velocity required to move D <sub>90</sub> : | <input type="text" value="2.9"/> ft./sec.  |
| D <sub>50</sub> <input type="text"/>   | Velocity from Cross-Section data:           | <input type="text" value="2.66"/> ft./sec. |
| <b>GOAL: Develop confidence by matching velocities from different sources.</b> | Velocity from basic field data:             | <input type="text" value="2.76"/> ft./sec. |
|  | Velocity from selected Q:                   | <input type="text" value="2.7"/> ft./sec.  |

**Channel Evolution Stage** IV  Stream Type (Rosgen)

**Notes**

8.6 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 3  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (S): 0.000524 ft/ft  
 Manning's n: 0.040  
 Flow Depth: 9.2 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

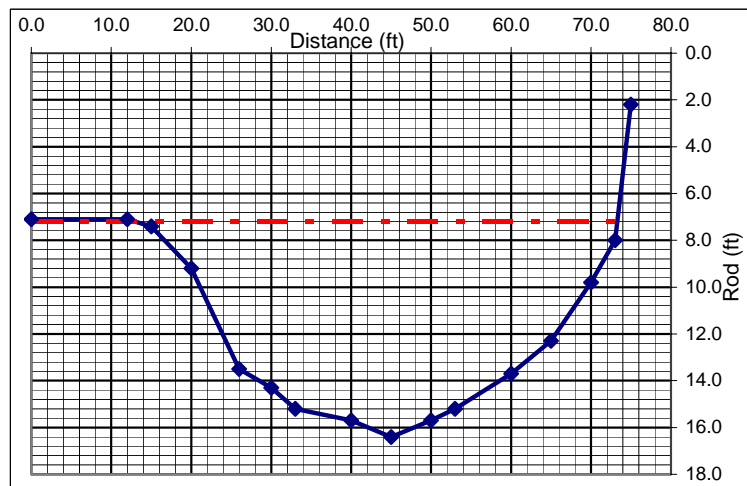
[back to I&E form](#)

Clear Cells

## Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 7.1      | 0.0           |
| 7.1      | 12.0          |
| 7.4      | 15.0          |
| 9.2      | 20.0          |
| 13.5     | 26.0          |
| 14.3     | 30.0          |
| 15.2     | 33.0          |
| 15.7     | 40.0          |
| 16.4     | 45.0          |
| 15.70    | 50            |
| 15.20    | 53            |
| 13.70    | 60            |
| 12.30    | 65            |
| 9.80     | 70            |
| 8.00     | 73            |
| 2.2      | 75            |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 9.2 ft        | 9.3           |
| Channel Flow (Q):         | 943.6 cfs     | 857.8         |
| Channel Velocity:         | 2.7 ft/sec    | 2.4           |
| Cross-Sectional Area (A): | 355.3 sq.ft.  | 361.3         |
| Hydraulic Radius (R):     | 5.5 ft        | 4.7           |



COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date 12/20/2005 By Wayne Kinney  
 Stream Name Otter Creek UTM Coord. E754897 N4357893  
 Landowner Name X sec 4  
 Drainage Area 105.72 sq. mi.

*Regional Curve Predictions:*

|                     |       |                |                      |                    |
|---------------------|-------|----------------|----------------------|--------------------|
| Bankfull dimensions | Width | <u>92</u> ft.  | Cross Sectional Area | <u>530</u> sq. ft. |
|                     | Depth | <u>5.8</u> ft. |                      |                    |

*Reference Stream Gage:*

|                          |               |                  |                     |                  |
|--------------------------|---------------|------------------|---------------------|------------------|
| Macoupin Creek near Kane | Station No.   | <u>05587000</u>  | Gage Q <sub>2</sub> | <u>9790</u> cfs  |
| Greene County, IL        | Drainage Area | <u>868</u> sq.mi | Regression          | <u>11800</u> cfs |

**REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

|                       |                                       |                                       |                                |
|-----------------------|---------------------------------------|---------------------------------------|--------------------------------|
| <u>Valley Slope:</u>  | <u>8.4</u> ft./mi. (user-entered)     | Regression Q <sub>2</sub>             | <u>4151</u> cfs                |
|                       | ft./mi (from worksheet)               | Adjusted Q <sub>2</sub>               | <u>3444</u> cfs                |
| <u>0.0016</u> ft./ft. | Rainfall <u>3.40</u> in (2 yr, 24 hr) | Typical Range for Bankfull Discharge: | <u>1370</u> to <u>2760</u> cfs |
|                       | Regional Factor <u>1.057</u>          |                                       |                                |

*Local Stream Morphology:*

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

|                                      |   |  |
|--------------------------------------|---|--|
| <i>Basic Field Data:</i>             | Stream Length                                     | <input type="text"/> ft.                       |
| Bankfull Width                       | Valley Length                                     | <input type="text"/> ft.                       |
| Mean Bankfull Depth                  | Contour Interval                                  | <input type="text"/> feet <input type="text"/> |
| Width/Depth Ratio                    | Estimated Sinuosity                               | <input type="text"/>                           |
| Max. Bankfull Depth                  | <i>Channel Slope:</i>                             | Bankfull Q from:                               |
| Width at twice max. depth (18.8 ft.) | Surveyed: <u>0.000878</u> ft./ft.                 | <u>Cross-Section</u> <u>1733</u> cfs           |
| Entrenchment Ratio <u>16.95</u>      | Estimated: <input type="text"/> ft./ft.           | Basic field data <u>1868</u> cfs               |
|                                      | Radius of Curvature (Rc) <input type="text"/> ft. | Selected Q <u>1800</u> cfs                     |
|                                      | Rc/Bankfull width: <u>0.00</u>                    |  |

*Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

|  |   |                      |
|--|---|----------------------|
| Bedload: D <sub>90</sub> <u>1</u> in.  | Velocity required to move D <sub>90</sub> : | <u>2.1</u> ft./sec.  |
| D <sub>50</sub> <input type="text"/> in.                                       | Velocity from Cross-Section data:           | <u>3.92</u> ft./sec. |
| <i>GOAL: Develop confidence by matching velocities from different sources.</i> | Velocity from basic field data:             | <u>4.23</u> ft./sec. |
|  | Velocity from selected Q:                   | <u>4.1</u> ft./sec.  |

Channel Evolution Stage III  Stream Type (Rosgen)

**Notes**

17.0 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 4  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (**S**): 0.000878 ft/ft  
 Manning's **n**: 0.040  
 Flow Depth: 9.4 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

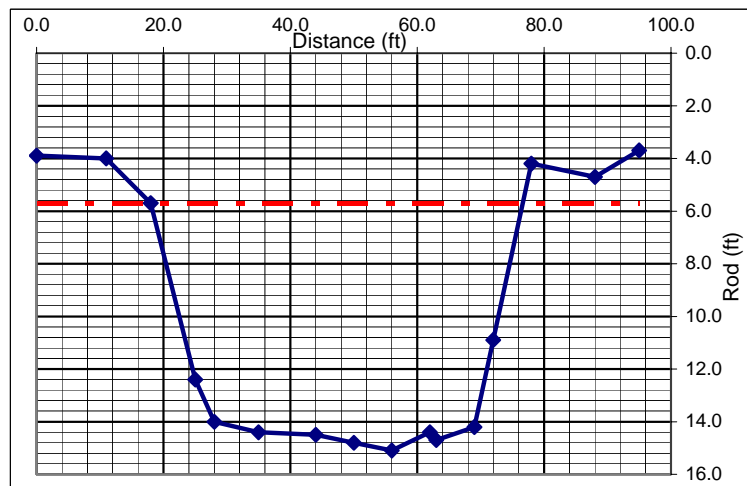
[back to I&E form](#)

Clear Cells

## Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 3.9      | 0.0           |
| 4.0      | 11.0          |
| 5.7      | 18.0          |
| 12.4     | 25.0          |
| 14.0     | 28.0          |
| 14.4     | 35.0          |
| 14.5     | 44.0          |
| 14.8     | 50.0          |
| 15.1     | 56.0          |
| 14.40    | 62            |
| 14.70    | 63            |
| 14.20    | 69            |
| 10.90    | 72            |
| 4.20     | 78            |
| 4.70     | 88            |
| 3.7      | 95            |

|                                    | Trial Depth 2 | Trial Depth 3 |
|------------------------------------|---------------|---------------|
| Selected Flow Depth:               | 9.4 ft        | 11.2          |
| Channel Flow ( <b>Q</b> ):         | 1,732.7 cfs   | 1,945.0       |
| Channel Velocity:                  | 3.9 ft/sec    | 3.5           |
| Cross-Sectional Area ( <b>A</b> ): | 441.7 sq.ft.  | 563.6         |
| Hydraulic Radius ( <b>R</b> ):     | 6.7 ft        | 5.6           |



COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date 12/20/2005 By Wayne Kinney  
 Stream Name Otter Creek UTM Coord. E242961 N4361889  
 Landowner Name X sec 5  
 Drainage Area 65.38 sq. mi.

*Regional Curve Predictions:*

|                     |       |                |                      |                    |
|---------------------|-------|----------------|----------------------|--------------------|
| Bankfull dimensions | Width | <u>76</u> ft.  | Cross Sectional Area | <u>383</u> sq. ft. |
|                     | Depth | <u>5.0</u> ft. |                      |                    |

*Reference Stream Gage:*

|                          |               |                  |                     |                  |
|--------------------------|---------------|------------------|---------------------|------------------|
| Macoupin Creek near Kane | Station No.   | <u>05587000</u>  | Gage Q <sub>2</sub> | <u>9790</u> cfs  |
| Greene County, IL        | Drainage Area | <u>868</u> sq.mi | Regression          | <u>11800</u> cfs |

**REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

|                                       |                                       |                                |
|---------------------------------------|---------------------------------------|--------------------------------|
| <u>9.8</u> ft./mi. (user-entered)     | Regression Q <sub>2</sub>             | <u>3058</u> cfs                |
| <u>0.0019</u> ft./ft.                 | Adjusted Q <sub>2</sub>               | <u>2537</u> cfs                |
| Rainfall <u>3.40</u> in (2 yr, 24 hr) | Typical Range for Bankfull Discharge: | <u>1010</u> to <u>2030</u> cfs |
| Regional Factor <u>1.057</u>          |                                       |                                |

*Local Stream Morphology:*

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n" 0.04

|                     |                      |      |
|---------------------|----------------------|------|
| Stream Length       | <input type="text"/> | ft.  |
| Valley Length       | <input type="text"/> | ft.  |
| Contour Interval    | <input type="text"/> | feet |
| Estimated Sinuosity | <input type="text"/> |      |

*Basic Field Data:*

|                                      |              |     |
|--------------------------------------|--------------|-----|
| Bankfull Width                       | <u>44</u>    | ft. |
| Mean Bankfull Depth                  | <u>7.45</u>  | ft. |
| Width/Depth Ratio                    | <u>5.91</u>  |     |
| Max. Bankfull Depth                  | <u>10.4</u>  | ft. |
| Width at twice max. depth (20.8 ft.) | <u>1000</u>  | ft. |
| Entrenchment Ratio                   | <u>22.73</u> |     |

