DATE: 10-19-11

SUBJECT: Bunker Hill Road Crossing on W140-01-00

This memo summarizes the geometry and hydraulics of the original and current Bunker Hill Bridges over W140-01-00 (Briar Branch Creek). Items discussed include the original geometry of the Bunker Hill Bridge, current geometry of the Bunker Hill Bridge, hydraulics of the bridges, and a summary.

Analysis Summary
TCB Inc. analyzed the bridge hydraulics in the Bunker Hill Road Drainage Design and Hydrologic and Hydraulic Impact Analysis Report in May 2007. This project utilized and built upon the FEMA Effective model. The TCB Inc. study demonstrated no impact to the 100-year and 10-year water surface elevations and to the adjacent community. This impact analysis report was reviewed and approved by the appropriate regulatory agencies.

The following table summarizes the hydraulic data for the original and current crossings.

<table>
<thead>
<tr>
<th></th>
<th>Original Structure</th>
<th>Current Structure</th>
<th>Delta Current-Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-YR Flow at Upstream Bridge in RAS Model</td>
<td>515</td>
<td>515</td>
<td>0</td>
</tr>
<tr>
<td>100-YR WSEL Upstream (US)</td>
<td>79.02</td>
<td>78.54</td>
<td>-0.48</td>
</tr>
<tr>
<td>Top of Bridge/Headwall Elevation</td>
<td>79.82</td>
<td>79.25</td>
<td>-0.57</td>
</tr>
<tr>
<td>Bottom of Structure (Flowline)</td>
<td>69.44</td>
<td>66.11</td>
<td>-3.33</td>
</tr>
<tr>
<td>Structure Depth from Bridge Deck (ft)</td>
<td>8.8</td>
<td>12.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Open Area (SF) Below Bridge</td>
<td>112.0</td>
<td>84.0*</td>
<td>-28.0</td>
</tr>
<tr>
<td>Manning’s n Roughness</td>
<td>0.040</td>
<td>0.015</td>
<td>-0.025</td>
</tr>
</tbody>
</table>

Table 1: Comparison of Bridge Hydraulic Data

*Note: Open area = 84 square feet (12” steel pipe encasement runs through the culvert reducing the surface area from 94 square feet).
The 2007 TCB Inc. impact analysis was based on the following geometric hydraulic conditions for the original and current structures:

**Original Bunker Hill Road Bridge**
- Timber construction
- Earthen channel with broken concrete
- Open area = 112 square feet*
- Roughness coefficient (Manning’s n value) = 0.04

*See Attachment 1 for original surveyors drawing of bridge.

**Current Bunker Hill Road Bridge**
- (2)-7’x7’ concrete box culverts
- Efficient entrance and exit headwall
- Open area = 84 square feet (12” steel pipe encasement runs through the culvert reducing the surface area from 94 square feet)
- Roughness coefficient (Manning’s n value) = 0.015

**Summary**
1. The current structure is reduced in size relative to the original structure, but is significantly more efficient. The increased efficiency is achieved through the smooth concrete finish and the lower opening depth of the current structure.

2. The current structure was modeled as part of the impact analysis for the Bunker Hill Roadway improvements and was determined to have no impact. This impact analysis report was reviewed and approved by the appropriate regulatory agencies.