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Memorandum

To:	**Gary Fromm, Carter & Burgess, Inc.**	**Date:**	**12/18/07**
From:	**David Phelps, (J2)**	**Project Number:**	**03.3045**
Re:	**Beardsley Road Connector – 60% Scour estimates for New River**	**CC:**	**files**

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Purpose

This technical memorandum is intended to document the hydraulic engineering analysis and scour estimates within the New River as part of the Beardsley Road Connector Project. The design and analysis is intended to support the 60% bridge and channel plans for this project. Details regarding New River hydraulics are provided in a separate memorandum.

Scour Analysis

The Middle New River Watercourse Master Plan (MNRWMP) provides adequate scour analysis for New River. The MNRWMP documents scour components and provides the 100-yr total scour in New River. For this reach of New River, the magnitude of the 100-yr scour is greater than lower flow condition scour magnitudes. As recommended by the MNRWMP, bank protection for this project will be designed to survive the expected 100-yr scour event. The expected magnitude of the 100-yr scour components for this reach (MNRWMP Sta 11.664 to Sta 12.420) of New River are reported in Table 1.

Table 1 - New River Scour components reported by MNRWMP

Scour Component	Existing Bed	Future MNRWMP Improvements
Long-term scour (ft)	1.52	1.25
General scour (ft)	0.84	0
Local scour at channel bank (ft)	3.50	3.00
Bend scour (ft)	0	0
Anti-dune trough (ft)	0	0
Low-flow thalweg (ft)	2.0	2.0
Safety factor (ft)	2.3	1.9
TOTAL SCOUR (ft)	Use 10.0 ft	Use 8.0 ft

The values reported above are taken into account when placing the bottom toe of the gabion bank protection on the 60% plans. Additionally, scour protection measures are measured from the low flow invert.

Scour at the proposed bridge is estimated in a similar manner. The local scour at the bridge piers and abutments is estimated using the CSU equation as documented in FHWA HEC18 and verified using the routines provided within HEC-RAS. Total scour at the bridge is determined by summing the various components of scour shown above, however, the safety factor is not applied. At the bridge, the total scour is determined to be equal to the sum of long term scour (Y_{LT}), general scour (Y_{GS}), local scour (Y_{LS}), bend scour (Y_{BS}), bed form scour (Y_{BF}), and low-flow channel incisement (Y_{LF}) or:

$$Y_{TOT} = (Y_{LT} + Y_{GS} + Y_{LS} + Y_{BS} + Y_{BF} + Y_{LF}) \times 1.0$$ and for this project:

10-yr $Y_{TOT} = (1.52 + 0.84 + 10.0 + 0 + 0 + 0) \times 1.0 =$ 12.4' (existing channel bed)

100-yr $Y_{TOT} = (1.52 + 0.84 + 14.0 + 0 + 0 + 0) \times 1.0 =$ 16.4' (existing channel bed)

500-yr $Y_{TOT} = (1.52 + 0.84 + 17.0 + 0 + 0 + 0) \times 1.0 =$ 19.4' (existing channel bed)

where $Y_{LF} = 0$ when scour elevations are measured from the invert of the low flow channel.

The bridge deck and all foundation supports (piers, abutments and foundation) are required to survive a 500-yr event. As shown above, the 500-yr event develops the deepest scour hole at the bridge piers. As such, the following 500-yr scour data is provided in Table 2.

Table 2 - Total 500-yr scour values for the proposed Beardsley Road Bridge at New River

Scour Component	Existing Bed	Future MNRWMP Improvements
Long Term Scour (ft)	1.52	1.25
General Scour in river (ft)	0.84	0
Local Scour at piers (ft)	17.0	15.5
Bend Scour (ft)	0	0
Bed Form (ft)	0	0
TOTAL Scour Depth (ft)	Use 20-ft	Use 17-ft
500-yr Scour Elevation (ft)	1221.0	1223.0

The scour depths and elevations reported above incorporate the physical elements of the proposed bridge shown on the 60% plans. In particular, the 60% bridge design shows two sets of three piers per set supporting the bridge deck. The pier shape consists of 3'x7' oval above ground and an 8' diameter drilled shaft below ground. The recommended elevation for the top of the drilled shaft / bottom of oval shape is elev. 1237 (controlling elevation, four feet below the existing channel invert of 1241).

Conclusion

For the configuration of the Beardsley Road Bridge, the placement and shape of the abutment and foundation does not affect the potential scour depth. However, the scour hole at the bridge piers can move laterally. Therefore it is recommended that the bridge abutment foundation be self supporting at the same elevation as the bridge piers. The recommended self supporting elevation for the bridge piers and abutment foundations is 1221. This allows the bridge foundations to survive the expected 500-yr scour event.

David T. Phelps, P.E.