*Channel Slope:*

|            |                      |         |
|------------|----------------------|---------|
| Surveyed:  | <u>0.000878</u>      | ft./ft. |
| Estimated: | <input type="text"/> | ft./ft. |

*Bankfull Q from:*

|                  |             |     |
|------------------|-------------|-----|
| Cross-Section    | <u>1224</u> | cfs |
| Basic field data | <u>1381</u> | cfs |
| Selected Q       | <u>1303</u> | cfs |

Radius of Curvature (Rc)  ft.  
Rc/Bankfull width: 0.00

*Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

|   |                      |     |   |             |          |
|---|----------------------|-----|---|-------------|----------|
| Bedload: D <sub>90</sub>  | <u>1</u>             | in. | Velocity required to move D <sub>90</sub> : | <u>2.1</u>  | ft./sec. |
| D <sub>50</sub>   | <input type="text"/> | in. | Velocity from Cross-Section data:           | <u>3.73</u> | ft./sec. |
| GOAL: Develop confidence by matching velocities from different sources. |                      |     | Velocity from basic field data:             | <u>4.21</u> | ft./sec. |
|   |                      |     | Velocity from selected Q:                   | <u>4.0</u>  | ft./sec. |

Channel Evolution Stage III  Stream Type (Rosgen)

**Notes**

19.9 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 5  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (**S**): 0.000878 ft/ft  
 Manning's **n**: 0.040  
 Flow Depth: 10.4 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

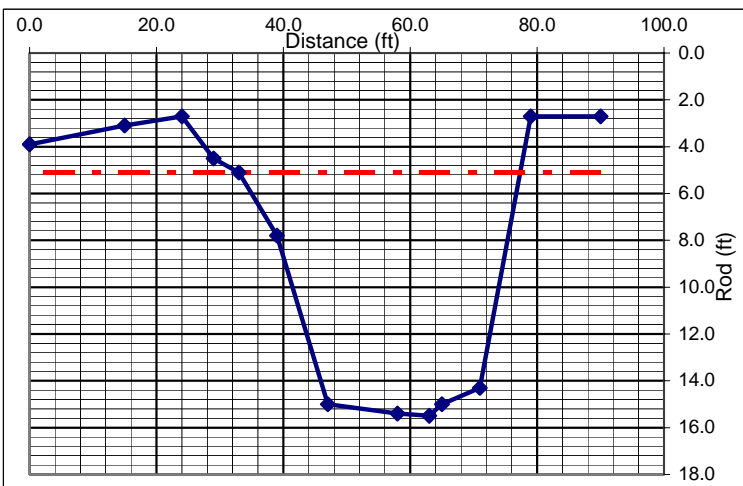
[back to I&E form](#)

Clear Cells

### Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 2.7      | 90.0          |
| 2.7      | 79.0          |
| 14.3     | 71.0          |
| 15.0     | 65.0          |
| 15.5     | 63.0          |
| 15.4     | 58.0          |
| 15.0     | 47.0          |
| 7.8      | 39.0          |
| 5.1      | 33.0          |
| 4.50     | 29            |
| 2.70     | 24            |
| 3.10     | 15            |
| 3.90     | 0             |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |

|                                    | Trial Depth 2 | Trial Depth 3 |
|------------------------------------|---------------|---------------|
| Selected Flow Depth:               | 10.4 ft       | 12.8          |
| Channel Flow ( <b>Q</b> ):         | 1,223.6 cfs   | 1,406.5       |
| Channel Velocity:                  | 3.7 ft/sec    | 3.0           |
| Cross-Sectional Area ( <b>A</b> ): | 328.1 sq.ft.  | 463.3         |
| Hydraulic Radius ( <b>R</b> ):     | 6.2 ft        | 4.6           |



COMMENTS:



**Stream Stabilization I & E Form**

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
**Date** 12/20/2005  **By** Wayne Kinney   
**Stream Name** Otter Creek  **UTM Coord.** E246133 N4363472   
**Landowner Name** X sec 6   
**Drainage Area** 58.99 sq. mi.

*Regional Curve Predictions:*

**Bankfull dimensions** Width 73 ft.  Cross Sectional Area 357 sq. ft.   
 Depth 4.9 ft.

*Reference Stream Gage:*

Macoupin Creek near Kane  Station No. 05587000  Gage Q<sub>2</sub> 9790 cfs   
 Greene County, IL  Drainage Area 868 sq.mi  Regression 11800 cfs   
**REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

**Valley Slope:** 11.9 ft./mi. (user-entered)  Regression Q<sub>2</sub> 3096 cfs   
 ft./mi (from worksheet)  Rainfall 3.40 in (2 yr, 24 hr)  Adjusted Q<sub>2</sub> 2568 cfs   
 0.0023 ft./ft.  Regional Factor 1.057  Typical Range for Bankfull Discharge: 1020 to 2060 cfs

*Local Stream Morphology:*

**Channel Description:** (c) Clean, winding, some pools and shoals

**Manning's "n"** 0.04

**Basic Field Data:** Stream Length  ft.  
 Valley Length  ft.  
 Bankfull Width 53 ft.  Contour Interval  feet   
 Mean Bankfull Depth 6.1 ft.  Estimated Sinuosity   
 Width/Depth Ratio 8.69

**Channel Slope:** Max. Bankfull Depth 8 ft.  Surveyed: 0.000878 ft./ft.  Bankfull Q from: Cross-Section 1122 cfs   
 Width at twice max. depth 600 ft.  Estimated:  ft./ft. Basic field data 1192 cfs   
 (16.0 ft.) Entrenchment Ratio 11.32  Radius of Curvature (Rc)  ft. Selected Q 1157 cfs   
 Rc/Bankfull width: 0.00

*Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft./sec.)*

**Bedload:** D<sub>90</sub> 1  in.  Velocity required to move D<sub>90</sub>: 2.1 ft./sec.   
 D<sub>50</sub>  in.  Velocity from Cross-Section data: 3.47 ft./sec.   
**GOAL:** Develop confidence by matching velocities from different sources. Velocity from basic field data: 3.69 ft./sec.   
 Velocity from selected Q: 3.6 ft./sec.

