List of Meeting Materials
Complete Streets Implementation Team
Meeting #16

Wednesday, April 7, 2021, 3:00 pm

Microsoft Teams

Agenda ......................................................................................................................... page 2

Street types (graphics and table) .................................................................................. 3

Comment log ................................................................................................................ 8

Draft minutes of March 3 CSIT meeting .................................................................... 18

Draft minutes of March 9 CSIT meeting .................................................................... 29

Draft of Design Manual Volume III Chapter 4,
Design of Bridges, Retaining Walls and Small Structures .......... following page 40

(a copy of Chapter 4 with changes tracked is attached as a separate file)
Agenda
Complete Streets Implementation Team
Meeting #16

Wednesday, April 7, 2021, 3:00 pm
Microsoft Teams

Introduction, roll call, agenda review.................................................................3:00

New street types ..............................................................................................3:05

Chapter 4: bridges and structures.................................................................4:15

Comment log (as time permits)........................................................................4:30

Next steps............................................................................................................4:50

• Second part of this CSIT meeting: Friday, April 9, 2021 at 1:00 pm
  o Additional time to review comment log, as needed
  o Performance measure tracking/annual report
  o Scheduling of upcoming meetings

• Action items from this meeting

Adjourn ............................................................................................................5:00
<table>
<thead>
<tr>
<th>Street Type</th>
<th>Typical Section(s)</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| **Boulevard**                   | **Mix-Use/Higher Density Areas**  • 4-Lane Divided Roadway  •  Grass Median/Center Turn Lane  •  Separated Bikeways  •  Sidewalks*  •  Parking/No Parking Options  
*Sidewalks could be extended beyond the right of way to the building line, allowing for street furniture, restaurant seating, etc. |         |
| **Town Center Connector**       | **Mix-Use/Higher Density Areas**  • 3-Lane Roadway  •  Center Turn Lane  •  Separated Bikeways  •  Sidewalks*  •  Parking/No Parking Options  
*Sidewalks could be extended beyond the right of way to the building line, allowing for street furniture, restaurant seating, etc. |         |
| **Town Center Street**          | **Mix-Use/Higher Density Areas**  • 2-Lane Roadway  •  Separated Bikeways  •  Sidewalks*  •  Parking/No Parking Options  (Curb extensions could be provided with parking)  
*Sidewalks could be extended beyond the right of way to the building line, allowing for street furniture, restaurant seating, etc. |         |
| **Neighborhood Yield Street**   | **Residential Areas**  •  Two-Way Traffic  •  Low Volume  •  Shared Lane  •  Sidewalk  •  On-Street Parking  •  Curb-to-Curb Width Based on Guidance in Current Design Manual:  
  o 24' curb to curb in lower density areas  
  o 26' curb to curb in medium density areas  
  o 28' curb to curb in higher density areas |         |
<table>
<thead>
<tr>
<th>Street Type</th>
<th>Typical Section(s)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parkway</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Density Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4- or 6-Lane Divided Roadway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass Median/Center Turn Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared Use Paths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Parking</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neighborhood Connector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential and Commercial Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Lane Roadway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center Turn Lane Interspersed with Raised Medians</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared Use Paths (≥ 35 mph)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking/No Parking Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neighborhood Street 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential and Commercial Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Lane Roadway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffered Bike Lanes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidewalks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking/No Parking Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighborhood Street 2</td>
<td>[Comments]</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>• Residential and Commercial Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 2-Lane Roadway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Shared Use Path</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sidewalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking/No Parking Options</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighborhood Yield Street</th>
<th>[Same as in mixed use areas]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Type</td>
<td>Typical Section(s)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Alley</td>
<td>• Countywide&lt;br&gt;• 1-Lane Driveway/Garage Access&lt;br&gt;• Shared Lane&lt;br&gt;• No Sidewalk&lt;br&gt;• No On-Street Parking&lt;br&gt;• Private</td>
</tr>
<tr>
<td>Industrial Street</td>
<td>• Industrial Areas&lt;br&gt;• Marked Center Line&lt;br&gt;• Shared Use Path&lt;br&gt;• Sidewalk&lt;br&gt;• Flexible Configuration&lt;br&gt;  o 40' curb to curb&lt;br&gt;  o Could be striped as two lanes with outside used for parking (shown)&lt;br&gt;  o Could be striped as three lanes if needed</td>
</tr>
<tr>
<td>Country Road</td>
<td>• Outside PSA&lt;br&gt;• Collector&lt;br&gt;• 2-Lane Roadway&lt;br&gt;• On-Road Bike Lanes&lt;br&gt;• No On-Street Parking</td>
</tr>
<tr>
<td>Rural Development Street</td>
<td>• Outside PSA&lt;br&gt;• Local&lt;br&gt;• 2-Lane Roadway&lt;br&gt;• Shared Lane&lt;br&gt;• No On-Street Parking</td>
</tr>
</tbody>
</table>
### Howard County Complete Streets

#### Street Types FOR NEW CONSTRUCTION

- **DRAFT**
- **April 5, 2021**

<table>
<thead>
<tr>
<th>Type</th>
<th>ROW Width</th>
<th>Center Turn Lane/Median (gutter pan+curb+grass)</th>
<th>Inside Travel Lane*</th>
<th>Outside Travel Lane</th>
<th>Shoulder/Offset from Curb</th>
<th>Parallel Parking</th>
<th>On-Street Bike Lane</th>
<th>Tree Zone***</th>
<th>Separated Bike Lane</th>
<th>Sidewalk</th>
<th>Shared Use Path (SUP)</th>
<th>Carrying Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulevard</td>
<td>114'</td>
<td>10'/18'</td>
<td>10' **</td>
<td>11'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>35-40k</td>
</tr>
<tr>
<td>Boulevard No Parking</td>
<td>98'</td>
<td>10'/18'</td>
<td>10' **</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>35-40k</td>
</tr>
<tr>
<td>Town Center Connector</td>
<td>86'</td>
<td>11'</td>
<td>N/A</td>
<td>11'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>&lt;20k</td>
</tr>
<tr>
<td>Town Center Connector No Parking</td>
<td>70'</td>
<td>11'</td>
<td>N/A</td>
<td>10' **</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>&lt;20k</td>
</tr>
<tr>
<td>Town Center Street</td>
<td>78'</td>
<td>N/A</td>
<td>N/A</td>
<td>10.5'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Town Center Street No Parking</td>
<td>64'</td>
<td>N/A</td>
<td>N/A</td>
<td>11'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>6.5'</td>
<td>5' min. (2 sides)</td>
<td>N/A</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Parkway (6-lane)</td>
<td>124'</td>
<td>10'/18' min.</td>
<td>11' **</td>
<td>11'</td>
<td>1'</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>10' (2 sides)</td>
<td>?</td>
</tr>
<tr>
<td>Parkway (4-lane)</td>
<td>114'</td>
<td>10'/30'</td>
<td>11'</td>
<td>11'</td>
<td>1'</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>10' (2 sides)</td>
<td>35-40k</td>
</tr>
<tr>
<td>Neighborhood Connector</td>
<td>86'</td>
<td>11'/11'</td>
<td>N/A</td>
<td>11'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>10' (2 sides)</td>
<td>&lt;20k</td>
</tr>
<tr>
<td>Neighborhood Connector No Parking</td>
<td>70'</td>
<td>11'/11'</td>
<td>N/A</td>
<td>10' **</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>10' (2 sides)</td>
<td>&lt;20k</td>
</tr>
<tr>
<td>Neighborhood Street 1</td>
<td>78'</td>
<td>N/A</td>
<td>N/A</td>
<td>10'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (2 sides)</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Neighborhood Street 1 No Parking</td>
<td>64'</td>
<td>N/A</td>
<td>N/A</td>
<td>10'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (2 sides)</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Neighborhood Street 2</td>
<td>72'</td>
<td>N/A</td>
<td>N/A</td>
<td>10.5'</td>
<td>N/A</td>
<td>7' **</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (1 side)</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Neighborhood Street 2 No Parking</td>
<td>60'</td>
<td>N/A</td>
<td>N/A</td>
<td>11' **</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (1 side)</td>
<td>&lt;12k</td>
</tr>
<tr>
<td>Neighborhood Yield Street</td>
<td>50'</td>
<td>N/A</td>
<td>N/A</td>
<td>11'/12'/13' **</td>
<td>N/A</td>
<td>flexible</td>
<td>N/A</td>
<td>6'/6'/5'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (2 sides)</td>
<td>200/1k/2k</td>
</tr>
<tr>
<td>Alley</td>
<td>24'</td>
<td>N/A</td>
<td>N/A</td>
<td>10'</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>local</td>
</tr>
<tr>
<td>Industrial Street</td>
<td>76'</td>
<td>N/A</td>
<td>N/A</td>
<td>12'</td>
<td>N/A</td>
<td>flexible</td>
<td>N/A</td>
<td>6'</td>
<td>N/A</td>
<td>N/A</td>
<td>5' (1 side)</td>
<td>10-15k</td>
</tr>
<tr>
<td>Country Road</td>
<td>60'</td>
<td>N/A</td>
<td>N/A</td>
<td>12'</td>
<td>8'</td>
<td>N/A</td>
<td>shoulder</td>
<td>10'</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Rural Development Street</td>
<td>50'</td>
<td>N/A</td>
<td>N/A</td>
<td>12'</td>
<td>N/A</td>
<td>flexible</td>
<td>N/A</td>
<td>13'</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>local</td>
</tr>
</tbody>
</table>

