Little Swan Lake

Preliminary Siltation Calculations and Bathymetric Survey Results

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MUSLE – MODIFIED UNIVERSAL SOIL LOSS EQUATION

$$A = R * K * LS * C * P$$

Where:

R = Rainfall-Runoff Erosivity Factor (What is the Force of the Rainfall?)

K = Soils Erodibility Factor (How Susceptible is the Soil to Erosion?)

LS = Slope Length Factor (How Steep or Flat is the Watershed?)

C = Cover-Management Factor (What is the Landuse?)

P = Support Practice Factor (Are Their Any Alternative Conservation/Landuse Practices?)

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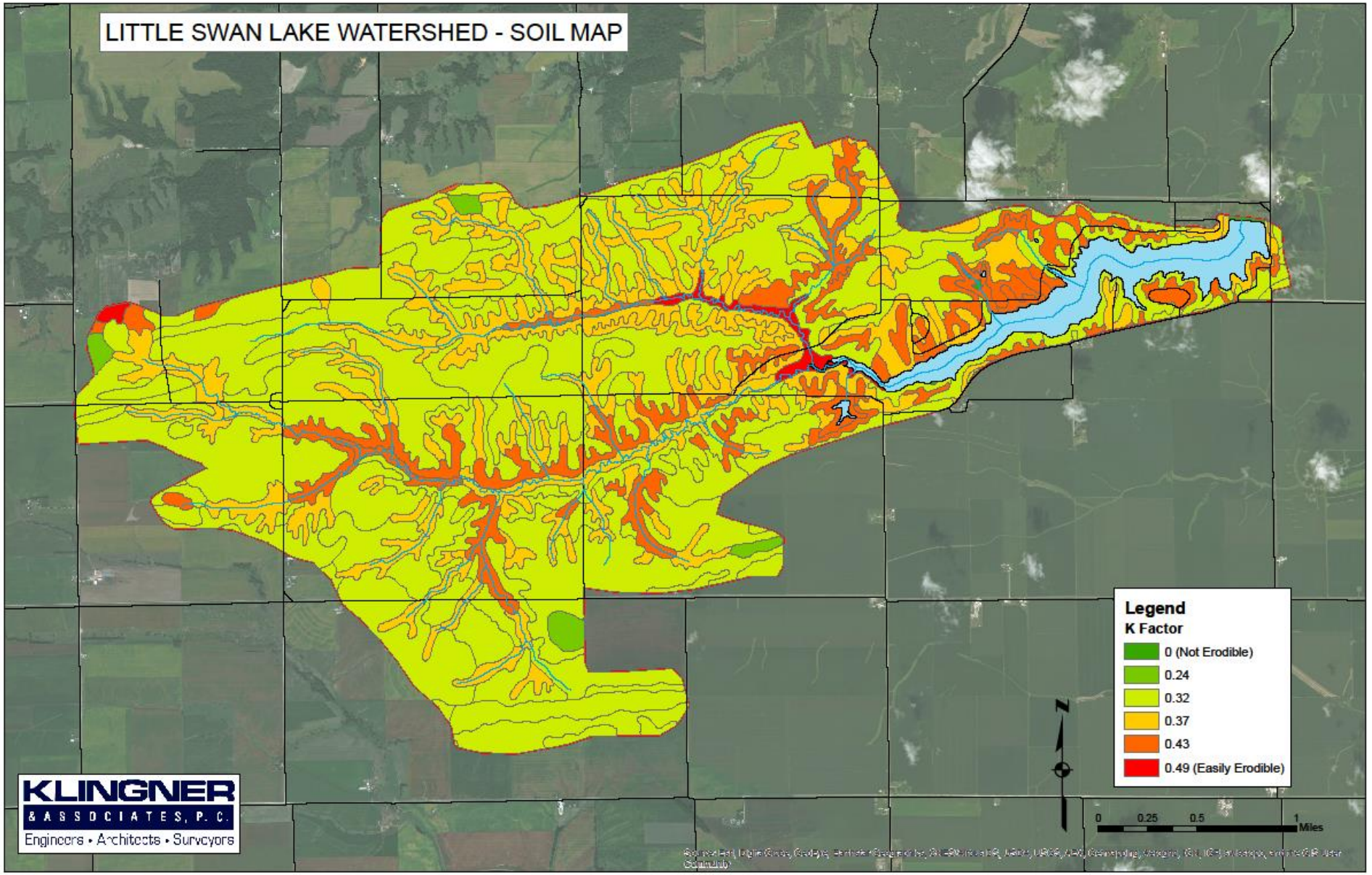
MUSLE – SOIL MAP