**Channel Evolution Stage** IV  **Stream Type (Rosgen)**

**Notes**

19.61 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 6  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (S): 0.000878 ft/ft  
 Manning's n: 0.040  
 Flow Depth: 8.0 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

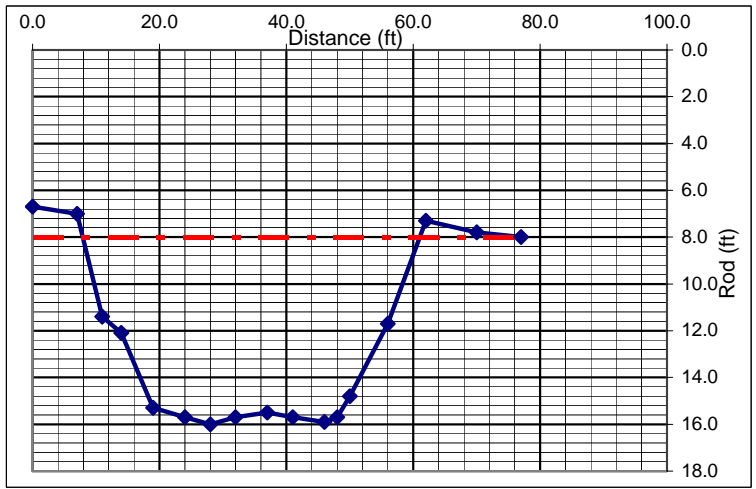
[back to I&E form](#)

Clear Cells

**Survey Data:**

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 6.7      | 0.0           |
| 7.0      | 7.0           |
| 11.4     | 11.0          |
| 12.1     | 14.0          |
| 15.3     | 19.0          |
| 15.7     | 24.0          |
| 16.0     | 28.0          |
| 15.7     | 32.0          |
| 15.5     | 37.0          |
| 15.70    | 41            |
| 15.90    | 46            |
| 15.70    | 48            |
| 14.80    | 50            |
| 11.70    | 56            |
| 7.30     | 62            |
| 7.8      | 70            |
| 8.0      | 77            |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 8.0 ft        | 8.7           |
| Channel Flow (Q):         | 1,122.4 cfs   | 1,113.7       |
| Channel Velocity:         | 3.5 ft/sec    | 3.0           |
| Cross-Sectional Area (A): | 323.6 sq.ft.  | 369.9         |
| Hydraulic Radius (R):     | 5.6 ft        | 4.5           |



COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date  By   
 Stream Name  UTM Coord.   
 Landowner Name   
 Drainage Area  sq. mi.

**Regional Curve Predictions:**

|                     |       |                                      |                      |  |
|---------------------|-------|--------------------------------------|----------------------|--|
| Bankfull dimensions | Width | <input type="text" value="70"/> ft.  | Cross Sectional Area | <input type="text" value="331"/> sq. ft. |
|                     | Depth | <input type="text" value="4.7"/> ft. |                      |  |

**Reference Stream Gage:**

|                          |               |  |                     |  |
|--------------------------|---------------|--|---------------------|--|
| Macoupin Creek near Kane | Station No.   | <input type="text" value="05587000"/>  | Gage Q <sub>2</sub> | <input type="text" value="9790"/> cfs  |
| Greene County, IL        | Drainage Area | <input type="text" value="868"/> sq.mi | Regression          | <input type="text" value="11800"/> cfs |

**REFERENCE STREAM DATA ONLY**

**USGS Flood-Peak Discharge Predictions:**

|   |                                       |   |
|---|---------------------------------------|---|
| <b>Valley Slope:</b> <input type="text" value="11.3"/> ft./mi. (user-entered) | Regression Q <sub>2</sub>             | <input type="text" value="2761"/> cfs                                     |
| <input type="text" value="0.0021"/> ft./ft.                                   | Adjusted Q <sub>2</sub>               | <input type="text" value="2291"/> cfs                                     |
| Rainfall <input type="text" value="3.40"/> in (2 yr, 24 hr)                   | Typical Range for Bankfull Discharge: | <input type="text" value="910"/> to <input type="text" value="1840"/> cfs |
| Regional Factor <input type="text" value="1.057"/>                            |                                       |   |

**Local Stream Morphology:**

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n"

|   |  |   |  |
|---|--|---|--|
| <b>Basic Field Data:</b>  | Stream Length  | <input type="text"/>                                    | ft.  |
| Bankfull Width <input type="text" value="53"/> ft.                        | Valley Length  | <input type="text"/>                                    | ft.  |
| Mean Bankfull Depth <input type="text" value="5.49"/> ft.                 | Contour Interval                                     | <input type="text"/>                                    | feet <input type="text"/>                              |
| Width/Depth Ratio <input type="text" value="9.65"/>                       | Estimated Sinuosity                                  | <input type="text"/>                                    |  |
| Max. Bankfull Depth <input type="text" value="8.1"/> ft.                  | <b>Channel Slope:</b>                                | Surveyed: <input type="text" value="0.000878"/> ft./ft. | Bankfull Q from:                                       |
| Width at twice max. depth <input type="text" value="500"/> ft. (16.2 ft.) | Estimated: <input type="text"/>                      | ft./ft.   | Cross-Section <input type="text" value="949"/> cfs     |
| Entrenchment Ratio <input type="text" value="9.43"/>                      | Radius of Curvature (Rc) <input type="text"/>        | ft.   | Basic field data <input type="text" value="1000"/> cfs |
|   | Rc/Bankfull width: <input type="text" value="0.00"/> |   | Selected Q <input type="text" value="975"/> cfs        |