* Against center line; ** One foot gutter pan not included in this dimension; ***Dimension measured from back of curb to sidewalk/SUP
<table>
<thead>
<tr>
<th>#</th>
<th>Chapter</th>
<th>Section</th>
<th>Date</th>
<th>Comment by</th>
<th>Comment</th>
<th>Status</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>-</td>
<td>11/12/2020</td>
<td>White</td>
<td>Thank you for sharing this. Because we are in the early stages of the design manual review it is a perfect time for CSIT to discuss the review process. Is it possible for us to add this to the agenda for December, if time allows? I highly encourage us to start off creating a master comment sheet early in this process. The design manual is a critical document and providing an opportunity for CSIT to provide input on how to standardize the review may be helpful. Plus, this may assist stakeholders in sharing their feedback. For us, having the process flushed out concretely will be helpful as we prepare feedback.</td>
<td>Resolved</td>
<td>Process and schedule presented at December 2020 CSIT meeting</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>-</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Change &quot;will&quot; to &quot;shall&quot; throughout</td>
<td>Resolved</td>
<td>Changed &quot;will&quot; to &quot;shall&quot; in all cases except where (1) the distinction is not important or (2) &quot;will&quot; is consistent with other approved documents</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1.1</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>The map graphic in the introduction section 1.1 (pg. 4) is too small to read.</td>
<td>Resolved</td>
<td>The graphic has been rotated and enlarged, and a caption has been added to clarify that this is simply an illustration rather than the map that will be used to identify specific project locations</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>I've seen other manuals include NACTO. I've also seen others give a complete list. Should we?</td>
<td>Parked</td>
<td>To consider as the CSIT works through subsequent chapters</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>3rd paragraph, last sentence: What about places where they contradict, or where one is stricter than another. In accordance with CS policy, priority should always be given to vulnerable users.</td>
<td>Resolved</td>
<td>Text has been modified</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>4th paragraph, &quot;intended to guide&quot;: Are minimum requirements for,... Also, add a sentence, perhaps in the next paragraph with the &quot;restrict&quot; concept, that designers are encouraged to go beyond the minimum requirements to reflect current best practices that achieve safe, efficient, etc. (see first paragraph).</td>
<td>Resolved</td>
<td>In some cases the Manual is a standard, and in others it is guidance, so changing this text to &quot;minimum requirements&quot; is not necessarily accurate. The recommended sentence has been provided in the following paragraph.</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;Howard County Complete Streets Design Manual&quot; should be the title of the document.</td>
<td>Resolved</td>
<td>The title has been modified</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>5th paragraph: What does &quot;economical&quot; mean? I wouldn't want this to mean cutting scope.</td>
<td>Resolved</td>
<td>Removed the word economical; it now reads &quot;innovative and practical designs&quot;</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1.1 A</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Consolidate benefits, potentially combining with 1.1 D</td>
<td>Resolved</td>
<td>Benefit text has been compressed and moved to the policy section</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1.1 C</td>
<td>11/4/2020</td>
<td>CSIT</td>
<td>Last paragraph: Does the VPI system apply to developers? If so, clarify how and where applicability will be described.</td>
<td>Resolved</td>
<td>The VPI system does not apply to developers.</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1.1 E</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;enacted November 24, 1975&quot;: Weren't there later revisions? If so, at least mention. Won't this version be adopted by the Council? If so, leave a placeholder here.</td>
<td>In process</td>
<td>DPW will verify dates of DM updates and appropriate legal language to use here</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1.1 F</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;Transportation projects&quot; should be &quot;All projects that impact transportation shall be developed in accordance with the Complete Streets Policy and developed in accordance with processes outlined therein. Such projects...&quot;</td>
<td>Parked</td>
<td>Text will be added to the Design Manual that notes that coordination occurs internally without going into exact specifics. The CSIT will discuss the internal DPW coordination process at a future meeting.</td>
</tr>
<tr>
<td>#</td>
<td>Chapter</td>
<td>Section</td>
<td>Date</td>
<td>Comment by</td>
<td>Comment</td>
<td>Resolution</td>
<td>Status</td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
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<td>------------</td>
<td>------------</td>
<td>---------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>1.2</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;are divided into&quot; should be &quot;consist of&quot;</td>
<td>Resolved</td>
<td>Changed text</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>1.2</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;privately funded&quot; should be &quot;funded by the developer, which is often a private entity&quot; LS: Wanting to include federal, state and local gov't. projects.</td>
<td>Resolved</td>
<td>Changed text</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1.2 C</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>If there is ever a time when a capital project needs to be pursued outside of the capital budget process, does it also undergo the scoring process? If so does that set off a new priority ranking of previously ranked projects? Some capital projects are budgeted across multiple years. Do they need to be scored again against new projects every budget cycle? If so is it possible for a low scoring project to be continuously bumped as a result?</td>
<td>Resolved</td>
<td>Capital projects are never pursued outside of the capital budget process except in case of emergency. Proposed projects will always go through the TIPS scoring process. Once a high-scoring proposed improvement is included in the budget as a capital project, it generally stays in the budget through design and construction and is not re-scored. Emergency projects do not go through the capital projects but they are also exempt from the TIPS scoring process.</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>1.2 C</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;Project Prioritization&quot; should be &quot;Project Prioritization for Capital Projects&quot;</td>
<td>Resolved</td>
<td>Changed text</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>1.2 C</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;capital transportation projects&quot; should be &quot;capital projects&quot;; all projects should be included</td>
<td>Resolved</td>
<td>Changed text</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>1.2 C</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;transportation projects when funding is available to do so&quot; should be &quot;transportation goals&quot;; LS: I believe this more accurately reflects the Policy. The Policy doesn't limit it to transportation projects, and doesn't discuss funding limitations at all - simply gives sources of funding.</td>
<td>Resolved</td>
<td>The TIPS process will be utilized based on funding availability, and the TIPS process only applies to capital transportation projects; all text here is consistent with the TIPS process approved by the CSIT</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>1.2 C</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Second paragraph, second sentence: strike &quot;transportation&quot;</td>
<td>Resolved</td>
<td>The TIPS process only applies to capital transportation projects all text here is consistent with the TIPS process approved by the CSIT</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>1.2 C</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Second paragraph, third sentence: strike &quot;transportation&quot;</td>
<td>Resolved</td>
<td>The TIPS process only applies to capital transportation projects all text here is consistent with the TIPS process approved by the CSIT</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>1.2 E</td>
<td>11/11/2020</td>
<td>Rigby</td>
<td>Thank you! I really appreciate that the Office of Transportation and MMTB are involved in the decision-making process for exceptions to the Complete Streets policy.</td>
<td>Resolved</td>
<td>Noted</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>1.3</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>Section 1.3 Street Types would be an appropriate place to include a section for street cross sections rather than in chapter two or in the Volume IV of the design manual. They should at least be presented here in concept to identify all the items that should be considered for the various street types and conceptually where they should be located. Perhaps the numerous and specific cross section types could be in the specific design sections but their introduction should be in 1.3.</td>
<td>Resolved</td>
<td>Typical sections will be included in one location (Design Manual Volume IV) and will be cross-referenced in Chapter 1 and/or Chapter 3. Chapter 1 and/or Chapter 3 may also include an example of a typical section so long as it is clear that Volume IV governs.</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>1.3</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>Section 1.3 should also include a section of intersection elements and transitions to those intersection elements, at least to identify the elements that need to be considered for complete street intersections. Currently, the whole design manual has intersection design based on Level of Service but complete streets pulls in other competing elements and weights the importance of those competing elements with a renewed emphasis.</td>
<td>Parked</td>
<td>Intersections will be addressed in Chapters 3 and 5</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>1.3 A</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>Land Use Context - a reference or example should be included with a reference and description of where you can find the latest land use map so that you don’t have to revise the manual every time the land use map changes.</td>
<td>In process</td>
<td>The team is working with DPZ to advance this issue</td>
</tr>
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<tr>
<td>25</td>
<td>1</td>
<td>1.3 A</td>
<td>11/11/2020</td>
<td>Rigby</td>
<td>Considering the push for a Code rewrite and the anticipated updates to the Code, zoning regulations, and General Plan, how will we ensure that the design manual is adaptable to future changes?</td>
<td>In process</td>
<td>The team is working with DPZ to advance this issue</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>1.3 B</td>
<td>11/4/2020</td>
<td>CSIT</td>
<td>Split collectors into major and minor</td>
<td>In process</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>1.3 B</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Add to first paragraph: &quot;The classifications are historically based on a hierarchy from the Federal Highway Administration and are primarily focused on motor vehicle throughput. Requirements that facilitate multi-modal access on each type of street are covered in later chapters of this Manual.&quot;</td>
<td>In process</td>
<td>The team is developing language to clarify that functional classification is about mobility and access for all road users</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>1.3 C</td>
<td>11/10/2020</td>
<td>Schoen</td>
<td>Typology - Many streets will transition throughout their length to various categories and land use context. How will DPW determine what land use context to use? This is a policy document and the policy for this very likely occurrence should be spelled out.</td>
<td>In process</td>
<td>To discuss during January CSIT meeting through looking at case studies</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>1.3 D</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Please address requirements for land developments when there is an opportunities projects to create a connection NOT shown on the current Bike Howard plan. This was discussed in the 11/4/20 meeting.</td>
<td>Parked</td>
<td>Revisit this conversation once case studies are reviewed</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>1.3 E</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>&quot;low traffic volumes&quot; should be &quot;low motor vehicle traffic volumes and often have no facilities for pedestrians or bicycles&quot;</td>
<td>Resolved</td>
<td>Changed text</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>1.3 E</td>
<td>11/12/2020</td>
<td>Schoen</td>
<td>Point 1: Here is what it says: Protecting scenic character. Scenic roads may be altered to make necessary safety, access, drainage, or road capacity improvements, including improvements to meet the requirements of the adequate public facilities act (title 16, subtitle 11) or to install pull-offs or utility, water or sewage systems. Projects which alter the appearance of a scenic road, including maintenance, capital projects and improvements required through the subdivision or development process, shall be designed to protect to the maximum extent possible the features of the road right-of-way that contribute to the scenic character of the road.</td>
<td>Parked</td>
<td>This quote is from Section 16.1404, which speaks to Alterations to scenic road rights-of-way. As stated by Councilwoman Rigby, Section 16.125(c)(4) reference the design standards and &quot;protection of scenic roads.&quot; Revisit the cross references in this section after the section is fully developed and proposed typologies are applied to areas with a scenic overlay.</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>1.3 E</td>
<td>11/11/2020</td>
<td>Rigby</td>
<td>Would it be helpful to also reference Section 16.125 of the County Code, which pertains to protection of scenic roads? Section 16.125(c)(4) permits limited use of multi-use pathways within scenic roads buffers, which may be relevant to any complete streets improvements along scenic roads.</td>
<td>Parked</td>
<td>Current draft mentions Section 16.1403 which gives Council the power to designate scenic roads. Section 16.125(c)(4) references the design standards and &quot;protection of scenic roads.&quot; Revisit the cross references in this section after the section is fully developed and proposed typologies are applied to areas with a scenic overlay.</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>1.4 B</td>
<td>11/10/2020</td>
<td>Russell</td>
<td>4th bullet wording is confusing. That &quot;were studied?&quot; That &quot;are to be studied?&quot; Does not make sense.</td>
<td>Resolved</td>
<td>Changed to &quot;that were studied&quot;</td>
</tr>
</tbody>
</table>
| 34 | 1        | 1.1 C-D | 12/21/2020 | White      | Benefits of Complete Streets & Complete Streets Policy