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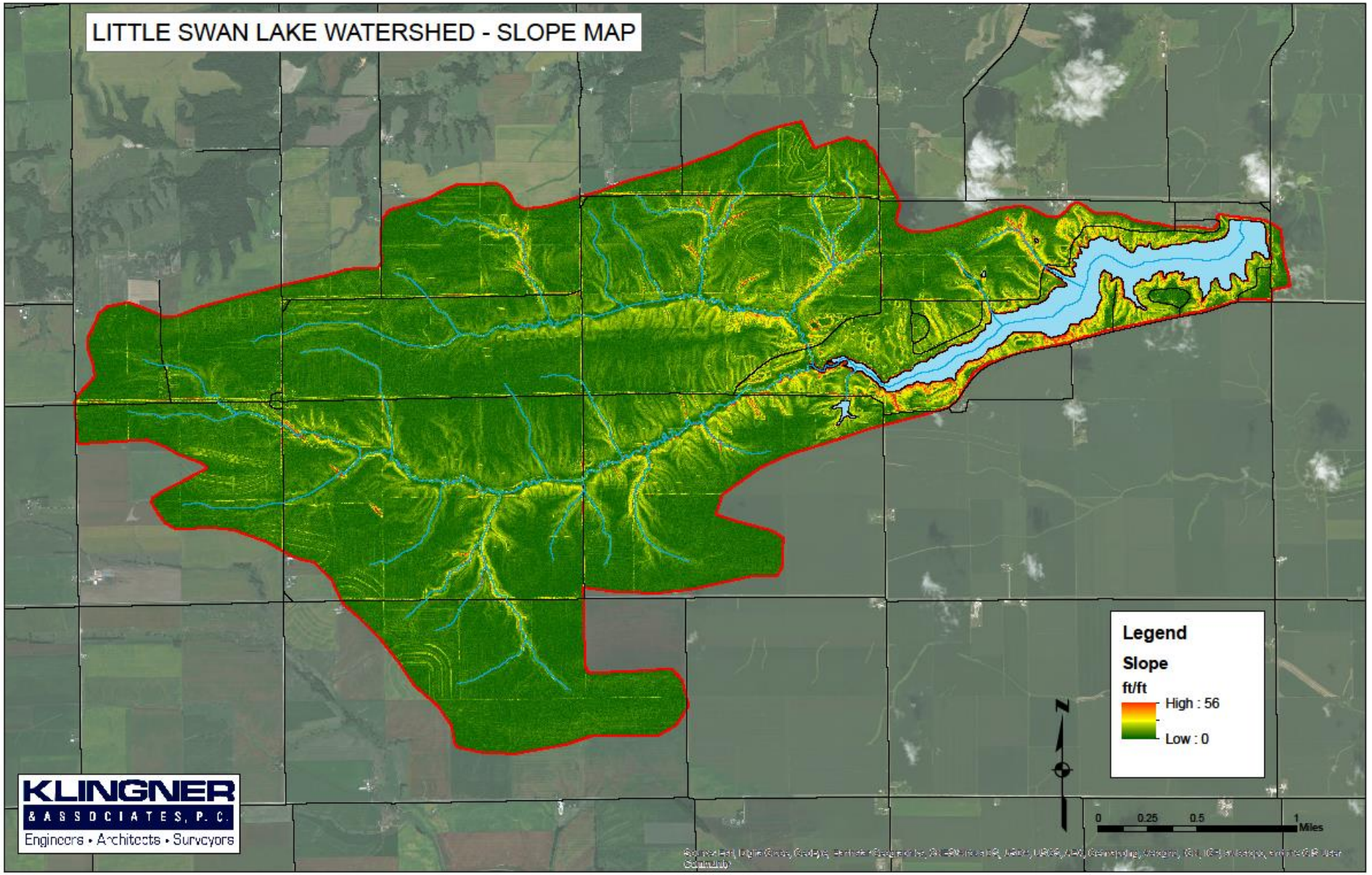
MUSLE – SLOPE MAP



