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MEMORANDUM

To: Tawn Nugent
From: Katie Handley
Date: 9-10-2014
Subject: 211th Street H&H Analysis

Initially, the discharge and culvert sizing for RCBs 460+77, 609+25, and 624+50 was checked. The RCBs 609+25 and 624+540 were ran in HY-8 as the hydraulic analysis done in CulvertMaster was defaulting to outlet control when they were actually in inlet control. It was recommended to either lower the slope for RCBs 609+25 and 624+50 or provide outlet protection.

Both 460+77 and 609+25 were then analyzed for the 100-year storm event since they are located in a FEMA Zone A. The analysis showed a rise of 3.2 feet for the proposed 460+77 and a rise of 3.4 feet for the proposed 609+25. In order to reduce the rise with the proposed conditions, RCB 460+77 would need to be a 14'x4' or equivalent size and RCB 609+25 would need to be a 14'x5'. The overtopping was lowered so that the required size of RCB 460+77 decreased to an 8'x4'.

Re-analysis was completed due to a change in location for the Outer Road RCB to 463+46 and 609+25 was moved to 608+47. It was determined that 608+47 created a rise in the 100 year due to the increase in culvert length. The upstream flowlines of 608+47 and on 463+46 were lowered to reduce the rise. Headwater elevations were checked to make sure they were below the allowable headwater. The downstream flowline on RCB 624+50 was raised to reduce outlet velocities.

Next, analysis was completed to determine the outlet protection required for each RCB. For RCB 463+46, MoDOT's Rock Lining for Culvert Outlet standard was recommended with a minimum depth of 2.5 feet and a minimum width of 25 feet. It was recommended that the lining be extended to the culvert downstream. For RCB 608+47, a riprap apron was recommended with a

length of 50 feet and a downstream width of 34 feet, using MoDOT's Type 2 Rock Ditch Liner with a minimum thickness of 1.5 feet. For RCB 624+50, a riprap apron was recommended with a length of 62 feet and a downstream width of 37 feet using MoDOT's Type 3 Ditch Liner with a minimum thickness of 3 feet. Type 3 Ditch Liner requires the use of bedding material (609.60.2.5).

Another re-analysis was completed prior to sending information to SEMA. RCB 463+46 resulted in a design headwater of 980.6 with a rise of 0.9 feet in the 100 year. RCB 608+47 resulted in a design headwater of 978.6 with a rise of 0.8 feet in the 100 year. RCB 624+85 (RCB 624+50 moved east) resulted in a design headwater of 967.4.

An analysis of a broken-back pipe was completed for the storm sewer to determine the velocity in the pipe. The 18 inch concrete pipe with a discharge of 2.14 cfs resulted in reaching a velocity of 16 feet per second in the steep portion of the culvert.