Field Investigation of Sedimentation Analysis at Stream-Bridge Crossings

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Research Location:
Bucknell University
Lewisburg, PA
Summer of 2009

ABSTRACT

Aggradation, or sediment deposition, is a very common problem at many bridges crossing small streams in the Susquehanna River watershed. Modifications to the channel near a bridge crossing can lead to the extensive deposition of sediment in the bridge waterway. This partial blockage of the bridge waterway poses serious safety problems to the overall bridge structure. The most common solution for aggradation in Pennsylvania is to dredge the stream channel frequently. While this mitigation procedure is successful in clearing some of the sediment that is blocking the waterway, it also creates conditions that promote further sediment deposition at the bridge. Sediment transport and bridge hydraulics need to be investigated to determine a more sustainable solution to aggradation at bridge crossings. The main goal of the presented research was to initiate monitoring sites to measure changes in stream bed elevation. This data will then be used to develop mathematical models of the sediment transport processes at these bridge crossings. The current bridge design guidelines focus on the transport of just the water through the bridge waterway. The monitoring and mathematical modeling of sediment transport at bridges will help inform bridge design guidelines that account for the transport of sediment through the bridge waterway in addition to the water.

BACKGROUND

Scope: Erosion of streamed sediment by forces of fast-moving water.

Agragation: Sediment build-up caused by a sudden drop in water velocity.

GOALS & OBJECTIVES

- Monitor streamed elevations.
- Develop a mathematical model of the sediment transport processes.
- Develop recommendations for the design of stream-bridge crossings.

MITCHELL CREEK MODEL

- HEC-RAS 4.0 used for modeling.
- Input stream cross-section geometry
- Input precipitation and sediment data
- Used to study the effects of streambed modifications that commonly occur at bridge crossings.
- Each modification consisted of its own unique streambed geometry.
- Trials were run for five separate storms.
- 1,3,5,10,25-year return period storms

PROJECT OUTLINE

- Site Selection:
  - Chosen from data supplied by PennDOT, Reasonable driving distance, USGS streamgage within its watershed.
- Site Investigation:
  - Field visit, Visible problems, Sediment size, Bridge location/alignment.
- Data Collection/Site Monitoring:
  - Survey cross-sections, Pebble counts, Before and after storms.
- Model Creation/Data Analysis:
  - HEC-RAS (U.S. Army Corps of Engineers, Hydrologic Engineering Center)
  - Develop Recommendations

*11 different geometry files
- Straight channel: No modifications
- Decrease in slope
  - 25% Slope
  - 50% Slope
  - 75% Slope
- Increase in width
  - 50% Width
  - 150% Width
- 5ft Bridge built
  - Single Span
  - One Center Pier
  - 5ft Bridge built
  - Single Span
  - One Center Pier

STREAMBED GEOMETRY

MONITORING SITE 1

Trout Run & US 15 Bridge in Trout Run, PA

MONITORING SITE 2

White Deer Creek & Old Route 15 Bridge in White Deer, PA

MODEL RESULTS

Sediment Accumulation

| Location | Year | Width | Changes | Result | Sediment
| --- | --- | --- | --- | --- | --- |
| Trout Run | 2009 | 5ft. | 25% Width | Increase | 50%
| US 15 Bridge | 2010 | 5ft. | 75% Width | Increase | 150%
| Trout Run | 2011 | 5ft. | 75% Slope | Decrease | 25%
| Trout Run | 2012 | 5ft. | 150% Width | Increase | 50%

Shear Stress

<table>
<thead>
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RANKING: TEN YEAR STORM RESULTS

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NEXT STEPS

- Continue gathering data at the other two sites.
- Trout Run & White Deer Creek
- Resurvey stream cross-section
- Direct measurements of sediment transport
- Perform the same analysis as well as a 2-D Analysis.
- Actual field measurements can be made to verify the models results which will ensure accuracy.

ACKNOWLEDGEMENTS

Michael Baker Jr. Summer Research Program
Bucknell University
Ben Hayes, Director of the Susquehanna River Initiative & summer interns at Bucknell University

Shear stress prediction correlates well with the slope modification
- Increase prediction with the width modification.
- The three foot bridge correlates while the five foot bridge does not.
- Flow did not reach the five foot bridge.