This section should quote Howard County's Complete Streets Policy. It references the resolution, number and then a short list of benefits. While we understand the intent may be to incorporate the policy into individual chapters, it would be helpful to include it here at the beginning of the Guide, such as Section 1: Vision, and Section 2: Scope. This would be a helpful foundation to have at the beginning of the Design Manual. | In process      |                                                                           |
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</table>
| 35 | 1       | 1.2 D   | 12/21/2020 | White      | Community Engagement Plan  
This section states that one purpose of community engagement is to develop public support for projects. We recommend revising this. The purpose of community engagement is to give voice to all users of the transportation system who may be impacted by a project, and not to "sell" the project. Engagement should include non-traditional outreach methods to reach people who are often left out of the process and are not able or likely to attend public meetings. | In process   |                               |
| 36 | 1       | 1.3 B   | 12/21/2020 | White      | Transportation Classification  
This section needs to provide a functional classification system that is not solely focused on motor vehicles. This section adopts the traditional Functional Classification System (FCS) - arterials, collectors and local streets that was developed in the 1970's. This older FCS is widely viewed as outdated. A range of shortcomings have been identified in using the older FCS, including the lack of differentiation in the suburban and urban context, which is particularly impactful in Howard County (see NCHRP Research Report 855 for more information on the shortcomings of the FCS). We would like to highlight that the current text in Section 1.3B does not acknowledge pedestrians, bicyclists or transit.  
An important aspect of a Complete Streets Design Manual is to provide a new functional classification overlay that acknowledges and responds to land use, and defines how these street types function for all users, including pedestrians, bicyclists, transit users, and motor vehicles.  
Complete streets guidelines replace or overlay the outdated FCS with new classes. Below are a few examples in Maryland:  
- Gaithersburg Street Design Standards. This includes nine street types including Mixed Use Boulevards, Park Boulevards, Main Street, Neighborhood Residential, Shared Streets, Alleys, Frontage Roads, Commercial Service Roads, and Commercial Thoroughways.  
- Prince George's County Urban Street Design Guidelines. This includes six street types for urbanized areas – Mixed Use Boulevards (2, 3, and 4 lane options), Neighborhood Connector, Neighborhood Residential, Industrial Road, Shared Street and Alley.  
- Montgomery County Complete Streets Design Guidelines (draft). This includes twelve different street types, and is responsive to urban, suburban and rural contexts.  
If it is not the intent for us to develop a new functional classification system, this manual should acknowledge the shortcomings of the arterial/collection/local FCS, and should set the stage for a new FCS in Howard County. It should also use care in relating the older system to the wide variety of road types and land uses that each category may represent, and should define needs of pedestrians, bicyclists, and transit users within the context of each roadway type. | In process   |                               |
| 37 | 1       | 1.4 B   | 12/21/2020 | White      | Content of Report  
This section is focused on motor vehicles and does not address the types of information needed to evaluate safety and accessibility impacts for vulnerable users. Since most developers are familiar with the County's process of evaluating traffic impacts and less familiar with how to evaluate pedestrian, bicycle and transit user impacts, it would be beneficial to elaborate on those types of evaluations in this section. | In process   |                               |
<p>| 38 | Street Types | General  | 2/8/2021   | White      | The cross sections should match the street types. It is difficult to review since we have yet to settle on street types. While we are considering a hybrid of functional and descriptive, grouping Commercial, Industrial and Lower Density Residential are different types of land uses and should not be in one category. | Ready for discussion | Updated for March CSIT meeting. |</p>
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<tr>
<td>39</td>
<td>Street Types</td>
<td>2/8/2021</td>
<td>White</td>
<td>For any wider road like the Intermediate Arterial, people riding bicycles need separation from high speed traffic. These are four lane roads and traffic will undoubtedly be higher. One option should show separated bike lanes. The other option should show shared use paths and no bike lanes (shared use paths + bike lanes is too much). The decision between these two options is mainly based on frequency of pedestrian use. For example, in a residential area where pedestrian use is more frequent, separation is needed between pedestrians and bicyclists. The separated bike lane can either be two-way on one side, or one way on each side depending on site conditions and other constraints.</td>
<td>Ready for discussion</td>
<td>Typical sections have been revised to show shared use paths in suburban areas (with lower pedestrian volumes) and separated bike lanes in mixed use areas (where higher pedestrian volumes can be expected).</td>
</tr>
<tr>
<td>40</td>
<td>Street Types</td>
<td>2/8/2021</td>
<td>White</td>
<td>The cross sections for these categories show bike lanes directly adjacent to travel lanes. This design should not be an option, as it will require bicyclists to operate adjacent to fast traffic. These bike lanes are not likely to be used because they will be uncomfortable for anyone other than experienced bicyclists. For that reason, this design is no longer recommended in the AASHTO Bike Guide. Both cross section options in each category should include separated bike lanes. One should be a two-way separated bike lane on one side of the street, and the other should be separated bike lanes on both sides of the street.</td>
<td>Ready for discussion</td>
<td>The current AASHTO Bike Guide, FHWA Bikeway Selection Guide, and LTS guidance all incorporate bike lanes adjacent to travel lanes where speeds are lower. Street types where higher speeds are expected have been revised to include shared use paths or separated bike lanes.</td>
</tr>
<tr>
<td>41</td>
<td>Street Types</td>
<td>2/8/2021</td>
<td>White</td>
<td>Unless these streets are designed for an operating speed of 20 mph or less, a separated bike lane will be needed. If an option without a bicycle facility is provided, it should be made clear that geometric design measures must be taken to ensure operating speeds are low.</td>
<td>Ready for discussion</td>
<td>The FHWA Bikeway Selection Guide and LTS guidance permit conventional or buffered (not separated) bike lanes at speeds higher than 20 mph.</td>
</tr>
<tr>
<td>42</td>
<td>Street Types</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>I don't see a typical section for when you have a shared use pathway on only one side of the road in the different land use contexts. I would imagine such a configuration could require a wider pathway than a section that shares volume on both sides of the roadway.</td>
<td>Ready for discussion</td>
<td>The current sections are designed for new construction. In retrofit situations, provisions will be made in the Design Manual for a single shared use path where land use or constraints dictate.</td>
</tr>
<tr>
<td>43</td>
<td>Street Types</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>Also related to the potential need for wider sidewalk scenarios: the inclusion of street furniture (post office boxes, benches, bike parking, cafe/outdoor seating), areas where you want a double row of trees/promenade, etc.</td>
<td>Ready for discussion</td>
<td>Mixed use street types provide very wide space between the building face and the curb to allow for a variety of uses.</td>
</tr>
<tr>
<td>44</td>
<td>Street Types</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>No typical sections that put bikes/peds/or transit in a wide median or central promenade (either as a wide park-like boulevard or retrofit of wider median) That is a fairly typical design for providing open space in urbanizing mixed use areas, especially given that HoCo has really wide existing roads.</td>
<td>Ready for discussion</td>
<td>This is a good topic for discussion. The principal concern with shared use paths in medians is the fact that drivers don't expect people walking or bicycling in the median at intersections.</td>
</tr>
<tr>
<td>45</td>
<td>Street Types</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>I'm not sure if the typical sections is the appropriate place to put this but I think the design manual needs to address implementation/construction that on construction plans a note needs to be added to the effect that&quot; stripping of lanes shall begin with the bike lane and bike lane buffer to ensure striped widths match the plan then move towards vehicular traffic lanes.&quot; Reason being that I find contractors often start with the inside vehicular lanes and every lane they are ever so slightly off the mark and those inches add up to squeeze the bike lane from the designed width to instead be too skinny. Any room for error or variance should not come at the expense of the bike facilities.</td>
<td>Parked</td>
<td></td>
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<tr>
<td>46</td>
<td>Street Types</td>
<td>General</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>The utility zone is variable in these sections. The consultant should study exactly what is permitted and expected in the utility zone, the clearances needed between utilities and see what width utility zone is necessary. Also, is it OK to plant trees and light pole and foundations in the same zone over the utilities? Has consideration been made to allow the &quot;utility zone&quot; under the Shared use Path in addition to the Tree zone?</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>47</td>
<td>Street Types</td>
<td>General</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>Intersections are critical for bikeways. The cross sections are good for the linear part of the road but transitioning to the intersections where turning movements are introduced, multiple turning lanes, free right turns, additional capacity lanes, possible lane width changes and the like need to be considered. Perhaps typical sections at intersections and how the standard cross section transitions to the intersection cross section should be considered</td>
<td>Parked</td>
</tr>
<tr>
<td>48</td>
<td>Street Types</td>
<td>General</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>There are no dimensions on any of the cross sections. - Please ensure that &quot;tree/utility zone&quot; is a min 6' width. - Median/turn lanes should show width so that we can plan for the total ROW required. - Total minimum ROW width for typical sections should be shown in cross section. Are sidewalks considered in the public ROW or private? Building setbacks are measured from ROW line so important to know ROW width to plan for setbacks.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>49</td>
<td>Street Types</td>
<td>General</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>Are there any considerations for SWM in the roadways? If yes, they should be incorporated in the sections</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>50</td>
<td>Street Types</td>
<td>General</td>
<td>2/11/2021</td>
<td>Russell</td>
<td>It appears from some of the photo examples that buses pull into the bike lanes when they stop at a bus stop? Can this be avoided?</td>
<td>Parked</td>
</tr>
<tr>
<td>51</td>
<td>Street Types</td>
<td>Lower-Density Residential Area</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>35 mph will only be achieved in suburban areas with curves. Many, not all, of our lower density roads are straighter and thus have FFS greater than 35.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>52</td>
<td>Street Types</td>
<td>Commerical Area</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Again, 35 mph is not likely to be the case for much of our commercial, which I interpret as office and retail. We tend to have wider roads and higher speed traffic like LPP, roads in Gateway, Stanford Blvd, etc. The only ones 35 mph or less are in old E.C., inside the Mall, inside Gateway Overlook, inside Dobbin Center, inside Columbia Crossing, etc.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>53</td>
<td>Street Types</td>
<td>Low-Density/ Commercial/ Industrial (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Bicyclist goes on shared use path for LTS 1</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>54</td>
<td>Street Types</td>
<td>Low-Density/ Commercial/ Industrial (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>For bike lanes, clarify what happens with turn lanes to avoid right hook and other crashes</td>
<td>Parked</td>
</tr>
<tr>
<td>55</td>
<td>Street Types</td>
<td>Low-Density/ Commercial/ Industrial (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Enhance bike lanes with physical separation, which can achieve LTS 1</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>56</td>
<td>Street Types</td>
<td>Low-Density/ Commercial/ Industrial (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Conventional bike lanes could work for many of our roads, provided that there is an alternate LTS 1 that provides access, the perhaps by a more indirect route.</td>
<td>Ready for discussion</td>
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<tr>
<td>57</td>
<td>Street Types</td>
<td>Low-Density/Commercial/Industrial (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Curb is a problem for bikers when adjacent to bike lanes. Eliminate the curb, add a foot and create a separation between the biker and the cars. Clarify how the turn lanes will work and intersection treatment.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>58</td>
<td>Street Types</td>
<td>Low-Density/Commercial/Industrial (Minor Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Repeat comments from previous slides U.O.N. It's really hard to get the &quot;feel&quot; for the road and its use from just the classification w/o the context, driveway interruptions, setbacks, etc. There are many roads that straddle categories and change significantly over short distances. I think we need a whole bunch of arrows in the quiver and individual judgements may need to be made by planners, engineers, development staff, transportation specialists.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>59</td>
<td>Street Types</td>
<td>Low-Density/Commercial/Industrial (Minor Collector)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>If it's really a minor collector, with speeds at 25 mph this is ok, otherwise need physical protection or sidepath.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>60</td>
<td>Street Types</td>
<td>Low-Density/Commercial/Industrial (Collector, Local Street)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Can we eliminate the yellow line? Our roads don't look like this - the yellow lines go all over the road surface as turn lanes come and go, bike lanes end, etc.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>61</td>
<td>Street Types</td>
<td>Low-Density/Commercial (Collector)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>Will never be 30 mph until density and volume are much higher, so this doesn't work.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>62</td>
<td>Street Types</td>