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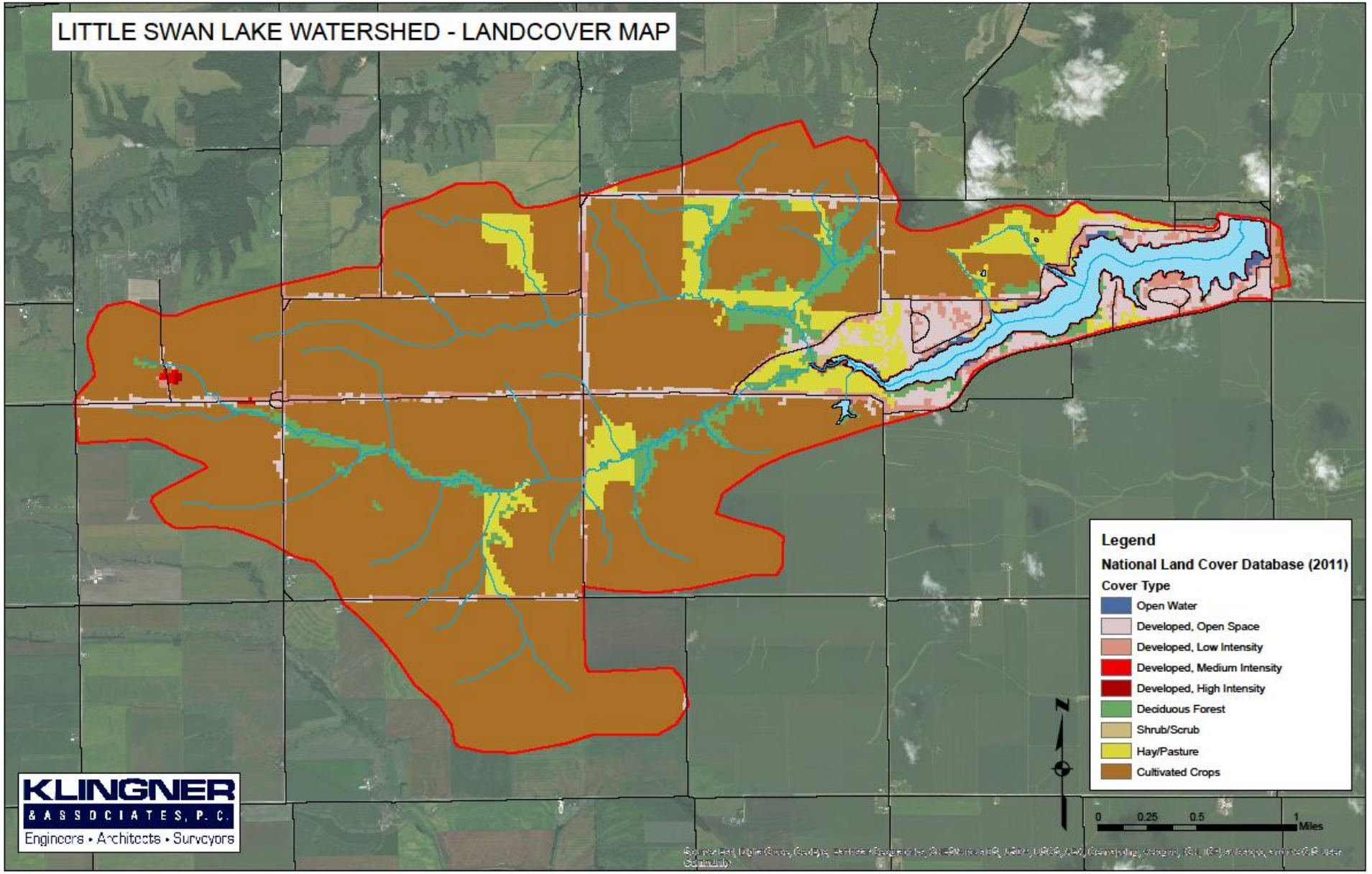
MUSLE – LANDUSE MAP