**Bankfull Velocity Check:** (typical Illinois streams will have average bankfull velocity between 3 and 5 ft./sec.)

|   |   |  |
|---|---|--|
| Bedload: D <sub>90</sub> <input type="text" value="1"/> in.             | Velocity required to move D <sub>90</sub> : | <input type="text" value="2.1"/> ft./sec.  |
| D <sub>50</sub> <input type="text"/>                                    | Velocity from Cross-Section data:           | <input type="text" value="3.26"/> ft./sec. |
| GOAL: Develop confidence by matching velocities from different sources. | Velocity from basic field data:             | <input type="text" value="3.44"/> ft./sec. |
|   | Velocity from selected Q:                   | <input type="text" value="3.4"/> ft./sec.  |

**Channel Evolution Stage** IV  Stream Type (Rosgen)

**Notes**

18.5 cfs.sq. mi.

# Natural Open Channel Flow

Project: X sec 7  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (S): 0.000878 ft/ft  
 Manning's n: 0.040  
 Flow Depth: 8.1 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

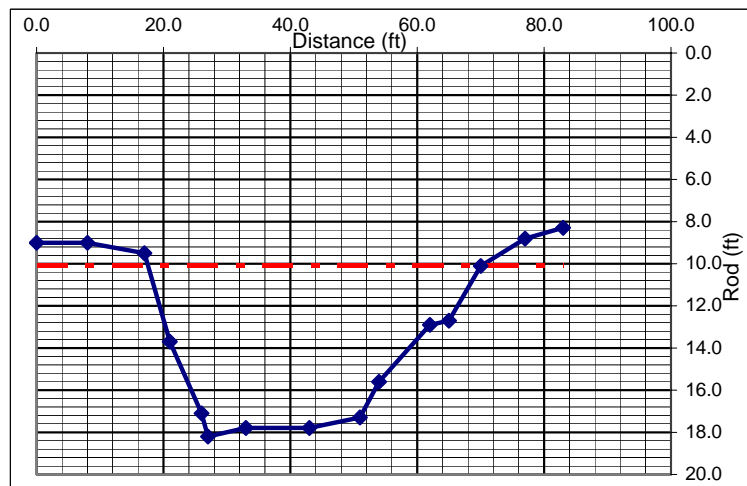
[back to I&E form](#)

Clear Cells

## Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 9.0      | 0.0           |
| 9.0      | 8.0           |
| 9.5      | 17.0          |
| 13.7     | 21.0          |
| 17.1     | 26.0          |
| 18.2     | 27.0          |
| 17.8     | 33.0          |
| 17.8     | 43.0          |
| 17.3     | 51.0          |
| 15.60    | 54            |
| 12.90    | 62            |
| 12.70    | 65            |
| 10.10    | 70            |
| 8.80     | 77            |
| 8.30     | 83            |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 8.1 ft        | 9.2           |
| Channel Flow (Q):         | 949.4 cfs     | 1,045.7       |
| Channel Velocity:         | 3.3 ft/sec    | 2.9           |
| Cross-Sectional Area (A): | 291.1 sq.ft.  | 354.7         |
| Hydraulic Radius (R):     | 5.1 ft        | 4.4           |



COMMENTS:

**Stream Stabilization I & E Form**

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date **12/23/2005** By **Wayne Kinney**  
 Stream Name **Otter Creek** UTM Coord. **E251906 N4373485**  
 Landowner Name **X sec 8**  
 Drainage Area **6.84** sq. mi.

**Regional Curve Predictions:**

|                     |       |                |                      |                   |
|---------------------|-------|----------------|----------------------|-------------------|
| Bankfull dimensions | Width | <b>32</b> ft.  | Cross Sectional Area | <b>83</b> sq. ft. |
|                     | Depth | <b>2.6</b> ft. |                      |                   |

**Reference Stream Gage:**

|   |               |                  |                     |                  |
|---|---------------|------------------|---------------------|------------------|
| Macoupin Creek near Kane <input type="text"/> | Station No.   | <b>05587000</b>  | Gage Q <sub>2</sub> | <b>9790</b> cfs  |
| Greene County, IL                             | Drainage Area | <b>868</b> sq.mi | Regression          | <b>11800</b> cfs |

**REFERENCE STREAM DATA ONLY**

**USGS Flood-Peak Discharge Predictions:**

|   |                                       |                       |
|---|---------------------------------------|-----------------------|
| <b>Valley Slope:</b> <b>13.4</b> ft./mi. (user-entered) | Regression Q <sub>2</sub>             | <b>597</b> cfs        |
| <input type="text"/> ft./mi (from worksheet)            | Adjusted Q <sub>2</sub>               | <b>496</b> cfs        |
| <b>0.0025</b> ft./ft.                                   | Typical Range for Bankfull Discharge: | <b>190 to 400</b> cfs |

Rainfall **3.40** in (2 yr, 24 hr)  
 Regional Factor **1.057**

**Local Stream Morphology:**

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n" **0.04**

|                                     |                     |  |
|-------------------------------------|---------------------|--|
| <b>Basic Field Data:</b>            | Stream Length       | <input type="text"/> ft.                       |
| Bankfull Width <b>22</b> ft.        | Valley Length       | <input type="text"/> ft.                       |
| Mean Bankfull Depth <b>2.92</b> ft. | Contour Interval    | <input type="text"/> feet <input type="text"/> |
| Width/Depth Ratio <b>7.53</b>       | Estimated Sinuosity | <input type="text"/>                           |

