Streambank/Bluff Erosion Estimates for High Island Creek and Watonwan River Watersheds

Patrick Baskfield
Minnesota pollution Control Agency
Excess Sediment; what is the problem?

Minnesota and Mississippi

Mississippi and St. Croix
Sediment Sources:

- Construction Sites
- Classic Gullies
- Urban Stormwater
- Agricultural Runoff/Open Tile Intakes
- Streambanks and Bluffs
Watonwan River: Streambank/bluff Erosion Estimates
Watonwan River: Erosion Estimates

Upland erosion from agricultural lands

Streambank/Bluff Erosion

- Discharge (cfs)
- TSS conc. (mg/L)

- 8 mg/L
- 80 mg/L
- 800 mg/L
## Sample Selection Method

<table>
<thead>
<tr>
<th>Flow Range (cfs)</th>
<th>Total # Samples</th>
<th>% of Samples Used in Each Cat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-100</td>
<td>31</td>
<td>19%</td>
</tr>
<tr>
<td>100-250</td>
<td>36</td>
<td>19%</td>
</tr>
<tr>
<td>250-500</td>
<td>50</td>
<td>20%</td>
</tr>
<tr>
<td>500-750</td>
<td>28</td>
<td>18%</td>
</tr>
<tr>
<td>750-1000</td>
<td>19</td>
<td>21%</td>
</tr>
<tr>
<td>1000-1500</td>
<td>23</td>
<td>22%</td>
</tr>
<tr>
<td>1500-2500</td>
<td>28</td>
<td>21%</td>
</tr>
<tr>
<td>2500-3500</td>
<td>9</td>
<td>44%</td>
</tr>
<tr>
<td>&lt;3500 cfs</td>
<td>13</td>
<td>46%</td>
</tr>
<tr>
<td><strong>sample total</strong></td>
<td><strong>237</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

Percent of samples used = 22%
Step 1: Watonwan River
Streambank Erosion Regression

\[ y = 2.6215x^{0.4052} \]
\[ R^2 = 0.6947 \]
Step 2: Compute Daily Streambank Erosion (SBE) Loads

Example:

Daily Average Discharge = 20 gal/day

SBE concentration = 0.5 lb./gal.

Daily SBE load = 20 gal/day x .5 lb/gal = 10 lbs
Step 2: Compute Daily Streambank Erosion (SBE) Loads

Example

Daily Average Flow x TSS Concentration = Daily SBE Load
Step 3: Compute Seasonal Streambank Erosion Load  
(generally 4/1 through 9/30)

**Sum of Daily SBE loads = Seasonal SBE load**

**Example: 3 day season, 4/1 through 4/3**

\[
\text{April 1 SBE load} + \text{April 2 SBE load} + \text{April 3 SBE load} = \text{Seasonal SBE load}
\]

\[
30 \text{ kg} + 50 \text{ kg} + 100 \text{ kg} = 180 \text{ kg}
\]
Step 3: Compute **Actual** Seasonal Total Suspended Solids Load

![Graph of 2006 Waterway Outlet Daily Average Discharge and Sample Collection Dates](image-url)
Step 4: Compute SBE Proportion of Seasonal TSS Load

\[
\text{Streambank Erosion Proportion of Seasonal TSS Load} = \frac{\text{Actual Seasonal TSS Load}}{\text{Streambank Erosion TSS Load}}
\]

30 Tons ÷ 100 Tons = 30%
# Watonwan River SBE estimates 2000-2005

## Seasonal Flow

<table>
<thead>
<tr>
<th>Year</th>
<th>Monitoring Season Dates</th>
<th>Seasonal Flow Weighted Mean TSS Conc.</th>
<th>% of TSS from SBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>4/1-9/30</td>
<td>99.9</td>
<td>67%</td>
</tr>
<tr>
<td>2002</td>
<td>4/1-9/30</td>
<td>143.6</td>
<td>20%</td>
</tr>
<tr>
<td>2003</td>
<td>4/1-9/30</td>
<td>155.0</td>
<td>23%</td>
</tr>
<tr>
<td>2004</td>
<td>4/1-10/15</td>
<td>207.8</td>
<td>21%</td>
</tr>
<tr>
<td>2005</td>
<td>4/1-10/26</td>
<td>131</td>
<td>39%</td>
</tr>
</tbody>
</table>

*Five year average 34%*
Streambank/Bluff Erosion Estimates for High Island Creek Watershed

High Island Creek Watershed

Scott Matteson
Patrick Baskfield
Percentage of Land with Slopes Greater than 12% by Watershed
**HIGH ISLAND CREEK WATERSHED SLOPE CHARACTERISTICS**

**EXPLANATION**
Slope classes are based upon percent slope values calculated from the USGS Digital Elevation Model (DEM) data. DEM elevation data are based upon USGS 24,000 scale topographic maps. Elevation data are collected at 30 meter (98.4 ft) intervals.

<table>
<thead>
<tr>
<th>ACRES</th>
<th>PERCENT</th>
<th>SLOPE CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>146,485</td>
<td>99%</td>
<td>&lt;= 3%</td>
</tr>
<tr>
<td>3,593</td>
<td>2%</td>
<td>&gt; 3% and &lt;= 6%</td>
</tr>
<tr>
<td>1,586</td>
<td>1%</td>
<td>&gt; 6% and &lt;= 12%</td>
</tr>
<tr>
<td>1,558</td>
<td>1%</td>
<td>&gt; 12%</td>
</tr>
</tbody>
</table>

**MAP KEY**
- Watershed
- High Island Creek
- Minnesota River
- Stream
- Lake
- Public Ditch
- Municipality
- Road

**Prepared for:** High Island Creek Watershed Assessment Project  
**Prepared by:** Cis Berg  
**Water Resources Center, Minnesota State University, Mankato**  
**Date:** September 26, 2002  
**Software:** ARCINFO 7.1.2 and ArcView 3.2

**Data Sources**  
Include the International Coalition Land Use/Land Cover;  
MDOT Roads, Municipalities and Wildlife Management Areas;  
Minnesota River Basin Data Center Watershed Boundaries, Streams and Lakes; USGS Digital Elevation Model (DEM) data

**The High Island Creek Watershed Assessment Project** is a Minnesota Pollution Control Agency (MPCA) Clean Water Partnership.
HIGH ISLAND CREEK WATERSHED
SLOPE CHARACTERISTICS

EXPLANATION
Slope classes are based upon percent from the USGS Digital Elevation Model elevation data are based upon USGS maps. Elevation data are collected at 2" by 2" pixel resolution. Percent slope classes are:

<table>
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<tr>
<th>ACRES</th>
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<th>SLOPE CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>146,485</td>
<td>90%</td>
<td>&lt;= 3%</td>
</tr>
<tr>
<td>3,593</td>
<td>2%</td>
<td>&gt; 3% and &lt;= 8%</td>
</tr>
<tr>
<td>1,586</td>
<td>1%</td>
<td>&gt; 8% and &lt;= 12%</td>
</tr>
<tr>
<td>1,558</td>
<td>1%</td>
<td>&gt; 12%</td>
</tr>
</tbody>
</table>

INDEX MAP
PRIMARY SAMPLESHEDS

SITE 5P

SITE 10P
HIGH ISLAND CREEK WATERSHED
SLOPE CHARACTERISTICS

EXPLANATION
Slope classes are based upon percent from the USGS Digital Elevation Model. Elevation data are based upon USGS maps. Elevation data are collected at 5m cell size.

INDEX MAP
PRIMARY SAMPLE

LOCATION MAP

ACRES PERCENT
146,485 90%
3,593 2%
1,586 1%
1,558 1%

Site 5P
Site 10P
Sediment Sources for High Island Creek Watershed:

- Classic Gullies and runoff from Highly Erodible Lands
- Streambanks and Bluffs
- Agricultural Runoff/Open Tile Intakes
1. Develop streambank regression equation

\[ y = 3.3041x^{0.6516} \]

\[ R^2 = 0.7268 \]
2. Compute daily SBE loads
3. Sum daily SBE loads to get seasonal SBE load
4. Compute SBE proportion of the seasonal TSS Load
Sample Selection Criteria

- TSS concentrations at 5P less than 36 mg/L (clean water at the top of the transitional area)
- Low TSS concentrations at 9P – Buffalo Creek indicate gulley contributions of TSS are insignificant at the time the sample was collected
Sample Selection Criteria

If above criteria are met, TSS concentration at 10P is assumed to be from SBE/bluff erosion
High Island Creek Outlet SBE Total Suspended Solids vs. Flow Regression

\[ y = 3.3041x^{0.6516} \]

\[ R^2 = 0.7268 \]
## Results

<table>
<thead>
<tr>
<th>Year</th>
<th>Seasonal TSS FWMC (mg/L)</th>
<th>% of seasonal TSS load from stream bank/bluff erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>507</td>
<td>52%</td>
</tr>
<tr>
<td>2002</td>
<td>1223</td>
<td>11%</td>
</tr>
<tr>
<td>2003</td>
<td>347</td>
<td>25%</td>
</tr>
<tr>
<td>2004</td>
<td>643</td>
<td>32%</td>
</tr>
<tr>
<td>2005</td>
<td>358</td>
<td>33%</td>
</tr>
<tr>
<td><strong>Five Year Average</strong></td>
<td><strong>31%</strong></td>
<td><strong>31%</strong></td>
</tr>
</tbody>
</table>
Conclusions

Streambank/bluff proportion of seasonal TSS load:

- **Watonwan River = 34%**
  - Primary sources of sediment include streambank/bluff and upland
- **High Island Creek = 31%**
  - Primary sources of sediment include streambank/bluff, upland, and classic gulley

Streambank/bluff contributions vary according to seasonal climatic conditions; precipitation type, amount, intensity and timing