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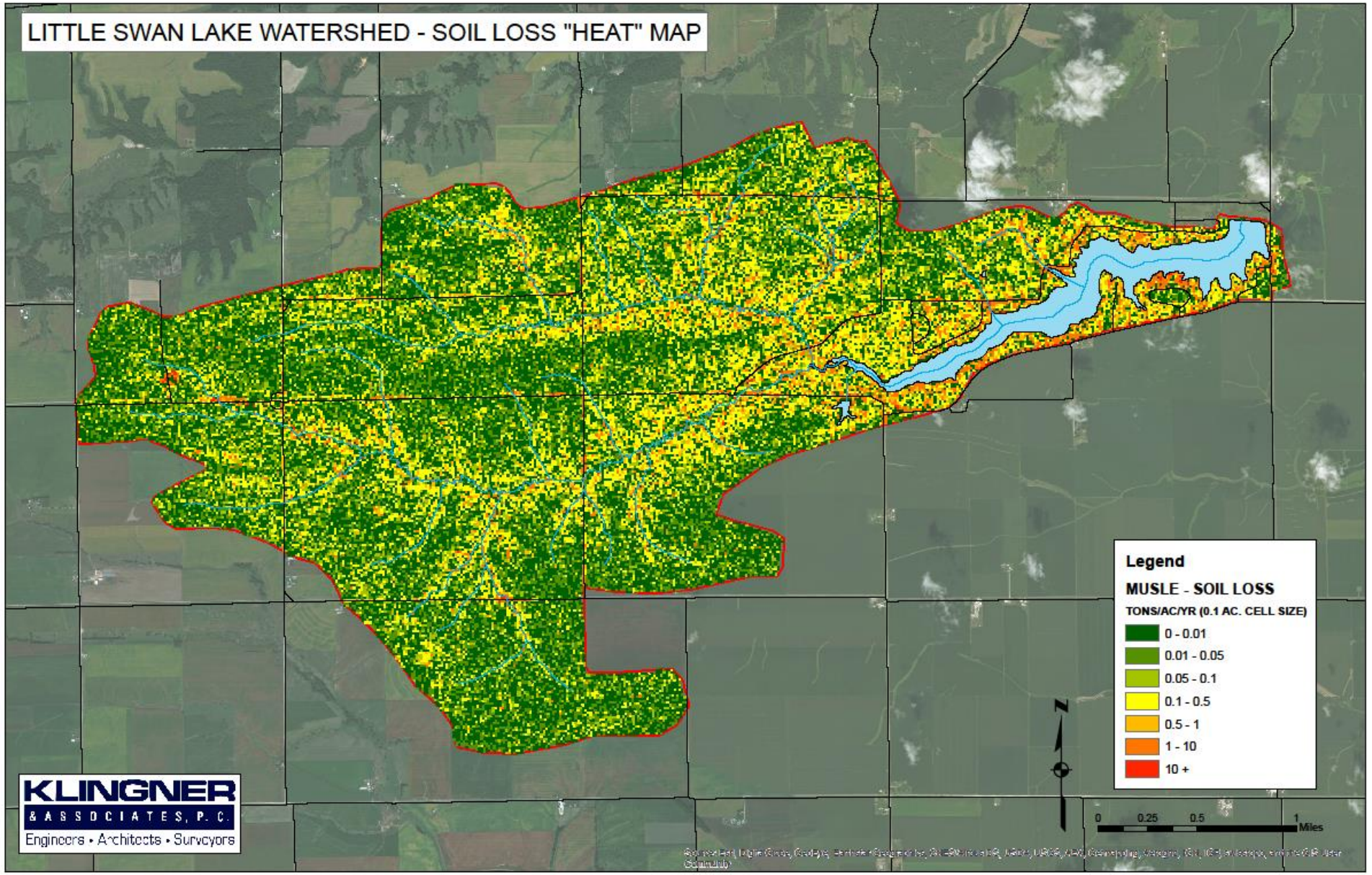
MUSLE – SOIL LOSS “HEAT MAP”