<td>Mixed-use (Intermediate Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>It would be good to see the ROW width. This looks comparable to Option 1, and it's less comfortable for bikers and cars. Maybe more comfortable for peds, since they don't share w/bikes. I don't see how it will ever be 25 mph, so this really doesn't work.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>63</td>
<td>Street Types</td>
<td>Mixed-use (Minor Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>It would be good to see the ROW width. This looks comparable to Option 1, and it's less comfortable for bikers and cars. Maybe more comfortable for peds, since they don't share w/bikes. I don't see how it will ever be 30 mph, so this really doesn't work.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>64</td>
<td>Street Types</td>
<td>Mixed-Use (Collector Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>I don't see how we would ever get 30 mph unless traffic volume is very high.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>65</td>
<td>Street Types</td>
<td>Mixed-Use (Local Street)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>LTS 1-3 is a wide range. We need a method to guide decision making.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>66</td>
<td>Street Types</td>
<td>Higher-Density Residential (Intermediate Arterial)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>I don't see how it will ever be 25 mph, so this really doesn't work.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>67</td>
<td>Street Types</td>
<td>Higher-Density Residential (Minor Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>It would be good to see the ROW width. This looks comparable to Option 1, and it's less comfortable for bikers and cars. Maybe more comfortable for peds, since they don't share w/bikes. I don't see how it will ever be 30 mph, so this really doesn't work.</td>
<td>Ready for discussion</td>
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<tr>
<td>68</td>
<td>Street Types</td>
<td>Higher-Density Residential (Collector Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>This strikes me as similar to Great Star Drive, but w/o the parking. It is not a complete street, safe for all uses. Speeds are well over 30 mph and there is no protection at intersections. Bike lane ends completely at the most dangerous spots x-ing 32 and at each end (32 @ N and Guilford @ S). We could fix it with physical protection at dangerous spots, slowing speeds with narrower lanes, coloring the bike lane in some spots. Need to draw attention to motorists that they are sharing the road.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>69</td>
<td>Street Types</td>
<td>Higher-Density Residential (Local Street)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>At what speed and volume is the yellow line needed? LTS 1 - 3 is a big difference and shd be a driver for the type of bike facility needed.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>70</td>
<td>Street Types</td>
<td>Outside PSA</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>I question whether we have anything left in the County that is rural. Roads that were previously rural now have multi-unit developments or houses dotted on 2 acre lots. Even if they don't have continuous development, many of them have now become collectors or more.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>71</td>
<td>Street Types</td>
<td>Rural (Intermediate Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>This does not work. From the Bicycle Facility Design Course, &quot;A shoulder is not a bikeway because it is not designated or maintained for bicycle use and may not meet the design standards for safe bicycle operation, such as minimum width. It does not provide physical separation from motor vehicle traffic, and bicyclists may have to exit the shoulder into the adjacent motor vehicle travel lane to avoid obstructions, drainage grates that are not designed to be compatible with bicycle travel, or pavement imperfections.&quot; At these higher speeds, which are almost always going to be the case, provide a buffer.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>72</td>
<td>Street Types</td>
<td>Rural (Intermediate Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>At these higher speeds, which are almost always going to be the case, provide a buffer. Also, the protection of the bike facility is going to be very important with the TWLTL and it should be colored different from the roadway.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>73</td>
<td>Street Types</td>
<td>Rural (Minor Arterial Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>At these higher speeds, which are almost always going to be the case, provide a buffer. Also, the protection of the bike facility is going to be very important with the TWLTL and it should be colored different from the roadway.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>74</td>
<td>Street Types</td>
<td>Rural (Collector Option 2)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>At these higher speeds, which are almost always going to be the case, provide a buffer.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>75</td>
<td>Street Types</td>
<td>Rural (Local Street)</td>
<td>2/11/2021</td>
<td>Schoen</td>
<td>I'm having trouble understanding what a rural local street is. If it has a yellow line, no bike lane and now shoulder, how could it ever be less than LTS 3 or 4? From the Bicycle Facility Design Course, &quot;...shared lanes and bicycle boulevards may be viable options on roadways with lower motor vehicle speeds and volumes, generally up to around 20 or 25 miles per hour and below around 2,000 vehicles per day. In the rural context, the only one I can think of is Manor Lane, which is a dead end.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>76</td>
<td>Street Types v2</td>
<td>Neighborhood Yield Street</td>
<td>2/28/2021</td>
<td>Edmondson</td>
<td>Shared a photo of a typical subdivision street, usually short looked or Cul de sac. Because these streets are low volume, slow speeds we require sidewalk on one side only. Peds walk down their driveway and cross the street at all points. Jurisdictions are mandated to reduce impervious area where possible. To limit clearing for additional SWM. A half mile long road with sidewalks on both sides is about a half-acre of impervious material requiring substantial area for SWM. I suggest on these low speed roads continue current design of one side walk but meeting the current wider request. This also provides space to park cars in the driveway. Otherwise cars would hang over the walk in some cases.</td>
<td>Ready for discussion</td>
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<tr>
<td>77</td>
<td>Street Types v2</td>
<td>Neighborhood Yield Street</td>
<td>2/28/2021</td>
<td>Edmondson</td>
<td>In response to question from WRA about whether driveway aprons are designed to accommodate a future sidewalk on the other side of the street. There is no plans for future sidewalk. As stated, Howard County requires sidewalk on one side of the road. Engineers have to make driveways longer on the side of the street to accommodate cars parked within the driveway where side walk exists. Parking in your driveway is a plus in any neighborhood, makes the lots more desirable, and increases safety. Cars not parked in the road makes maintenance easier, allows roads to be fully cleared of snow and increases sight distance. Sure we can continue this conversation.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>78</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>Current sections don't have shoulders in curbed situations and I would not be in favor of adding them now. Takes up real estate, costs more to build, and creates more runoff. Unless the shoulder is wide enough for a vehicle in distress, it doesn't do much good anyway.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>79</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>The Tree zone should be 6’ across the board. I surveyed a large number of developers and the dry utilities rarely go in the tree zone.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>80</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>What are the &quot;Buffers&quot; for? Conventional cross-sections use 1’ behind the SW to set the R/W. I don’t see any reason to use more real estate.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>81</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>I think we should consider SUP on one side with a 5’ SW on the other. Having SUPs on both sides seems extravagant.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>82</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>I think the need for both a separated bike lane and a sidewalk is rare. A SUP is much more likely to serve the need, as it does along LPP.</td>
<td>Resolved</td>
</tr>
<tr>
<td>83</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>All sidewalks should be 5’. For the mixed use areas, just indicate an extension of the pedestrian zone &quot;as shown on the SDP&quot;. That’s what we did for Maple Lawn in the commercial areas.</td>
<td>Resolved</td>
</tr>
<tr>
<td>84</td>
<td>Street Types v2</td>
<td>General</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>Aren’t buffered bike lanes to guard against car doors opening? Should not need the extra width when there are no parked cars.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>85</td>
<td>Street Types v2</td>
<td>Level of Traffic Stress</td>
<td>3/2/2021</td>
<td>Gutschick</td>
<td>I have been thinking more about the presentation last month regarding bicyclist safety. The LTS categories seem very subjective, depending on the individual. For instance, I am not an accomplished rider, but I have ridden bikes since childhood, including to my elementary school.(about a mile). We rode along the side of what was probably a major collector and never felt unsafe. Are the LTS measures standardized? How do you factor in variations in individuals? After categorising the LTS, we then populate the table, which then results in decisions on separated bike facilities. Seems like it may start with too subjective of a foundation.</td>
<td>Ready for discussion</td>
</tr>
<tr>
<td>86</td>
<td>Street Types v2</td>
<td>Neighborhood Yield Street</td>
<td>3/3/2021</td>
<td>White</td>
<td>In response to the question &quot;Do we need a wider section with designated parking on both sides of the street for high density areas?&quot;, Neighborhood Yield Streets do not work well in high density areas. They only work where parking is less than 80% occupied, because drivers must pull into the unoccupied parking spots to enable other drivers to pass. If there are insufficient opportunities to pass, then the street ceases to function. Another option might be to intentionally create no parking/passing zones on a high density street, but this is not a common practice. Neighborhood Yield Streets are best used in neighborhoods where there is a mix of on-street and off street parking options. They can work in denser neighborhoods, but not in neighborhoods with a lot of apartment buildings and no off street parking spaces. None of this is to say that Yield Streets aren't a great street type, they are.</td>
<td>Resolved</td>
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<tr>
<td>87</td>
<td>Street Types v2 Neighborhood Yield Street</td>
<td>3/3/2021</td>
<td>White</td>
<td>Clarify this is a two-way street.</td>
<td>Resolved</td>
<td>Discussed at March 3 CSIT meeting.</td>
</tr>
<tr>
<td>88</td>
<td>Street Types v2 Neighborhood Yield Street</td>
<td>3/3/2021</td>
<td>White</td>
<td>Transit is the key determining factor in using 26' instead of 24'. Use 26' for transit.</td>
<td>Resolved</td>
<td>Discussed at March 3 CSIT meeting.</td>
</tr>
<tr>
<td>89</td>
<td>Street Types v2 Neighborhood Connectors and Town Center Connectors</td>
<td>3/3/2021</td>
<td>White</td>
<td>Regarding two-way left turn lanes: Use caution with applying them across the board, along the entire length of streets. While they are needed at intersections, they are often not needed at midblock, particularly when the only entrances onto the road are residential driveways or other low volume entrances. Where they are needed are for higher volume generators, like parking garages, major shopping centers, etc. When they are continuous at midblock locations (e.g. the entire length of the road between intersections) they create a wide street that results in higher speeds.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>90</td>
<td>Street Types v2 Neighborhood Connector Options 1 &amp; 2</td>
<td>3/3/2021</td>
<td>White</td>
<td>We would like to see the threshold lowered from 35 mph to 30 mph and clarify that this is the operating speed, not the speed limit. Otherwise, if it was intended to be the speed limit, this cross section would result in streets with 45 mph operating speeds, which would need separated bike lanes. The chart from the new AASHTO Bike Guide (under publication) is below.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>91</td>
<td>Street Types v2 Neighborhood Streets</td>
<td>3/3/2021</td>
<td>White</td>
<td>Depending on operating speed, see comment above, it may be preferable to use separated bike lanes instead of conventional bike lanes. This can be done in the same cross section, at street level to save ROW if necessary.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>92</td>
<td>Street Types v2 Country Road and Rural Development Street</td>
<td>3/3/2021</td>
<td>White</td>
<td>These streets may in some cases require adjacent shared use paths if they are part of a connected network of pathways.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>93</td>
<td>Street Types v2 Rural Development Street</td>
<td>3/3/2021</td>
<td>White</td>
<td>We question why this is the only street with 12' wide lanes? Would 10' wide lanes suffice here, to save some ROW costs? Ideally these would be very low speed streets.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>94</td>
<td>Street Types v2 Street Type Comparison Table</td>
<td>3/3/2021</td>
<td>White</td>
<td>Consider adding operating speeds to this table to make it clear to designers that measures should be taken to design these streets to achieve lower speeds.</td>
<td>Ready for discussion</td>
<td>To be discussed at second March CSIT meeting.</td>
</tr>
<tr>
<td>94</td>
<td>Street Types v2 General</td>
<td>3/3/2021</td>
<td>Jagarapu</td>
<td>Provided an image of Cedar Lane. IMG_8015 is on Cedar Lane with 10' lane widths. RTA mobility bus appeared to be trying to stay in the lane but is shying away from the face of the curb. The vehicle next to the RTA bus is a compact Ford Focus. Please see IMG_8032 to notice the gutter pan at the same location taken on a sunny day. Gutter pan appears to be failing, possibly due to vehicles driving on the joint.</td>
<td>Resolved</td>
<td>Discussed at March 3 CSIT meeting. No proposed sections show a 10-foot outside lane that includes a gutter pan, which is what is present on Cedar Lane.</td>
</tr>
<tr>
<td>95</td>
<td>Street Types v2 Neighborhood Yield Street</td>
<td>3/3/2021</td>
<td>Jagarapu</td>
<td>Provided an image of a 28' wide neighborhood street. IMG_7944 is on a County local road 28 feet wide with vehicles parked on both sides and a County snow plow. I cannot recommend parking on both sides of the streets with anything less than this width.</td>
<td>Resolved</td>
<td>Discussed at March 3 CSIT meeting. CSIT agreed to maintain the yield street widths that are currently in the Design Manual, ranging from 24 to 28 feet depending on land use and traffic volume.</td>
</tr>
</tbody>
</table>
Date: March 16, 2021

