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A Hydrologic and Hydraulic Analysis of Massie's Creek Gorge, Greene County, OH, Using HEC-RAS

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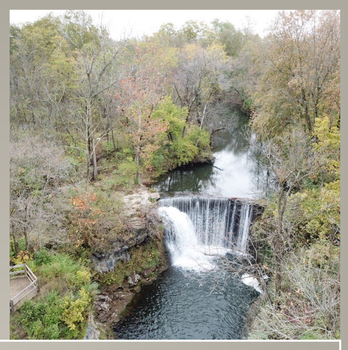


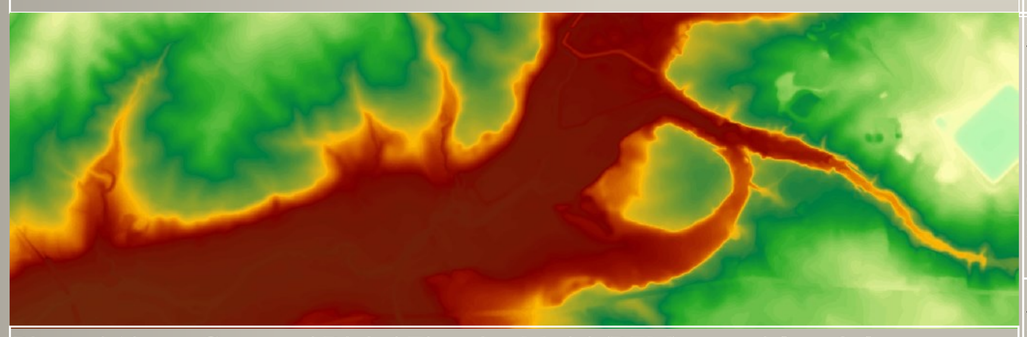
ABSTRACT

Massie's Creek is a small tributary of the little Miami River, located in southwest Ohio near the village of Cedarville. For approximately 1.5 miles (2.4 km) it flows westward through the Indian Mound Reserve Park, an area which occasionally undergoes flooding. In the first ½ mile (0.8 km) of the park, the stream is confined by a deep gorge, 40 feet (12 m) or more tall, and quickly flattens to a meandering stream through the rest of the park. The present study describes the application of HEC-RAS with the integration of ArcGIS for steady flow analyses and flood inundation mapping, as well as numerical data for stream velocity and shear stress through the area of interest (AOI). A Digital Elevation Model (DEM) of the Indian Mound Reserve Park is used in addition to bathymetric data points for flood inundation mapping. USGS stream gauge discharges equal to the 10%, 2%, 1% and 0.2% chance annual floods are used for investigation of various flood scenarios. Longitudinal profiles describe the energy gradients and critical flow levels through the AOI for respective floods. Color-coded stream velocity and shear stress maps indicate heightened values for the gorged portions of the AOI which settle out downstream. The steady flow simulation results of 10%, 2%, 1%, and 0.2% chance annual

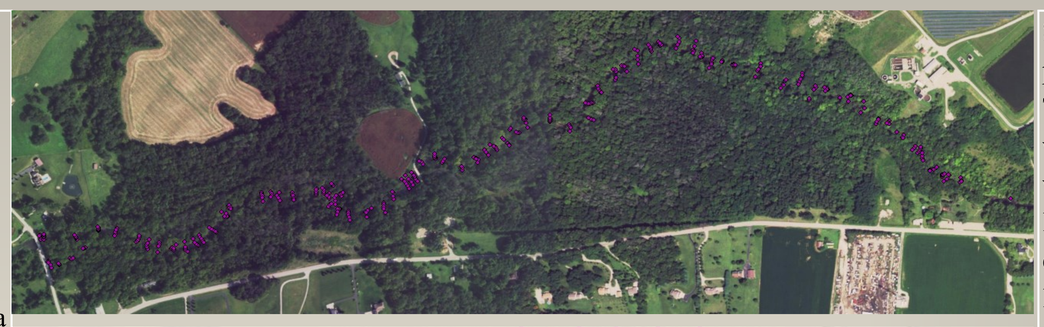
Pictured Above: Comparison of 'normal' conditions (left; 84 cfs) to 'flood' conditions (right; 1,780 cfs). Taken with the Mavic Pro drone.

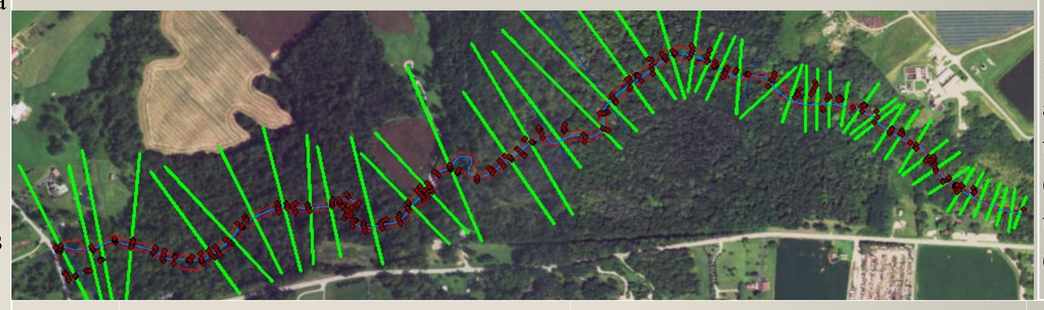
Methods

Steady flow analysis was run through HEC-RAS for four different flood events; 10%, 2%, 1%, and 0.2% chance annual floods. Discharge data was gathered using the downstream USGS Wilberforce stream gauge. Discharges were 3680, 5800, 7100, and 10,800 cfs, respectively. A 2-foot contour surface map was converted to a DEM in ArcGIS. Bathymetric data was collected by hand using a 25 ft. stadia rod and Trimble Juno 3B unit. HEC-GeoRAS was utilized to define stream attributes and cross section cut lines. Mixed flow regime, steady flow analyses were then run in HEC-RAS for each flood event. Data was analyzed and re-exported to ArcMap in order to create stream distribution and critical



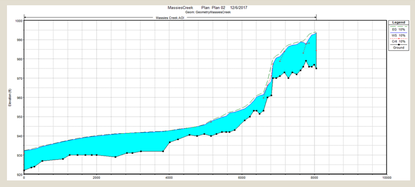
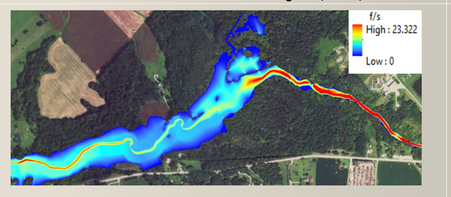
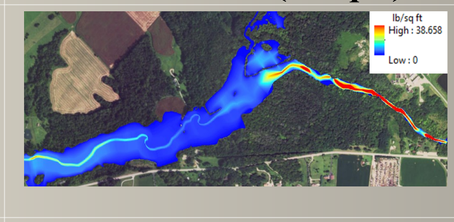
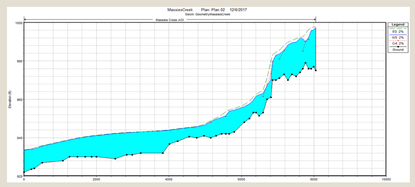
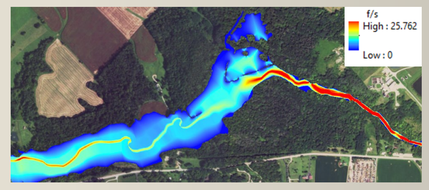
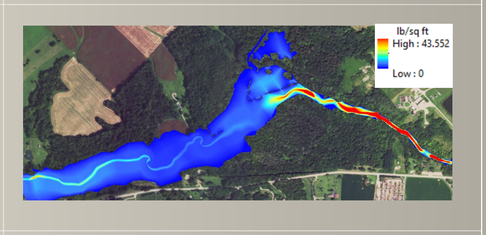
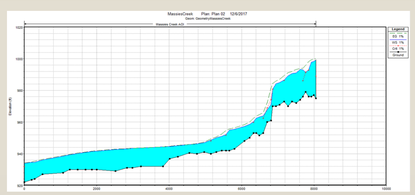
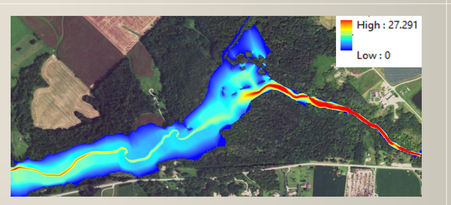
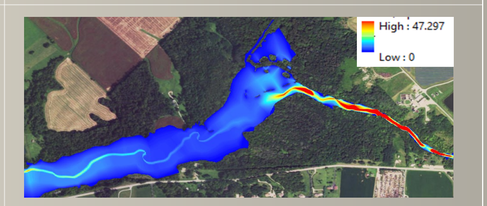
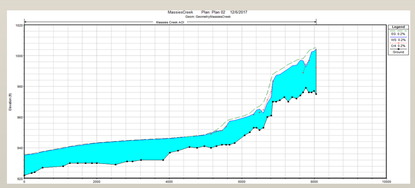
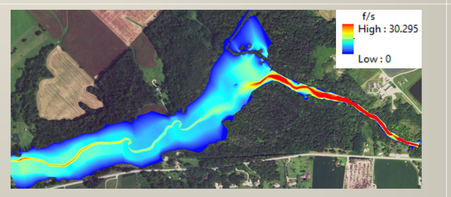
Pictured Above: Converted Digital Elevation Model (DEM) created from 2-foot contour map.





Shown Upper-left: 384 bathymetric data points measured using 25' stadia rod and Trimble 3B handheld unit. Data points were adjusted as needed based on the water surface elevation for a given collection day. Measurements from 3 bridges to the surface were used as the analogue for adjustments.

Shown Lower-left: HEC-GeoRAS works as an ArcMap extension which allows the user to define stream centerline (blue), bank lines (red lines), cross sectional cutlines (green), flow paths (designated with stream centerline and

Flood Event	Longitudinal Profile	Inundation & Stream velocity (f/s)	Inundation & Shear stress (lb/sq ft)
10%			
2%			
1%			
0.2%			

RESULTS

Longitudinal profiles show one hydraulic jump of one to two feet for the 10% and 2% chance annual floods. The 1% and 0.2% chance annual flood exhibit two areas of hydraulic jump, between two and five feet. Stream velocity data as well as shear stress data consistently shows heightened values in gorged sections of the AOI. Flood inundation maps do not reach any homes of the nearby Cedarville Township residents. 0.2% chance flood levels inundate the gorged portion of the AOI to about four feet under the top of the Cedarville dolomite, though none of the flood events analyzed here would overtop the gorge.

ACKNOWLEDGEMENTS

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