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MUSLE – PRELIMINARY RESULTS

- Soil Loss in the Watershed Ranged from 0.01 to over 10 Tons/Ac/Year
- Average Soil Loss for the Watershed was Approximately 0.5 Tons/Ac/Year
- This Equates to Approximately **2500 Tons of Sediment/Year**
- The Average Soil Loss for Upper Midwest Crop Land = 2 Tons/Ac/Year
- The Nationwide Average Soil Loss for Crop Land = 1.5 Tons/Ac/Year

- According to the MUSLE The Little Swan Lake Watershed Produces Less Sediment than the National and Regional Average.

BATHYMETRIC SURVEY

- Compared the Results of Three (3) Data Sources
  - Cochran & Wilken, Inc Report (2003)
  - Hartman Bathymetric Survey (2011)
  - Klingner Bathymetric Survey (2018)

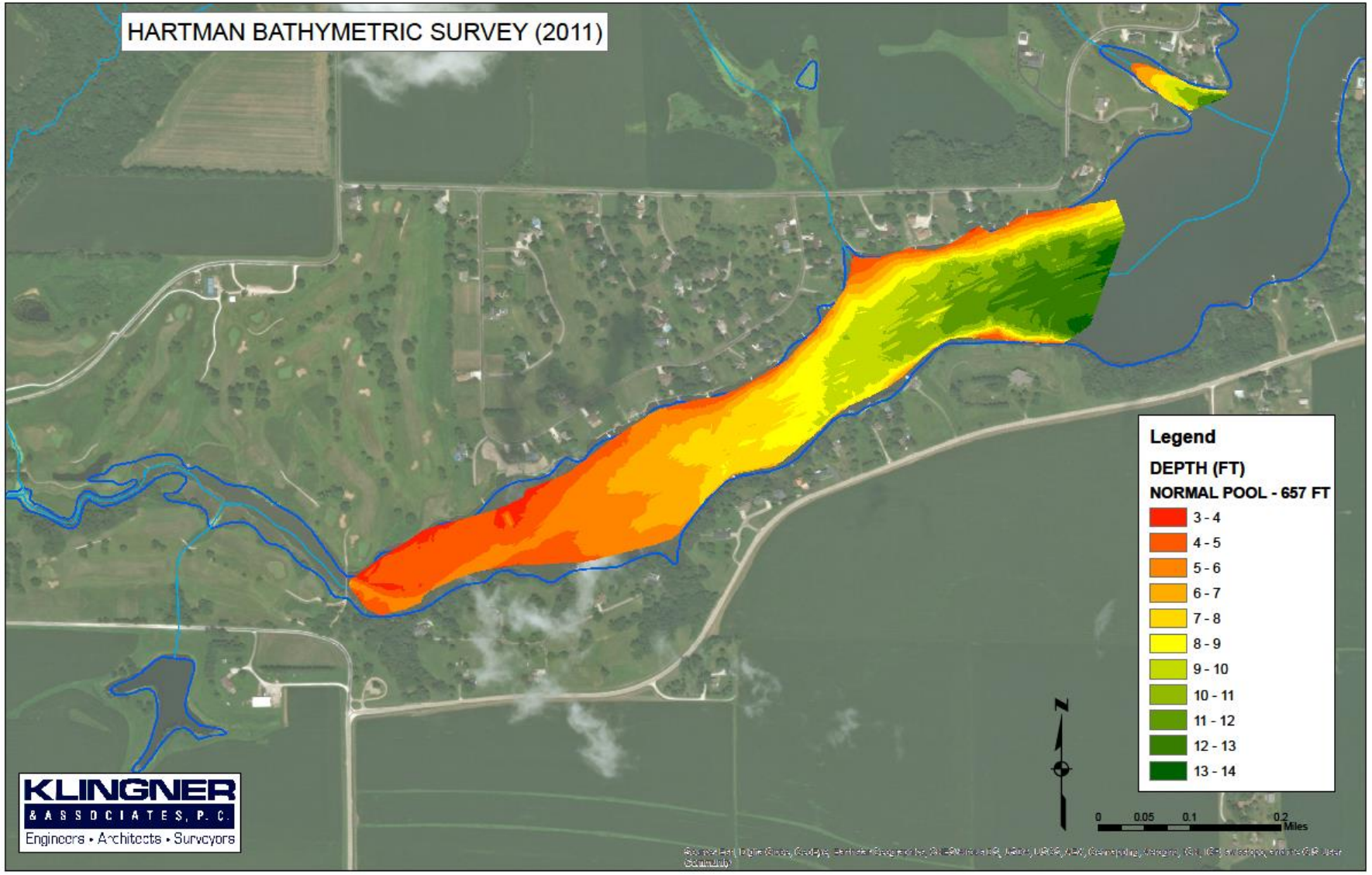
Cochran & Wilken, Inc Report (2003)

