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MEMO

To: City of Middleton Water Resources Commission

From: Uriah Monday, PE, CFM and Eric Thompson, PE, CFM

Subject: Middleton Confluence Pond – Outlet Capacity Analysis

Date: July 7, 2009

Purpose

This memo documents the performance of the weir at the outfall of the Confluence Pond in the City of Middleton. In this analysis, the possible effects of tailwater in the reach downstream of the weir are considered.

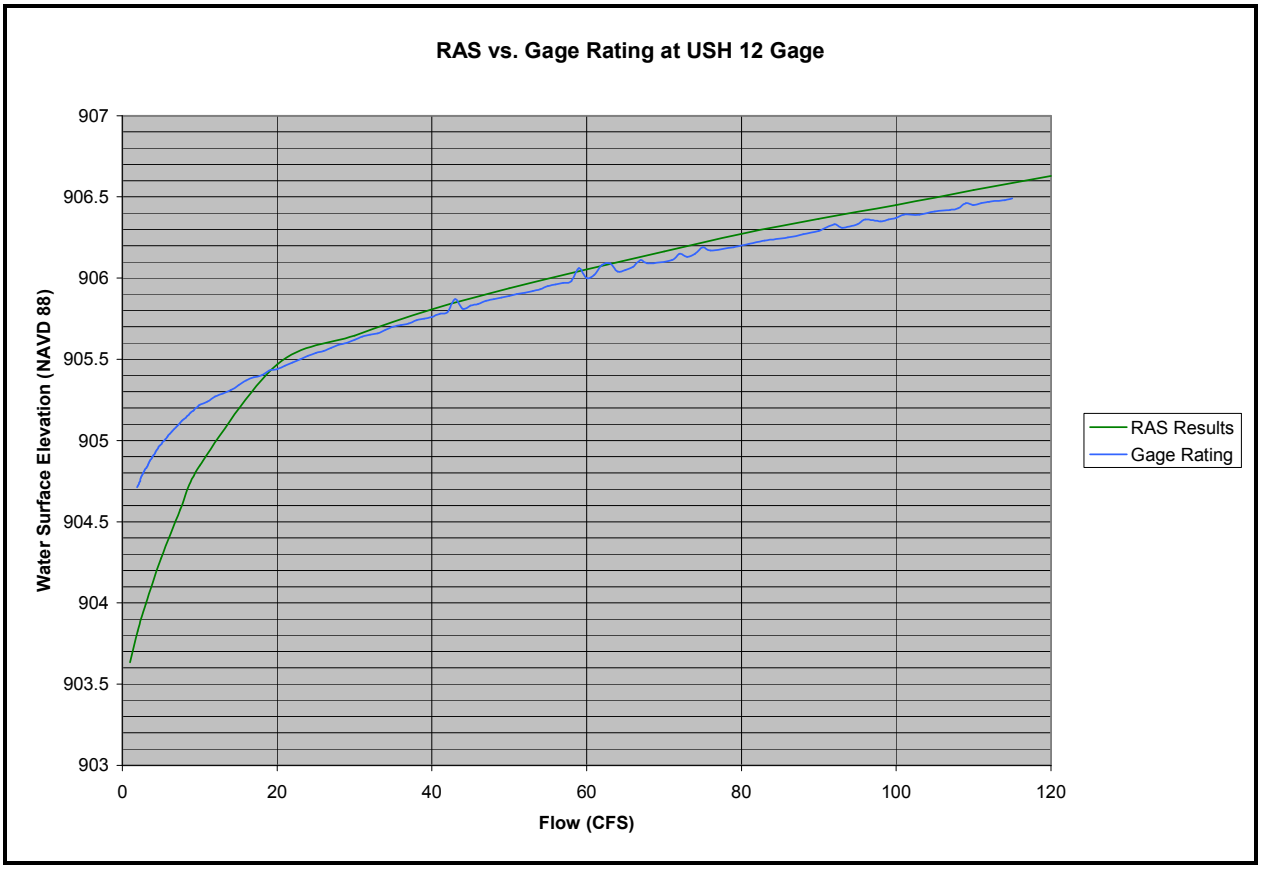
The water quality analysis of the confluence pond performed for the 2007 Storm Water Quality Plan used the DNR-approved WinDETPOND model. The WinDETPOND model, however, can only operate under the assumption that the V-notch weir had a free outfall uninfluenced by tailwater in the downstream channel. The presence of tailwater would decrease flows out of the pond for a given pond surface elevation, i.e. the outlet is essentially more restricted. This restriction increases the residence time of flows within the pond; in turn, this extended residence time allows more solids to settle out in the pond.

A V-notch concrete weir controls flows out of the Confluence Pond. The notch of the weir is set at elevation 907 and has a 120 degree opening angle. The notch is set two feet higher than the channel bottom. The notch is set in a one-foot-thick concrete wall which has a top elevation of 912. A sketch of the weir is attached to this memo.