Date of Meeting: March 3, 2021  
Meeting Location: Video conference  
Work Order Number: 32189-005  
Project: Howard County Complete Streets

Meeting Description: Complete Streets Implementation Team Meeting #15 (Part 1)

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<th>Email</th>
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Introduction

The purpose of the meeting was to provide members of the Complete Streets Implementation Team (CSIT) an overview of new street types, review the comment log, and to provide brief updates on tracking and reporting on performance measures and the revised project schedule.

Jeff Riegner welcomed all attendees and reviewed the agenda.

Members of the CSIT were provided a copy of the draft minutes from the February 3 meeting in advance. Christiana Rigby made a motion to approve the minutes and Chris Eatough seconded the motion.

Kris Jagarapu commented that the discussion regarding the width of neighborhood yield street width was inaccurate, and that the second reference to 26 feet on page 3 should read 28 feet instead. Jeff noted that the discussion in question during the February meeting was regarding whether 26 feet of roadway width was sufficient to accommodate a fire truck. Chad Edmondson observed that 28 feet is sufficient to accommodate on-street parking, and that anything narrower requires indented parking. Chris Eatough asked if this relates to detail R-1.02 in the current Design Manual. Chad responded he would have to check. Chris noted that currently, the Design Manual lists 24 feet as the appropriate width for access streets and 26 feet for townhouses and condominium developments. Tom Auyeung noted that the current section does not address parking needs. Kris requested that his statement be modified to say 28 feet which allows enough space for parking on both sides of the street. Larry Schoen asked whether a wider dimension affects the rideability and walkability of the street. Jeff replied that any further questions about street width would be discussed during the March meeting. There were no objections to the modification.

Carl Gutschick commented that the reference to the size of the root barrier should read six feet from the back of curb not from the face of curb.

The CSIT approved the minutes with the two edits.

Jeff led the group through the presentation attached to these minutes. He noted that new street types will be addressed first. Because revisions to the sections address some of the issues raised by members of the CSIT, the comment log will be discussed second.

New Street Types

Jeff shared that WRA sought advice from Erv Beckert, PE, who is the Chief of the Highway and Bridge Design Division for Prince George’s County. Prince George’s County has already implemented Design Manual changes in response to the adoption of a Complete Streets policy. Erv could not attend the February Core Team meeting but he did share some feedback with WRA. Erv noted that Prince George’s County guiding principles for street design are safety and responsible economic development. Although they kept the functional classification system, it is entirely separate from street design. This approach acknowledges that streets may need to be larger because of anticipated demand which doesn’t relate to the classification. Prince George’s County use 10-foot lanes in all urban areas except for industrial streets and on bus routes, where they use 11-foot lanes. Their rationale is to maximize the safety of all users of their streets. Erv highlighted the distinction between drivers feeling comfortable and drivers being safe. Very wide lanes can create a feeling of comfort, but as you narrow lanes drivers start to drive more defensively and pay more attention to each other and other street users. If you go too far in narrowing streets, it could compromise safety.
Jeff then reviewed the matrix approach that is organized according to street functional classification and land use contexts discussed at the last CSIT meeting. The core team looked more closely at applying descriptive street types to the matrix. Over 100 streets named during the December survey were reviewed using Google Street View, dimensions where available, and photographs, and then compared to the highway classification map. Jeff showed a series of streets in Howard County, asking the CSIT, “What functional classification is this street?” for each example.

Larry asked how someone would go about venturing a guess. Jeff responded that a local street serves local traffic, an arterial serves through traffic, and a collector provides a connection between the two.

The first example was Freestate Drive, a three lane section with bike lanes that is classified as a local street. Larry asked why Freestate Drive is considered a local street instead of a collector given the fact that it serves through traffic. Larry also cautioned that a 4-foot bike lane adjacent to a gutter pan does not provide sufficient accommodation for cyclists. The second example was Farewell Road, a narrow residential street with on-street parking. Although this street appears to be a local street, it is classified as a minor collector, in theory because it serves more through traffic. The next example was Gerwig Lane, an industrial street with on-street parking and two vehicular lanes that is classified as a major collector. Troy Hill Drive, a four-lane divided highway with no parking and buildings set back from the roadway, is classified as a local street. The last example was Old Annapolis Road (MD 108), a narrower three-lane road that is classified as a minor arterial even though it is a narrow roadway.

Jeff said the team concluded that, based on all of the streets analyzed, there is not a clear link between highway classification and the design of streets in Howard County. He clarified there is nothing wrong with this approach, but it does suggest it would be best to use descriptive street types for design instead of the matrix approach. Larry asked if there is a way to connect the two approaches and asked how streets are assigned classifications now. Jeff responded that there does not appear to be a way to connect the two approaches and referenced the highway classification map that is included in general plan.

Larry asked if highway classifications get updated. David Cookson responded that classifications are updated when the General Plan is updated. As new roads are built, classifications are determined as part of the planning and development review process. David noted that generally, local roads come in as part of development plans. Larry asked how the County would determine what descriptive street type to use for a capital project. Chris asked if Larry meant for new roads or existing streets, clarifying that existing streets are assigned a highway classification already. Larry noted that if there is no cross referencing between highway classification and descriptive street type, it is not clear how the designer would determine which street type to use. Jeff responded that other jurisdictions have followed two approaches. One approach is to produce a new map that shows which descriptive street types apply to the existing road network. The more common approach is less prescriptive. When a designer begins a project, they take into account surrounding land use, anticipated traffic volumes, whether transit is present, and then determine what they believe to be an appropriate street type. Larry confirmed that the proposed road type would be reviewed by County staff. Jeff responded that whoever designs the street would determine what is appropriate. Larry responded that proposed street types should be reviewed by the Office of Transportation.