- Surveyed the Upper Third of the Lake Using GPS and a Sounding Pole
- Developed a Series of Cross Sections with Pre-Existing and Current Lake Bottom Elevations.
- Used Average End Area Method to Develop an Estimated Amount of Siltation.
- Calculated 174,226 Cubic Yards of Siltation (178,600 Tons).
- This Equates to Approximately **4950 Tons/Yr or 0.8 Tons/Ac/Yr,** From 1968 to 2003.

- Using Measured Values, The Little Swan Lake Watershed Produces Less Sediment than the National and Regional Average.

Hartman Bathymetric Survey (2011)

- Used GPS and Sonar to develop and dense network of depth measurements.
- Points were aggregated to create a water depth grid (based on an assumed water surface elevation of 657 FT).



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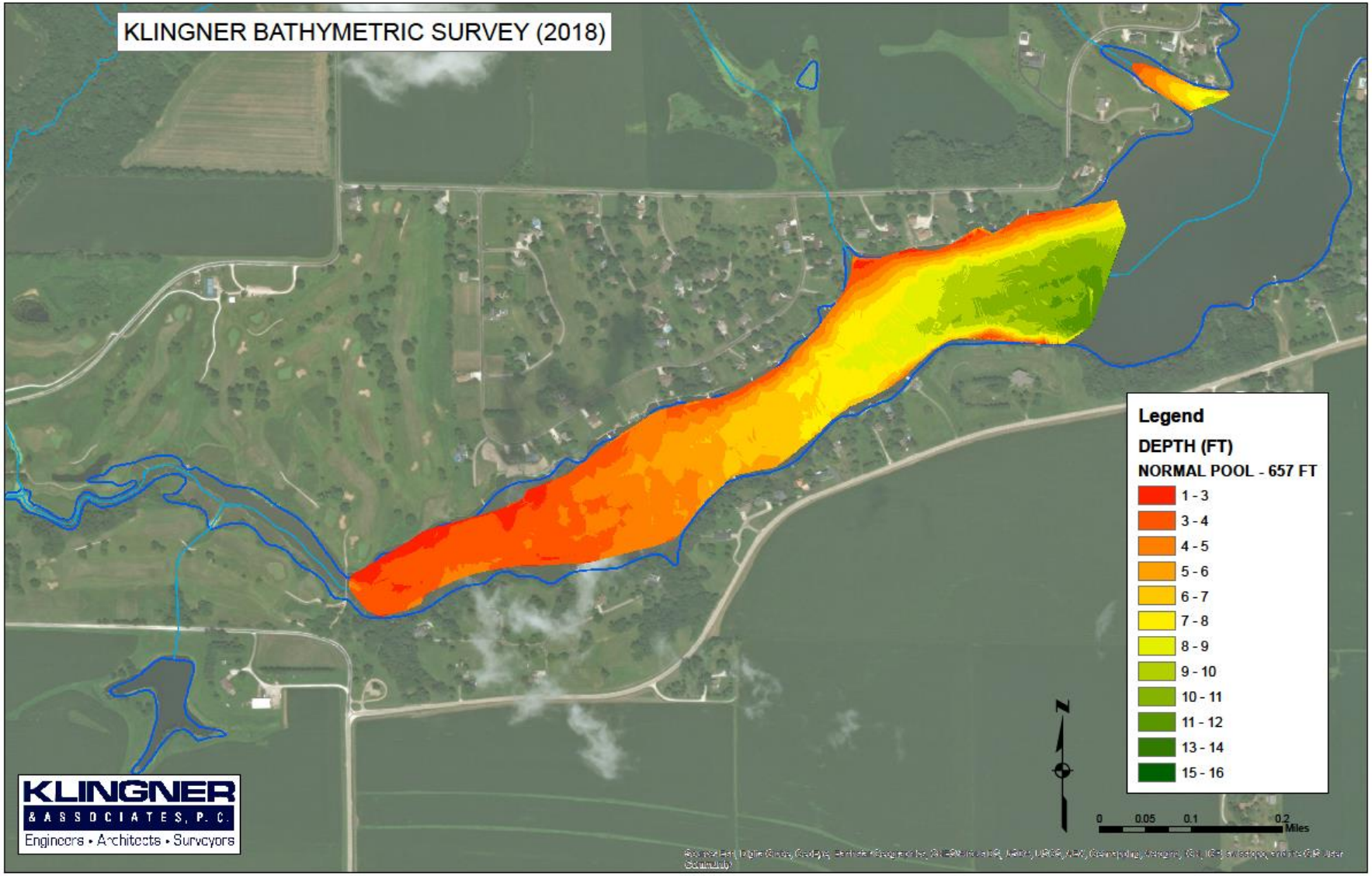
Klingner Bathymetric Survey (2018)