Channel Slope: Surveyed: **0.00122** ft./ft. Bankfull Q from: **Cross-Section 157** cfs  
 Estimated:  ft./ft. Basic field data **171** cfs  
 Selected Q **164** cfs

Max. Bankfull Depth **4** ft.  
 Width at twice max. depth **200** ft.  
 (8.0 ft.)  
 Entrenchment Ratio **9.09** Radius of Curvature (Rc)  ft.  
 Rc/Bankfull width: **0.00**

**Bankfull Velocity Check:** (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)

|   |   |                      |
|---|---|----------------------|
| Bedload: D <sub>90</sub> <b>1</b> in.                                   | Velocity required to move D <sub>90</sub> : | <b>2.1</b> ft./sec.  |
| D <sub>50</sub> <input type="text"/> in.                                | Velocity from Cross-Section data:           | <b>2.44</b> ft./sec. |
| GOAL: Develop confidence by matching velocities from different sources. | Velocity from basic field data:             | <b>2.66</b> ft./sec. |
|   | Velocity from selected Q:                   | <b>2.6</b> ft./sec.  |

**Channel Evolution Stage** v  Stream Type (Rosgen)

**Notes**

24.0 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 8  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (S): 0.001220 ft/ft  
 Manning's n: 0.040  
 Flow Depth: 4.0 ft

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

assuming uniform, steady flow

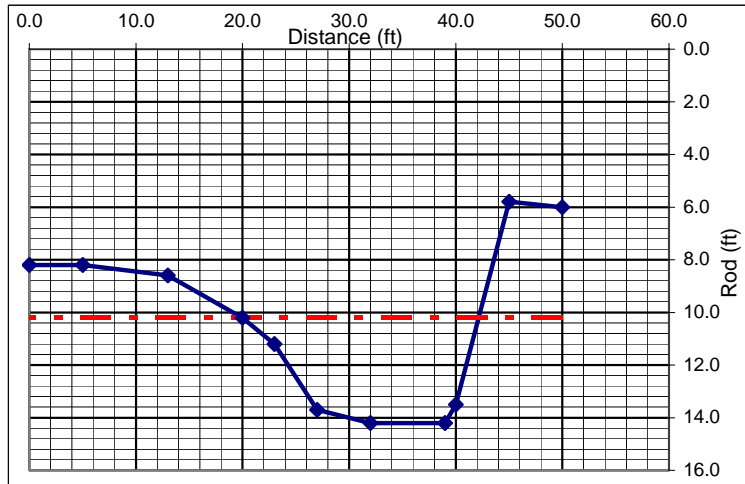
[back to I&E form](#)

Clear Cells

### Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 6.0      | 50.0          |
| 5.8      | 45.0          |
| 13.5     | 40.0          |
| 14.2     | 39.0          |
| 14.2     | 32.0          |
| 13.7     | 27.0          |
| 11.2     | 23.0          |
| 10.2     | 20.0          |
| 8.6      | 13.0          |
| 8.20     | 5             |
| 8.20     | 0             |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 4.0 ft        | 6.0           |
| Channel Flow (Q):         | 156.9 cfs     | 288.4         |
| Channel Velocity:         | 2.4 ft/sec    | 2.4           |
| Cross-Sectional Area (A): | 64.4 sq.ft.   | 120.0         |
| Hydraulic Radius (R):     | 2.6 ft        | 2.5           |



COMMENTS:

# Stream Stabilization I & E Form

ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book

**County** Macoupin  T.  R.  Sec.   
 Date  By   
 Stream Name  UTM Coord.   
 Landowner Name   
 Drainage Area  sq. mi.

*Regional Curve Predictions:*

|                     |       |                                      |                      |   |
|---------------------|-------|--------------------------------------|----------------------|---|
| Bankfull dimensions | Width | <input type="text" value="24"/> ft.  | Cross Sectional Area | <input type="text" value="52"/> sq. ft. |
|                     | Depth | <input type="text" value="2.1"/> ft. |                      |   |

*Reference Stream Gage:*

|                          |               |  |                     |  |
|--------------------------|---------------|--|---------------------|--|
| Macoupin Creek near Kane | Station No.   | <input type="text" value="05587000"/>  | Gage Q <sub>2</sub> | <input type="text" value="9790"/> cfs  |
| Greene County, IL        | Drainage Area | <input type="text" value="868"/> sq.mi | Regression          | <input type="text" value="11800"/> cfs |

**REFERENCE STREAM DATA ONLY**

*USGS Flood-Peak Discharge Predictions:*

|  |                                       |  |
|--|---------------------------------------|--|
| <a href="#">Valley Slope:</a> <input type="text" value="12.8"/> ft./mi. (user-entered) | Regression Q <sub>2</sub>             | <input type="text" value="337"/> cfs                                     |
| <input type="text" value="0.0024"/> ft./ft.  | Adjusted Q <sub>2</sub>               | <input type="text" value="280"/> cfs                                     |
| Rainfall <input type="text" value="3.40"/> in (2 yr, 24 hr)                            | Typical Range for Bankfull Discharge: | <input type="text" value="110"/> to <input type="text" value="230"/> cfs |
| Regional Factor <input type="text" value="1.057"/>                                     |                                       |  |