Jeff asked the CSIT whether it would be beneficial to create a street type map now or allow more discretion at design phase. No feedback was received.

Jeff noted that files were distributed over the weekend that included proposed street types for new construction. The proposed street types were developed in consideration of comments received from members of the CSIT. Effort was made to weigh the pros and cons of lane widths and different types of street configurations. He shared that some members of the CSIT have sent additional comments since these street types were distributed for review, and those comments have not yet been incorporated into the comment log.

Jeff reviewed each street type by land use, starting with streets in mixed-use areas. He noted the most prominent examples of mixed-use development in Howard County are in Maple Lawn and Columbia. Although there are not many other mixed-use areas in the County, there is a good chance there will be in the future, making this an important street type to plan for.
The boulevard street type is a four-lane roadway that may or may not have on-street parking. The top section shows on-street parking bottom section does not. Boulevards have a raised median, sidewalk, and separated bikeway, based on the level of traffic stress (LTS) and the amount of pedestrian demand. On four-lane roads it is assumed that the speed and traffic volume is high enough that there needs to be physical separation for cyclists. In new construction, the separated bike lane would be located behind the tree zone, which is six feet wide. The separated bike lane could be at same level as the sidewalk or at a lower level. The section shows the separated bike lane at a lower level than the sidewalk only for visual purposes. The sidewalk is significantly wider than in other types because sidewalk would extend to the face of the buildings. Inside travel lanes are 10 feet wide and outside travel lanes are 11 feet wide. This configuration provides more flexibility adjacent to parked cars and it is common to have bus service in mixed-use areas.

Larry commented that he agrees with the use of separate bike lanes along this type of street, but noted he wouldn’t want the 11-foot travel lanes shown in this typical section to be used as a precedent when the bike has to share the roadway with cars. He observed that the boulevard street type requires a lot of right of way and asked what would happen when the right of way is not available. Jeff responded that this street type is for new development only, for example the next Maple Lawn Boulevard. Bruce Gartner replied that the comment may apply to new construction if there is not sufficient space. Larry asked how the process would work if there are negotiations or compromises between the County and the developer. Jeff noted that if it is a greenfield development there should not be a need to compromise due to limited right-of-way. If there is a retrofit situation, the Design Manual would have a process based on the FHWA Bikeway Selection Guide, which provides guidance on determining the ideal width of a bicycle facility and how to narrow other street elements when there is not sufficient space for the ideal. Chris commented that if it was a developer project and the developer was proposing something that differed from the County’s street type, the developer would have to request a waiver. Chad affirmed that the waiver process would have to be followed when deviating from the typical section. Larry replied that he understands that Maple Lawn is existing, noting that he had never seen the need for two travel lanes on Maple Lawn Boulevard and asked whether it needs to be so wide.

Christina asked when the boulevard type would be utilized. Chad responded that historically, that answer depends on what is being built along the roadway and the projected average daily traffic (ADT). He noted that a shorter road with less built along it would require a smaller roadway section.

Paul Walsky asked whether something like the boulevard street type could be applied to Route 1. Christina noted that Route 1 is state owned and there isn’t much right of way on either side so it could not accommodate a median.

Jeff reminded members of the CSIT who provided comments to staff via email to speak up so the rest of the CSIT can hear those comments.

Kris confirmed that the boulevard street type would not apply to an existing roadway frontage but would be applied to a greenfield development. Jeff agreed, but noted that these sections will inform projects on the existing street network. He clarified that the number of existing streets that are in a mixed-use area with the demand for the boulevard type is very small, for example a portion of Twin Rivers Road and some other parts of downtown Columbia. Kris replied that if this type were to be applied for frontage improvements there would be a concern because there are not any areas with 100 feet of right of way available. He noted concern with a 7-foot-wide one-way bikeway, noting that the parking and tree zone already take up 14 feet and protect people on bikes from vehicular traffic. He observed the separated bike lane is shown as a different level from the sidewalk and asked what the rationale was.

Jeff responded that there are three options for separated bike lanes:

- Facility is at the same height as the sidewalk and the bike lane and sidewalk are differentiated by pavement types, i.e. an asphalt bike lane and concrete sidewalk
- Facility is at street level or about 8 inches below the sidewalk allowing for less complicated and less expensive drainage
Facility is between the street and sidewalk level with a beveled small curb between the separated bike lane and sidewalk.

Jeff noted that his personal preference for Howard County is for a sidewalk level separated bike lane. Kris asked why 7 feet is the recommended width when 5-foot lanes are applied elsewhere. Jeff replied that when a 5-foot bike lane is adjacent to travel lanes, cyclists can use the vehicular traffic lane to pass. A 7-foot separated bike lane allows for bikes to pass one another without entering the pedestrian area. Chris noted the added width is helpful for overtaking other cyclists as well as side by side riding. He noted that this treatment is only for mixed-use dense areas where significant pedestrian volume is expected. Jeff noted that if the separated bike lane is level with the sidewalk, 6 feet might work because bikes could use the sidewalk to facilitate passing, but AASHTO does not recommend that cyclists pass or overtake one another within 6 feet of space, recommending 7 feet.

Kris asked whether the sidewalk would extend to the edge of the right of way against a building. Carl noted that in Maple Lawn you cannot tell where the right of way line is located. Although the sidewalk does extend to the building, only 4 feet of the sidewalk is required by the Design Manual and located within the right of way. The remainder of the sidewalk width that extends to the building is shown on the site development plan. Therefore, the majority of the sidewalk is privately owned and maintained. The material used for the sidewalk is the same from the back of the curb to the building. He suggested 5 feet as a minimum sidewalk width that can be shown in the proposed section with a note saying that sidewalk outside the right of way can be continued per the site development plan as appropriate.

Jeff replied that approach makes sense, and that it is important to ensure there is sufficient hardscape between the separated bike lanes and the buildings for a high volume of pedestrians and sidewalk cafes. There are benefits of having those features outside of the right of way. Jeff asked Carl if there is a pavement joint at the right of way line. Carl responded that there is not; it is a continuous hardscape between the back of the curb and the building, which is 10-11 feet behind the right-of-way line.

Carl asked if there would be an on-street bike lane option for boulevards. Jeff responded that based on federal guidance, on-street bike facilities are not appropriate if there is sufficient volume of traffic to support a four-lane roadway.

Tom Auyeung asked whether there will be requirements for a storm drain system on the bike lane. Jeff replied that there would be if the bike lane is at a different level than the sidewalk and street. He noted that cross slopes are not shown in these sections, but if the sidewalk and separated bike lane are both draining to the curb you may be able to address drainage by having openings where water can flow through.

Chris asked Jeff to show a photograph of a flush bike lane so the CSIT could better envision how it would work. Jeff showed a picture of a sidewalk level separated bike lane on Vassar Street in Cambridge, Massachusetts. In this example the tree zone is paved except for occasional tree pits. The separated bike lane is asphalt and the sidewalk is surfaced with concrete unit pavers.

Carl noted that the cross section graphically shows a step down and asked whether the flush treatment would be made clear through a footnote. He agreed that the design and drainage would be much more complex with a step down. Jeff replied that the proposed typical section shows a step down because a decision has not yet been made on that detail, but after today’s conversation it seems that a separated bikeway flush with the sidewalk is preferred by the majority of the group. The designer can always provide a different level if they want but it will not be the default.

Larry asked if the paving treatment would differentiate between the bike lane and pedestrian area. Jeff responded yes, and Chris said there also would be bicycle pavement markings to make it clear.

Kris commented that during the February meeting a question was raised about U-turns and asked whether the design vehicle can make a U-turn in the boulevard section. Jeff replied that the proposed sections were compared to the current sections included in the Design Manual. With 4 lanes and a 16-foot median specified in both the proposed boulevard section and in the existing section in the Design Manual, not even a passenger car can make a U-turn. A passenger vehicle can make a U-turn in a four-lane section with a 30-foot median or a six-lane section with a 16-foot
median, both of which are options for the proposed parkway type. He clarified that neither the current nor proposed sections handle U-turns for vehicles larger than a passenger car.

Town Center Connector

Jeff moved on to the next proposed street type, town center connector, which has a three-lane cross section. He noted this street type might work at the entrance to a development where volumes do not warrant a four-lane cross section. If traffic projections anticipate less than roughly 20,000 vehicles per day, this type of section would be appropriate. The center lane would function as a two-way left-turn lane or a striped median. As with the boulevard section, the top example shows on street parking and the bottom example shows no parking. The remainder of the configuration is similar to the boulevard section, with a six-foot tree zone, separated bike lanes, and large sidewalks. Jeff noted the same recommendations received regarding sidewalks in the boulevard section could be applied to the town center connector street type. The reason for 11-foot wide lanes is due to potential bus traffic and higher volumes of traffic adjacent to on-street parking.

Carl asked if it would be possible to reduce the bike lane to six feet for this section. Christiana asked whether the bike lane would be at a different level than the sidewalk in this section. Jeff replied that the bike lanes could be sidewalk level, and the width would also correspond to the width shown in the boulevard section since the same principles apply. Larry asked whether seven feet is the preferred width for side by side passing and whether six feet is a compromise. Jeff responded in the affirmative, noting that the guidance for overtaking based on the bicycle as a design vehicle is seven feet. Kris asked if the adjacent sidewalk could be used by a cyclist when passing. Jeff responded yes, but only if it is not occupied by a pedestrian. He noted mixed-use areas are the only locations that so much right of way is being designated for walking and biking since the high density will result in higher volumes of people walking and biking. Chris noted that sidewalks sometimes have other items that may be obstacles to cyclists including sandwich boards, planters, and street furniture. Larry asked if parked cars present a known safety risk. Jeff replied based, on studies he is aware of, it is not. Larry noted that his preference would be a separated bike lane wide enough to accommodate side-by-side riding with a child, and a narrower travel lane that encourages slower travel.

Kris replied that looking at 122 feet of required right of way with only 28 or 18 feet of impervious area was concerning to him. He also expressed concern that a 10-foot two-way left-turn lane is too narrow and may present issues if a driver is trying to merge into the center turn lane after pulling out of a driveway.