- Used a survey method similar to the Hartman 2011 Survey.



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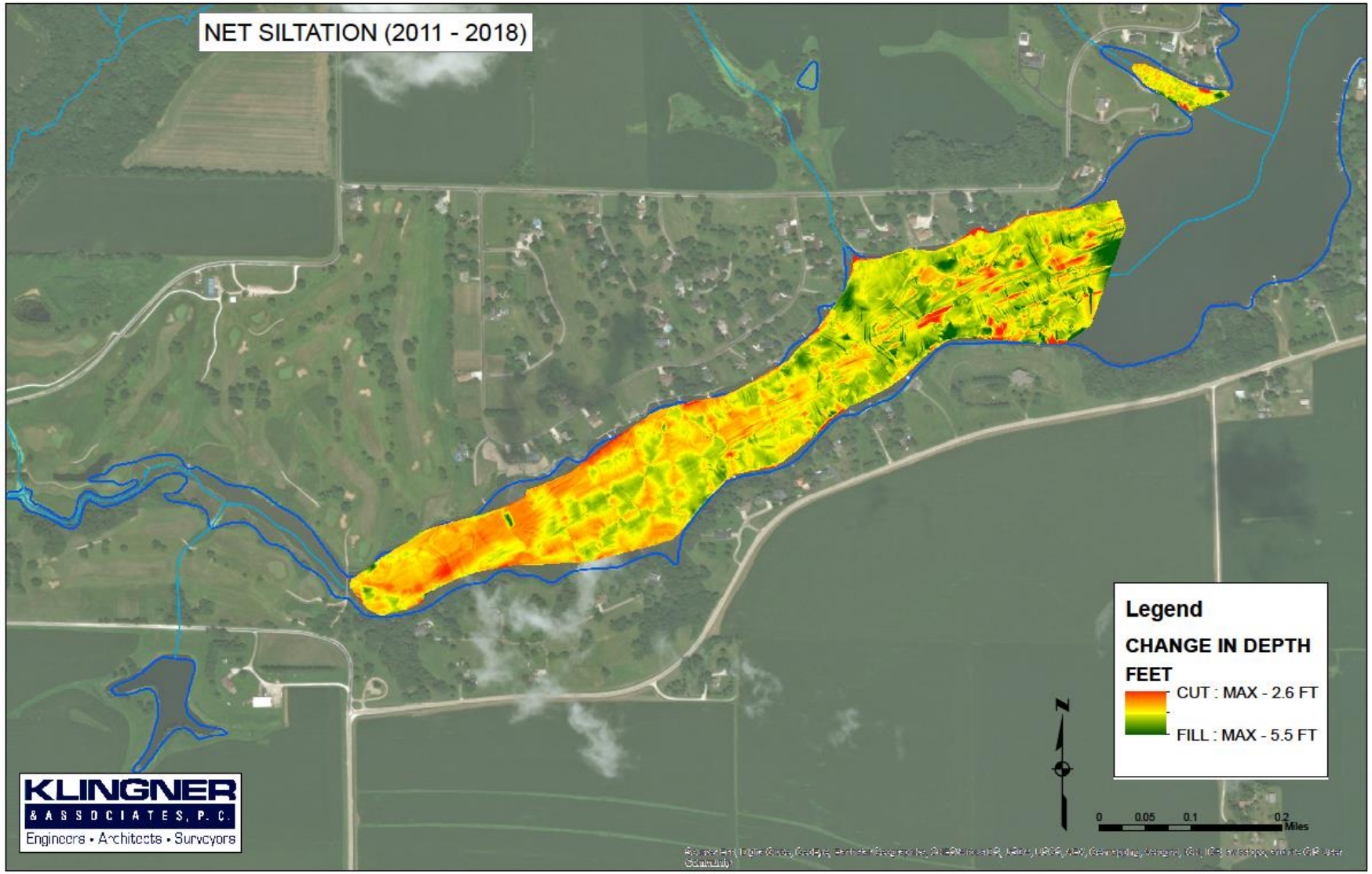
Siltation Pattern from 2011 to Today