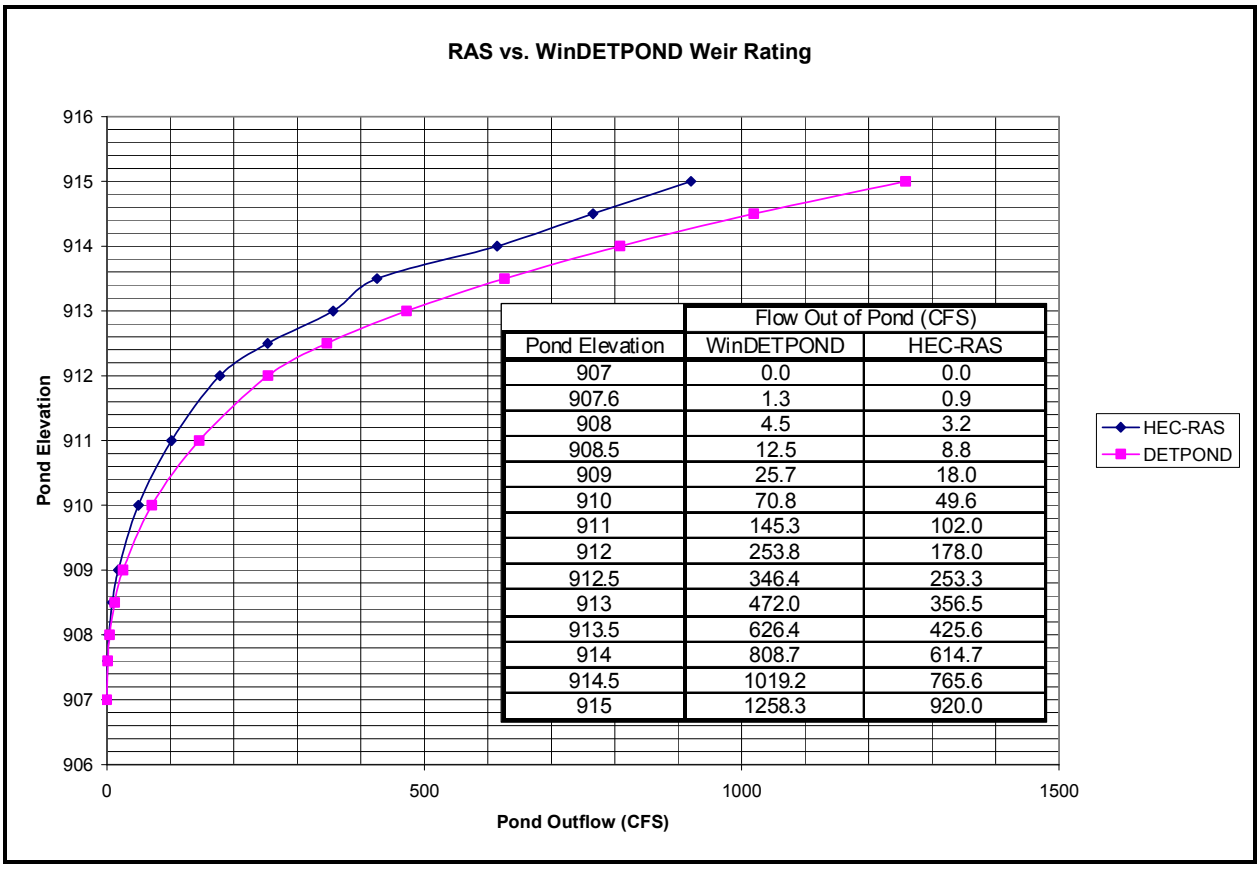
Methods

To assess the influence of tailwater on the pond's outlet, a HEC-RAS model of the downstream channel was constructed. This HEC-RAS model uses the same cross-section geometry data found in the XPSWMM model created by RS Grant Consulting for their 1999 design of the Confluence Pond, which is also the current regulatory FEMA model for floodplain along Pheasant Branch Creek. The RAS model output indicates that for flows

greater than 25 CFS, the tailwater in the stream exceeds elevation 907 and therefore begins to affect the weir. To verify that the HEC-RAS model generates elevations similar to actual observations, a comparison was made of the RAS results at the location of the USGS streamflow gage at USH 12 with actual results from the gage. The elevations compare favorably (within 0.1') for flow rates greater than about 20 CFS – see chart below.



Additionally, at flows less than 25 CFS, the weir takes on characteristics of a broad-crested weir (as opposed to sharp crested) due to the low ratio of the flow depth to weir thickness. When the pond exceeds elevation 912, the weir is overtopped. The higher flows resulting from the overtopping condition creates a much higher tailwater condition and restricts the outflow to an even greater extent. A graph is presented below which compares the elevation-outflow relationship of the RAS model vs. a weir with a free outfall condition (similar to that produced by the WinDETPOND model).



	Flow Out of Pond (CFS)	
Pond Elevation	WinDETPOND	HEC-RAS
907	0.0	0.0
907.6	1.3	0.9
908	4.5	3.2
908.5	12.5	8.8
909	25.7	18.0
910	70.8	49.6
911	145.3	102.0
912	253.8	178.0
912.5	346.4	253.3
913	472.0	356.5
913.5	626.4	425.6
914	808.7	614.7
914.5	1019.2	765.6
915	1258.3	920.0

Findings

The effects of the tailwater present in the downstream channel generally reduce the outlet capacity by about 25% to 30% compared to a free-outfall condition. The HEC-RAS hydraulic rating curve described above was entered into a P8 model of the confluence pond. The P8 model estimated a TSS reduction rate of 77.5%vs. the 58.2% previously indicated by the WinSLAMM model. The 2007 Storm Water Quality Plan was amended by replacing the WinSLAMM-reported reduction with the P8 model result. Note, however, that the loads originally reported in the 2007 document were left unchanged from the WinSLAMM results so as to maintain a constant point of comparison.

Source:

"Flood Control Plan for the Airport Road Business Park & South Fork Project."
R.S. Grant Consulting, Inc., 1999.

FIGURE 19

CONFLUENCE POND WEIR
AND OUTLET CHANNEL