Larry asked for safety data on the width of center turn lanes. Jeff replied that the information he has presented on vehicular safety as it relates to lane width is related to general purpose lanes. He further noted he has seen two-way left-turn lanes as wide as 20 feet and as narrow as 8 feet, and that many locations use 10 feet without safety issues.

Town Center Street

Jeff moved on to the town center street type, which would be applied in mixed-use areas with less traffic. This section has two travel lanes and would feature lower volumes and speeds. A narrower separated bike lane is suggested here because lower volumes of cyclists are anticipated and the need to accommodate overtaking is lower. This section also features five-foot sidewalks and there are parking and no-parking options.

Larry asked why the vehicular travel lanes are shown as 10.5 feet wide instead of 10 feet wide. Jeff replied the lanes were widened at the request of DPW, due to safety concerns adjacent to parked cars. Larry asked if parked cars present a known safety risk. Jeff replied based, on studies he is aware of, it is not. Larry noted that his preference would be a separated bike lane wide enough to accommodate side-by-side riding with a child, and a narrower travel lane that encourages slower travel.

Chad replied that County staff wanted to retain slightly wider lanes so that there is space for cars to veer away if a parked car door opens. 10.5 feet is not a lot of space for a larger vehicle and wider would be preferable. Bruce noted that generally, people wait to exit their car when another vehicle is passing. Chad replied that the extra space leaves
room for error. Carl noted that having extra space is similar to a cyclist having extra space in case a car door opens into their path.

Jeff noted that none of the discussed lane widths are wide enough to allow a motor vehicle to drive around an open car door. Drivers would have to wait until they have room to pass or the door shuts. Chad agreed but noted that situations could occur once the driver of the parked car has exited their car that would prevent them from leaving the vehicular lane, and that extra space creates a safer environment.

John Seefried commented that the group has been thinking about the ideal situation of people waiting for one another when someone is exiting a parked vehicle, but that sometimes that does not happen. He noted that when driving in Maple Lawn, he is unable to see four cars ahead of him if someone opens a door, and that the driver of the parked car may not have time to recognize a car is coming down the road. John mentioned that he may have to drive below the speed limit because he cannot see what is happening. He also informed the CSIT that he represents the Design Manual in legal cases when the County is sued. He noted that the extra half foot is there to create a safer environment, especially given the fact that pedestrians and cyclists are located on the other side of the tree zone. He reiterated that this is a safety issue and not a preference.

Jennifer revisited a question raised by Larry regarding group decision making. She noted that safety is being cited as the primary reason for recommending a particular street type feature, in this case a wider lane adjacent to parked cars, however Jeff indicated that he is not aware of any studies, safety concerns, or documentation around the issue. She noted that John expressed legal concerns and potential legal issues that could arise from decisions made as part of this process and that it would be helpful to speak with other jurisdictions for more feedback on legal concerns. Ideally, the CSIT decisions will be based on evidence. She noted the importance of moving forward in the process and asked for clarification on the CSIT’s decision making process when there are not evidence-based resources that point the group in a specific direction.

Jeff responded that he had cited the *Highway Safety Manual*, a primary source that is used for the application of safety considerations in street and highway design, at a previous meeting. He noted that the Manual shows that at these speeds there is no safety difference between 10-foot and 11-foot lanes. Kris asked permission to share his screen and showed a picture of Cedar Lane which has 10-foot lanes (including the gutter pan). He noted that this image shows why every 6 inches matter. The small bus ahead is shying away from the face of the curb. When driving large vehicles, it is hard to judge the side of the curb when driving along the roadway. There is a slight curve approaching the intersection. The compact car next to the bus also moved to the left and applied their brakes as the bus moved into the left lane. Occurrences like this are not recorded as an incident.

Jeff noted that every place a proposed section shows a vehicular lane adjacent to a curb, an 11-foot travel lane (including the gutter pan) is specified. Chris noted that 11-foot lanes also accommodate transit.

David Ramsay noted that school bus drivers are encouraged to use the right lane at all times because they want them to drive at slower speeds and be out of the way of moving traffic. For this reason, they prefer the wider lane to be the right side lane.

Kris emphasized he wanted to illustrate the difference six inches can make and noted that 12-foot lanes are not being shown in any of the recommended sections, all of the lane widths have been reduced.

John asked for clarification as to whether the *Highway Safety Manual* includes the gutter pan or not in their measurements, since Howard County’s experience seems to be different than the national standard. Chris observed that there is an operating speed referenced with the data. [*Note: the ITE Traffic Engineering Handbook cites “speeds of 45 mph or less.”*] Chris noted that Cedar Lane is likely in the low 40s for operating speed.

Larry offered to provide the point of view for pedestrians trying to cross the street. He noted that wider lanes encourage faster traffic because drivers feel more comfortable. Wider lanes also create more space that needs to be crossed by pedestrians and, while crossing, pedestrians are more at risk when speeds are higher. He reminded attendees of the graphic data shared at the last meeting regarding how speeds impact the rates of serious injury and
death for pedestrians. The reason for narrowing lanes is to calm traffic and protect vulnerable users. He acknowledged that where there is significant bus traffic it is important to increase lane width from 10 to 11 feet, but argued that one bus an hour is not significant bus traffic.

Bruce noted that there can be more than one bus an hour due to mobility buses on the road. Kris agreed that all members of the CSIT are here to address the concerns Larry articulated. The DPW position is to address other users who are on the roadway such as bus operators and truck drivers. He noted the importance of reducing speed and the need to make it work. He observed that mirrors were not included in the last image he showed, and that 10.5 feet wide will not feel wide enough to a bus driver. He noted that he followed a mobility bus down Cedar Lane to Freetown Road and it was clear the driver was having a hard time navigating the narrow lane configuration.

Larry noted that curves are another situation where 11-foot lanes may be needed, but questioned whether they are needed for the entire length of a roadway. He commented that Cedar Lane does not meet anyone’s needs and does not fit any design standards.

Bruce returned to the proposed section on the screen and raised the difference between 10.5- and 10-foot lanes with respect to pedestrians crossing. He observed that there are pedestrian facilities on both sides of the street, which is better than much of the County. He noted that good crosswalks will be provided, and there will only be one additional foot for pedestrians to cross. He also asked about side by side riding for bikes, and whether it is necessary when there are facilities on both sides of the street. He asked whether staggering your riding on a six-foot-wide separated bike lane a problem. He advocated that the proposed section is a good compromise. Larry noted that the default width for a one-way separated bike lane is 7 feet. He acknowledged that the proposed section is far better than what is in place across the County, but noted that these standards will affect the County for decades into the future, expressing a desire to get it right.

Jeff said more information will be provided from published sources on separated bike lane widths. The goal is to talk again before the first meeting in April.

**Neighborhood Yield Street**

Jeff then reviewed the last mixed-use street type, the neighborhood yield street. He noted many parts of the County have the same general type of configuration, where parking is permitted on both sides of the roadway because it tends to be less frequent. Vehicles yield to each other when cars are parked. He noted a 24-foot wide curb-to-curb width is only proposed in areas with lower density, since there would be fewer instances when cars are parked directly across from one another. In areas that are denser, where cars may be parked directly across from one another, the street would be 26 feet wide to allow for emergency vehicles. This section also features 6-foot tree zones and 5-foot sidewalks.

Jennifer noted she provided written comments but wanted to raise them for consideration. She noted it would be helpful to explicitly describe this as a two-way street. She noted that the wider section would be more appropriate where transit routes are located. She affirmed that this is a great street type. In response to the question, “do we need a wider section that accommodates parking on both sides of the street for high density areas,” she noted that neighborhood yield streets do not work well in high density areas since they require 80 percent or less parking occupancy. If there is not a way to pass, it becomes difficult for the street to function. As an alternative there could be no parking or no passing zones on a high-density street, but that is not commonplace. This street type is best used in neighborhoods with a mix of on-street and off-street parking. Although it can work in denser areas it cannot work where there are a lot of apartments.

Chris agreed that the density of parking is critical on this type of street. He noted that he lives on a 24-foot wide, recently built Howard County street. Its appropriateness depends on the housing type and driveway type. In his development, homes have two-car garages and driveways wide and long enough to park two additional vehicles. He noted they do not have much need for on-street parking, and the street works fine because it is never narrowed by parking. He noted kids can play in the street and speeds are reasonable. He could see being comfortable with a 26-foot-wide street, but 28 feet would impact the speed and feel unsafe. Jeff responded that he lives on a 28-foot-wide
street and does not feel comfortable with the speed cars choose to travel. He noted there is very little on-street parking with about 10 percent occupied. He noted he did not allow his children to play in the street when they were younger due to concerns about speed.

Kris noted he is responsible for maintaining all the roadways in the County. He noted when they have bad weather events they have to send equipment to each roadway in the County, and that some operators don’t like to go to more narrow streets because it is difficult for a truck to maneuver the plow in and out of the neighborhood. He acknowledged that snow events only happen a maximum of 10-15 times a year, being able to efficiently clear streets is important. He noted he receives phone calls from residents who need to get out immediately, and fire and rescue may need access. He acknowledged that these streets have the most impact on our daily lives. People want to have places to park. Many neighborhoods in Howard County have bigger lot sizes with longer driveways and people still choose to park in the street.

Jeff noted that current Design Manual guidance states that for streets with a volume of 1,000 vehicles per day or less, a 24-foot width is specified. If there are townhouses, condominiums, or apartment developments that width increases to 26 feet. For volumes exceeding 2,000 vehicles a day that would increase to 28 feet. He suggested, as a compromise, to maintain the same widths that are currently in the standards, with the exception of widening the sidewalks from four to five feet wide. Jeff asked if there were any objections. There were no objections.

Christiana asked Kris if there were other plow vehicles that would work on smaller streets better. Kris noted that is a great question, and that they can use a pickup truck, however the pickup trucks do not have the same salting capabilities. Once a truck is emptied of salt it has to travel back to the salt barn before it can continue. The County currently uses a ten-ton truck and a five-ton truck, although the smaller truck has a larger turning radius. The ten-ton truck can get through 10-15 miles of roadway before a refill of salt is necessary. The average mileage for each route is 15 miles. Christiana stated that using smaller trucks in neighborhoods is a capacity issue. Kris agreed, noting that a pickup truck has a capacity of less than one ton.