- Overall water depths increased upstream and decreased downstream.
- This would indicate a reduction in the rate of siltation from 2011 to today.
- Large amounts of silt that were previously in the Upper Reaches are migrating downstream, filling the main body of the lake.



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Record Rainfall Event – May 15th, 2009

- On May 15th, 2009 over 6-inches of Rainfall fell over the Little Swan Lake Watershed (according to LSL Records).
- This Equates to A Rainfall Frequency of Once Every 25 to 50 Years.
- The Rainfall Caused an Overtopping of the Little Swan Lake Emergency Spillway.
- During This Event a Large Earth Moving Project was Underway, Directly Upstream of the Lake.
  - An Estimated 75 Acres of Earth May Have Been Disturbed and was Thus Susceptible to Erosion.
  - To the Knowledge of the Little Swan Lake Siltation Committee, No Erosion Control Measures Were in Place.

- To Estimate the Sediment Produced from this Event The MUSLE was Altered to Reflect a Single Event.
- The R Value was Modified to Be Based on the Rainfall Energy of That Single Event Rather than a Yearly Geographic Average (This was done using the 15 minute rainfall gage at Yates City.)
- C Factor was Modified to Reflect Bare Earth.
- Given This Information it is Estimated That This Single Event Resulted in 12.75 Tons/Ac or 970 Total Tons of Sediment (Nearly 40% of the Expected Sediment for the Year).
- For Reference it was Estimated That This Event Would Have Caused 50-190 Tons of Sediment had Erosion Control Measures Been in Place.

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Preliminary Conclusions

- Using MUSLE, Expected Annual Sediment Load is Approximately 0.5 Tons/Ac/Yr
- Using Measured Values, Expected Annual Sediment Load is Approximately 0.8 Tons/Ac/Yr
- Both Methods Show that The Little Swan Lake is Expected to Produce Less Sediment than the Regional Average, 2.0 Tons/Ac/Yr.
- Bathymetric Survey Results Show The Lake Depth has Slightly Increased Upstream, and Decreased Downstream In the Timespan Between 2011 and Today.
- This Suggests that The Rate of Siltation has Slowed Since 2011.
- Sediment Load from the 2009 Rainfall Event was Estimated to be 970 Tons. This is from the Upstream Construction Project Only, Thus The Total Sediment from this Event was likely over 1000 Tons.
- It is Possible That the 2009 Event Caused a Large Spike in Sediment Entering the Lake, Since That Time Survey Results Suggest That The Sediment Rate Likely Returned to “Normal”.