ABSTRACT

Best management practice (BMP) strategies are used in rural and urban areas to reduce the impact of downstream water quantity and quality problems. The effectiveness of BMP facilities are evaluated using field data and computer tools. Field data are site specific and, in many cases, time and labor intensive. Many environmental and economic models require highly skilled and experienced professionals. A more user friendly and easy to use tool based on environmental (hydrology, flood routing, and pollutant removal mechanisms) and cost variables is needed to evaluate the effectiveness of BMP/LID facilities.

BACKGROUND

In existing urbanized areas, BMPs can be implemented to address a range of water quantity and water quality considerations. For new urban development, BMPs should be designed and implemented so that the post-development peak discharge rate, volume and pollutant loadings to receiving waters are the same as pre-development values (fig 1).

This poster intends to show the development of a new tool (using VBA programming for Microsoft Excel) to evaluate and link rainfall-runoff generation and outflows from selected BMPs facilities.

To evaluate the effect of a BMP on peak attenuation it is necessary to estimate the variation of flows in time and space. The routing process uses mathematical expressions to calculate flow from a reservoir or a storage facility once inflow, initial conditions, facility characteristics and operational rules are known [1].

All hydrologic routing methods are founded on the equation of continuity, which may be expressed as:

\[ \frac{dS}{dt} = I - O \] (1)

Where:
- \( S \) is storage (L3), \( t \) time (T), \( dS/dt \) the time rate of change in storage, \( I \) is the inflow rate, \( O \) the outflow rate (L3/T)

The Storage Indication Method is recommended for reservoir routing calculations and for detention facilities final design [2]. This method is based on the average rates of flows for some small increment of time during the hydrograph, producing the following approximation of the continuity equation

\[ 
\Delta t \left( \frac{2S_1 + S_2}{2} \right) - \left( \frac{2S_1 + S_2}{2} \right) = S_1 - S_2
\] (2)

Where:
- \( \Delta t \) is the time difference
- \( S_1 \) is the inflow
- \( S_2 \) the outflow

A reasonable estimate can often be made of \( O_2 \) and \( S_2 \), but the unknowns are \( S_1 \) and \( O_1 \). In order to step through time on the flow hydrograph, the equation may be reformulated as:

\[ 
\left( I_1 + I_2 \right) + \left( \frac{2S_1}{\Delta t} - O_1 \right) = \left( \frac{2S_1}{\Delta t} + O_1 \right)
\] (3)

The use of the Storage-Indication Method requires reliable description of the following three items [3]:

- An inflow runoff hydrograph.
- Determination of the relationships between Stage-Storage, which can be developed by successive calculations of storage vs. associated stages in the storage facility.
- Determination of the relationships between Discharge-Stage, it is based on the association of the reservoir stage (head) and the resulting outflow from the storage facility.

The basic equation for sharp-crested and broad-crested weirs, the most typically used weirs [4], is:

\[ Q = C_w L H^{1/2} \] (4)

Where:
- \( Q \) is the water flow rate, \( C_w \) discharge coefficient, \( L \) width of the weir, \( H \) height of the water over the weir.

In this example the storage values were computed by solving the broad-crested weir equation, assuming a constant discharge coefficient of 3.0, and weir length of 15 feet.

METHODOLOGY

The following flow chart shows the methods used in this project.

EXAMPLE SETUP

A hydrograph example to develop the routing process was taken from Austin Moore Hydrologic Calculator Version 1.2 model. Figure 2 shows the input screen and example from this model.

RESULTS

Model updates: The model will take into account other hydrologic abstractions like infiltration. Also, the tool will include screens for BMP cost and effectiveness. In addition we are planning test this tool by collecting data in a vegetated swale located in MSU South Farm.

FUTURE RESEARCH

REFERENCES