*Local Stream Morphology:*

**Channel Description:** (c) Clean, winding, some pools and shoals

Manning's "n"

|                                     |                          |                                   |  |
|-------------------------------------|--------------------------|-----------------------------------|--|
| <i>Basic Field Data:</i>            | Stream Length            | <input type="text"/>              | ft.  |
| Bankfull Width                      | Valley Length            | <input type="text"/>              | ft.  |
| Mean Bankfull Depth                 | Contour Interval         | <input type="text"/>              | feet   |
| Width/Depth Ratio                   | Estimated Sinuosity      | <input type="text"/>              |  |
| Max. Bankfull Depth                 | <i>Channel Slope:</i>    | Surveyed:                         | <input type="text" value="0.00267"/> ft./ft. |
| Width at twice max. depth (6.0 ft.) |                          | Estimated:                        | <input type="text"/>                         |
| Entrenchment Ratio                  | Bankfull Q from:         | Cross-Section                     | <input type="text" value="97"/> cfs          |
|                                     |                          | Basic field data                  | <input type="text" value="107"/> cfs         |
|                                     |                          | Selected Q                        | <input type="text" value="102"/> cfs         |
|                                     | Radius of Curvature (Rc) | <input type="text"/>              | ft.  |
|                                     | Rc/Bankfull width:       | <input type="text" value="0.00"/> |  |

*Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)*

|   |                                    |   |  |
|---|------------------------------------|---|--|
| Bedload: D <sub>90</sub>  | <input type="text" value="3"/> in. | Velocity required to move D <sub>90</sub> : | <input type="text" value="3.6"/> ft./sec.  |
| D <sub>50</sub>   | <input type="text"/>               | Velocity from Cross-Section data:           | <input type="text" value="2.96"/> ft./sec. |
| GOAL: Develop confidence by matching velocities from different sources. |                                    | Velocity from basic field data:             | <input type="text" value="3.25"/> ft./sec. |
|   |                                    | Velocity from selected Q:                   | <input type="text" value="3.1"/> ft./sec.  |

[Channel Evolution Stage](#) III  Stream Type (Rosgen)

**Notes**

29.9 cfs/sq. mi.

# Natural Open Channel Flow

Project: X sec 9  
 Assisted by: Wayne Kinney  
 Date: 12/20/2005  
 Channel Slope (S): 0.002670 ft/ft  
 Manning's n: 0.040  
 Flow Depth: 3.0 ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

assuming uniform, steady flow

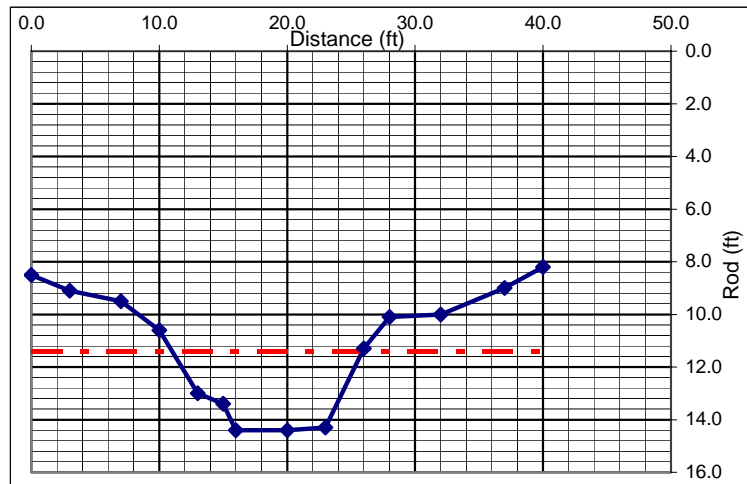
[back to I&E form](#)

Clear Cells

## Survey Data:

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 8.5      | 0.0           |
| 9.1      | 3.0           |
| 9.5      | 7.0           |
| 10.6     | 10.0          |
| 13.0     | 13.0          |
| 13.4     | 15.0          |
| 14.4     | 16.0          |
| 14.4     | 20.0          |
| 14.3     | 23.0          |
| 11.30    | 26            |
| 10.10    | 28            |
| 10.00    | 32            |
| 9.00     | 37            |
| 8.20     | 40            |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 3.0 ft        | 5.9           |
| Channel Flow (Q):         | 96.9 cfs      | 361.8         |
| Channel Velocity:         | 3.0 ft/sec    | 3.5           |
| Cross-Sectional Area (A): | 32.8 sq.ft.   | 103.6         |
| Hydraulic Radius (R):     | 1.9 ft        | 2.5           |



COMMENTS:



| Stream Stabilization I & E Form  |  | ILLINOIS NRCS - Version 2.05- modified 9/12/04 R.Book |   |
|--|--|---|---|
| <b>County</b>  | Macoupin <input type="text"/>                | T. <input type="text"/>                               | R. <input type="text"/> Sec. <input type="text"/> |
| Date   | 12/20/2005                                   | By  | Wayne Kinney                                      |
| Stream Name  | Otter Creek                                  | UTM Coord.  | E252224 N4376545                                  |
| Landowner Name   | Xsec 10                                      |   |   |
| Drainage Area  | 3.09 sq. mi.                                 | <input type="button" value="Clear Cells"/>            |   |
| <i>Regional Curve Predictions:</i>   |  |   |   |
| Bankfull dimensions  | Width  | 23 ft.  | Cross Sectional Area                              |
|  | Depth  | 2.1 ft.   | 48 sq. ft.  |
| <i>Reference Stream Gage:</i>  |  |   |   |
| Macoupin Creek near Kane <input type="text"/>  |  | Station No.   | 05587000  |
| Greene County, IL  |  | Drainage Area   | 868 sq.mi   |
|  |  | Gage Q <sub>2</sub>                                   | 9790 cfs  |
|  |  | Regression Coefficient                                | 11800 cfs   |
| <b>REFERENCE STREAM DATA ONLY</b>  |  |   |   |
| <i>USGS Flood-Peak Discharge Predictions:</i>  |  |   |   |
| <u>Valley Slope:</u>   | 12.1 ft./mi. (user-entered)                  | Regression Q <sub>2</sub>                             | 304 cfs   |
|  | <input type="text"/> ft./mi (from worksheet) | Adjusted Q <sub>2</sub>                               | 252 cfs   |
|  | 0.0023 ft./ft.                               | Rainfall  | 3.40 in (2 yr, 24 hr)                             |
|  |  | Regional Factor                                       | 1.057   |
|  |  | Typical Range for Bankfull Discharge:                 |   |
|  |  | 100 to 210 cfs  |   |
| <i>Local Stream Morphology:</i>  |  |   |   |
| <b>Channel Description:</b> (c) Clean, winding, some pools and shoals <input type="text"/>                             |  |   |   |
| Manning's "n"  | 0.04   | Stream Length   | <input type="text"/> ft.                          |
| <i>Basic Field Data:</i>   |  | Valley Length   | <input type="text"/> ft.                          |
| Bankfull Width   | 15 ft.                                       | Contour Interval                                      | <input type="text"/> feet <input type="text"/>    |
| Mean Bankfull Depth  | 1.99 ft.                                     | Estimated Sinuosity                                   | <input type="text"/>                              |
| Width/Depth Ratio  | 7.54   |   |   |
| Max. Bankfull Depth  | 2.9 ft.                                      | <i>Channel Slope:</i>                                 | Bankfull Q from:                                  |
| Width at twice max. depth  | 70 ft.                                       | Surveyed: 0.00267 ft./ft.                             | <a href="#">Cross-Section</a> 83 cfs              |
| (5.8 ft.)  |  | Estimated: <input type="text"/> ft./ft.               | Basic field data 91 cfs                           |
| Entrenchment Ratio   | 4.67   | Radius of Curvature (Rc)                              | Selected Q 87 cfs                                 |
|  |  | Rc/Bankfull width:                                    | 0.00  |
| <i>Bankfull Velocity Check: (typical Illinois streams will have average bankfull velocity between 3 and 5 ft/sec.)</i> |  |   |   |
| Bedload:   | D <sub>90</sub> 3 <input type="text"/> in.   | Velocity required to move D <sub>90</sub> :           | 3.6 ft./sec.                                      |
|  | D <sub>50</sub> <input type="text"/> in.     | Velocity from Cross-Section data:                     | 2.78 ft./sec.                                     |
| GOAL: Develop confidence by matching velocities from different sources.  |  | Velocity from basic field data:                       | 3.05 ft./sec.                                     |
|  |  | Velocity from selected Q:                             | 2.9 ft./sec.                                      |
| <a href="#">Channel Evolution Stage</a>  | IV <input type="text"/>                      | Stream Type (Rosgen)                                  | <input type="text"/>                              |
| <b>Notes</b>   |  |   |   |
| 28.2 cfs/sq. mi.   |  |   |   |

# Natural Open Channel Flow

Project:   
 Assisted by:   
 Date:   
 Channel Slope (S):  ft/ft  
 Manning's n:   
 Flow Depth:  ft

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

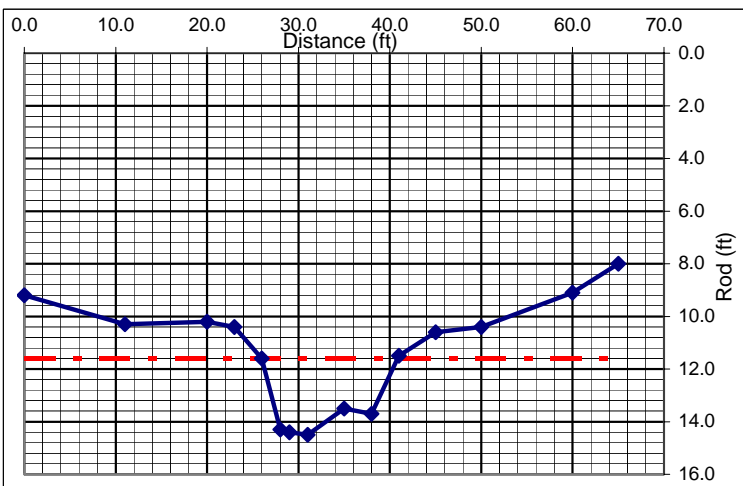
assuming uniform, steady flow

[back to I&E form](#)

**Survey Data:**

| Rod (ft) | Distance (ft) |
|----------|---------------|
| 9.2      | 0.0           |
| 10.3     | 11.0          |
| 10.2     | 20.0          |
| 10.4     | 23.0          |
| 11.6     | 26.0          |
| 14.3     | 28.0          |
| 14.4     | 29.0          |
| 14.5     | 31.0          |
| 13.5     | 35.0          |
| 13.70    | 38            |
| 11.50    | 41            |
| 10.60    | 45            |
| 10.40    | 50            |
| 9.10     | 60            |
| 8.00     | 65            |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |
|          |               |

|                           | Trial Depth 2 | Trial Depth 3 |
|---------------------------|---------------|---------------|
| Selected Flow Depth:      | 2.9 ft        | 5.3           |
| Channel Flow (Q):         | 82.8 cfs      | 306.9         |
| Channel Velocity:         | 2.8 ft/sec    | 2.8           |
| Cross-Sectional Area (A): | 29.8 sq.ft.   | 109.4         |
| Hydraulic Radius (R):     | 1.7 ft        | 1.8           |



COMMENTS: