NEW JERSEY AGRICULTURAL EXPERIMENT STATION
RUTGERS COOPERATIVE RESEARCH & EXTENSION

Hydraulic Modeling using HEC-GeoRAS: A Case Study of the Many Mind Watershed, NJ

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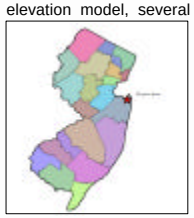
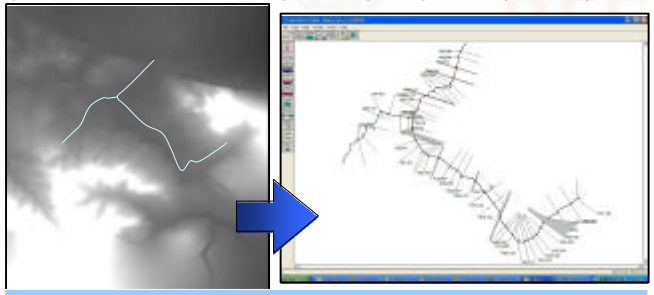
Abstract:

A cost effective GIS based hydraulic model was used to simulate water surface elevations expected for a variety of design storms along the Many Mind Creek in Atlantic Highlands and Middletown, NJ. Using a county-obtained digital elevation model, several field surveyed stream cross sections, along with other readily available land use GIS data layers, the Rutgers Cooperative Research & Extension's Water Resources Program was able to predict problem areas in a relatively small, but highly populated watershed on the coast of New Jersey. Poor water quality attributed to erosion could be analyzed in the context of water velocity and stream sinuosity. Various land use alterations were modeled to forecast the effect of several modifications. All information was presented to the Many Mind Regional Stormwater Management Planning Committee for consideration.



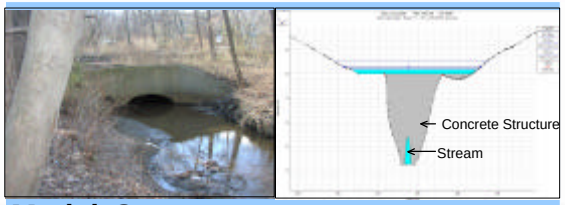
Introduction:

Rutgers Cooperative Research & Extension's Water Resources Program has completed a hydrologic and a hydraulic evaluation of the Many Mind Watershed, located in Atlantic Highlands and Middletown, NJ. The study was performed to assist the Many Mind Regional Stormwater Management Planning Committee in their efforts to assess water quality issues that adversely affect the health and safety of local residents, as well as water quantity issues that impact the structure of stream banks and the quality of the water. This study intended to represent the existing characteristics of the hydrology and hydraulics within the watershed and to provide insight into potential improvement plans.



Data Collection:

With the availability of extensive Geographic Information System (GIS) data coverages for the watershed, modeling set up and post processing was achieved using an ArcView GIS interface using ESRI's ArcView software. HEC-GeoHMS and HEC-GeoRAS are the ArcView extensions that were used to generate a good portion of the input data for HEC-HMS and HEC-RAS, respectively. A high resolution digital elevation model obtained through the county provided the basis for the watershed topography and the cross sectional geometric data.



Model Output:

HEC-RAS was able to supply expected water surface elevations at critical areas such as bridges and culverts with the input of the design storm peak flows provided by the hydrologic model. The effect of managing the peak flow could be easily evaluated.

Analysis:

Once the peak flows generated from HEC-HMS for the selected storm events were defined at the flow change locations for all stream reaches, the steady state hydraulic simulation was performed with HEC-RAS. The output from the simulation include:

- the steady state water surface elevation,
- critical depths,
- energy gradient elevations,
- energy gradient slopes,
- flow area and velocities at the cross sections.

These results can be displayed graphically as X-Y plots of the river system schematics, cross sections, rating curves, and hydrographs. Final water surface elevation can be exported to the GIS project for a visual representation.

Conclusions:

The HEC-HMS and HEC-RAS models developed for the Many Mind Watershed provide a detailed understanding of the dynamic nature of the watershed's runoff and stream responses during a variety of storm events. Using these tools, the decision makers can evaluate the conditions that lead to flooding and erosion, and identify where changes can be made to make the most significant impact.

The hydrologic and hydraulic models were able to conceptually represent the benefits of increased infiltration, or decreased runoff through the use of lower curve numbers within the model runs. This reduction showed benefits, but not enough to consider this curve number reduction by itself as a solution to eliminate flooding. An additional use of the models was to portray a potential reduction in flow that would be expected with the use of a detention or retention area.

References:

Monmouth County Office of GIS, Many Mind Digital Elevation Model, received from John Brockwell, July 2004.

U.S. Army Corps of Engineers, November 2002. HEC-RAS River Analysis System: User's Manual. Available at http://www.hec.usace.army.mil/software/hec-ras/documents/userman/html

U.S. Army Corps of Engineers, November 2000. HEC-GeoRAS An extension for support of HEC-RAS using ArcView.

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