Chris asked whether the County does any outreach to residents advising them to not park on both sides of the street when snow is coming. He noted that awareness may be helpful. Kris responded that they have tried in the past, even on a neighborhood-by-neighborhood basis. Maple Lawn created a parking lot which would be kept clear so that the County can clear snow on the roadways. It worked for a little while, but then people started to park in the street again. Larry commented that people learned not to park in the street where he grew up in Brooklyn when the plow drivers buried their cars. Larry volunteered to ride with a snow plow driver if Kris agreed to take a bike ride with Larry.

Jeff reiterated that there are currently standards varying between 24 and 28 feet based on volume and land use and asked whether there is any objection to maintaining that approach. No objections were heard.

**Schedule Changes**

Jeff provided a brief update on changes to the schedule. He observed it just took the CSIT two full hours to make it through one land use type, and it is clear that more time is necessary to discuss the rest of the proposed street types. He reminded the group that the goal is to have a draft Design Manual complete by mid-summer to ensure there is time for public outreach and adoption by the October deadline. He asked the CSIT whether they would be able to meet next week to work through the remainder of the agenda. Hearing no concerns, Jeff offered to send out a poll to determine the time that works the best for all members of the CSIT.

Jeff proposed the following process in light of the fact that the CSIT has already reviewed Chapter 1. He noted that this proposed schedule assumes that the remainder of the street types will be vetted by the CSIT in early March. Each chapter that has not been covered so far will first be reviewed with County subject matter experts, some of whom may be outside of the core team. The chapter will then be reviewed with the core team, followed by the CSIT, and repeated as needed to address all comments. He noted that yesterday, WRA presented the bridge chapter to the County’s lead bridge engineer to solicit buy in on specific technical issues and make sure they are resolved before introducing the draft to the broader group. The CSIT will have the opportunity to collaborate on any changes
that affect functionality for multi-modal issues. Once all of the chapters are addressed the CSIT will seek stakeholder input.

Jeff then presented a draft schedule. Chapter 1, the Introduction, is partially complete and needs street type input and some additional sections. It will be reviewed by staff in March and brought to the CSIT in April and May. Chapter 4, Bridge and structure design will be reviewed with staff in March and also be brought to the CSIT meeting in April and May. Chapter 2, Traffic Studies, needs significant edits and will be reviewed by staff in March and April and brought to the CSIT in May and June. Chapter 3, Street Design, will be reviewed by staff in April and May and also brought to the CSIT in May and June. Larry asked whether traffic design refers to signalization. Jeff said it refers to signals, signs, and pavement markings.

Jeff observed that it will require more than two hours a month to advance this schedule, and suggested two meetings early in the month. Larry agreed that more meetings are necessary to meet the schedule. Larry observed that the CSIT has not yet seen Chapter 2. Jeff affirmed that the core team has reviewed Chapter 2 but the CSIT has not. Larry noted concern with the fact that the CSIT is only getting involved three quarters of the way through the discussion. Jeff noted that the entire CSIT had agreed that content would be discussed with County staff first and then be brought to the CSIT. Bruce commented that it has to be done this way since a lot of these issues require knowledge transfer up front to ensure County staff are all on the same page.

Jennifer White affirmed that meeting as frequently as necessary is appropriate at this stage, and understands that County staff need to meet internally in order to inform larger group discussions. As the schedule is developed, it would be helpful to put together a timeline that details when CSIT members can provide comments with enough time to ensure that external feedback still informs internal discussions.

Bruce noted that April and May are budget season and there are a lot of meetings that will need to be worked around. Christina agreed this is a difficult time of year, but stated that the Complete Streets work is important and affirmed her commitment to the process on behalf of Council.

Larry commented that he wants to have sufficient time to do a review. Jeff responded that all of us feel rushed in this process, but confirmed that the goal is to share materials with the CSIT in a timely manner, and to do otherwise would not be fair or respecting the process. He noted that Larry may have less time than he would prefer, but that staff share his pain and are working to get things done as quickly as possible.

**Tracking and Reporting**

Jeff provided a brief update on the tracking and reporting of Complete Streets policy performance measures. The Complete Streets policy requires an annual report be presented to the CSIT and County Council each April that details progress made during the previous calendar year. The annual report will include the status of the performance measures listed in the Complete Streets policy. Jeff shared the 13 performance measures and noted that the Core Team is confident in providing information on ten of the 13 measures. Three of the measures will be more challenging. Performance measure number 10 concerns access to the low-stress bike network. The County is relying on the state to provide LTS mapping, however the data has not yet been released. If it is completed on time the analysis will be performed, but if not the team will supplement with what is available. The County’s current sidewalk data is good at showing where sidewalks are located, but it is not routable so it cannot show connectivity within the network. The team is currently working to see how long a process developing a routable sidewalk layer would be, and it may need to be supplemented at a later date.

David Cookson noted that OOT has done some preliminary work with Mead and Hunt on a sidewalk network mode, and offered to set up a conversation between OOT, WRA, and Mead and Hunt to discuss next steps. Leah said she would provide WRA’s availability.
Next Steps

Jeff noted the action items from this meeting:

- CSIT members are to review the street cross sections and provide comments.
- WRA will distribute two polls, one to schedule second half of this meeting, and a second to ascertain availability early in the month for a reoccurring second CSIT meeting.

The next regularly scheduled CSIT meeting is scheduled for Wednesday, April 7 at 3:00 pm. An additional March and April CSIT meeting will be scheduled ASAP.

Leah Kacanda, AICP
Date: March 22, 2021

Date of Meeting: March 9, 2021

Meeting Location: Video conference

Work Order Number: 32189-005

Project: Howard County Complete Streets

Meeting Description: Complete Streets Implementation Team Meeting #15 (Part 2)

Participants:

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<tr>
<th>Name</th>
<th>Company</th>
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Introduction

The purpose of the meeting, which was a continuation of the March 3 Complete Streets Implementation Team (CSIT) meeting, was to provide members of the CSIT an overview of new street types and review the comment log.

Jeff Riegner welcomed all attendees and reviewed the agenda.

Jeff led the group through the presentation attached to these minutes. He noted that suburban street types will be addressed first. Because revisions to the sections address some of the issues raised by members of the CSIT, the comment log will be discussed second.

New Street Types

Jeff noted that street types for mixed-use contexts were discussed at the last CSIT meeting. Mixed-use street types apply to a small proportion of the County, including areas such as Downtown Columbia, Maple Lawn, and Columbia Gateway as it redevelops. Although some areas of eastern Howard County may redevelop as town centers, the majority of the eastern part of the County is suburban. The suburban street types are organized from larger street types to smaller street types. There are some common elements among the different street types but there are also some differences which will be highlighted.

Parkway

Jeff first described the Parkway type, noting that the term parkway was chosen because it is frequently used to refer to these types of streets in Howard County. Both four- and six-lane divided roadways are shown since both types are currently used in Howard County. Similarities between the two parkway types include 11-foot travel lanes because speeds along these road types will exceed 45 mph. All of the guidance the CSIT has discussed so far concurs that 10-foot lanes are only appropriate where speeds are 45 mph or less. Due to the high vehicular speeds and volumes along this street type, 10-foot shared use paths are proposed for people walking and bicycling. No parking is included in this type because the land use would not require it, but 5-foot shoulders are proposed.

Differences between the parkway types include the median width. The 6-lane parkway type has a 16-foot median and the 4-lane section has a 30-foot median. The wider median is necessary to accommodate U-turns.

Jeff noted that the benefits of a 5-foot shoulder include providing space to plow snow. Although 5 feet is not enough room to accommodate a stopped car, the space can be used if there is an emergency. The shoulder also creates more physical separation between moving cars and people using the shared use path. Disadvantages to providing a shoulder include additional impervious surface area. A wider paved surface will likely cause speeds to increase. A shoulder was shown in the proposed section to facilitate conversation about whether a shoulder should be provided in this street type.

Jessica Bellah agreed that additional impervious surface is not a good thing, but asked whether a 5-foot shoulder provides an opportunity for running utilities. She noted that if utilities are in the shoulder instead of outside of the curb, they will not be impacted by tree roots or require disturbing cyclists and pedestrians when maintenance is necessary.

Jennifer Biddle asked Jeff if he received any comments from Kris Jagarapu (who joined the meeting after this comment was made). She noted that Department of Public Works (DPW) staff met to discuss the proposed street types but they had not yet completed their review. She commented that a 5-foot shoulder is not wide enough to accommodate a stopped vehicle since it does not provide the appropriate clearance for a passing vehicle. Many Howard County parkways do not have shoulders. DPW will need a little bit more time to review the proposed street types.
Jeff added that most parkways in Howard County do not have shoulders currently, and the question is whether a 5-foot shoulder is sufficient. Typically, sections utilities are placed under sidewalks or a shared use path. He asked whether placing utilities in the shoulder would allow BGE to complete maintenance without closing the sidewalk or shared use path outside of the curb.

Christiana Rigby asked Cory Summerson from Baltimore Gas and Electric (BGE) to provide some insight on whether utilities could be located in the shoulder. Cory responded that the utilities could be located there, but the adjacent vehicular lane would still need to be closed down for maintenance, which was confirmed by Jennifer B. Jeff clarified that a lane closure would be required whether there is no shoulder, a 5-foot shoulder, or an 8-foot shoulder.

Jessica noted that there is an equity issue when closures disproportionately impact people walking or biking. Closing one vehicular lane is better than closing the full roadway; it spreads the inconvenience of construction across all modes. Cory responded that cables only need to be replaced once every 30 years or so, and that the biggest disruption is during new installations.

Larry Schoen asked how other jurisdictions make decisions about shoulder and median widths. Jeff responded that for this type of roadway shoulders are usually provided except in retrofit situations. Since the typical sections are for new construction, most jurisdictions would show a 5-foot, 8-foot, or larger shoulder.

Larry noted that if the goal is designing a street that people will use, there should be space in the sidewalk zone for tables or other amenities for people. He noted the provision of a shoulder only helps cars. Jeff responded that Little Patuxent Parkway east of downtown Columbia and Broken Land Parkway approaching Route 32 are good examples of this street type. Buildings are set back from the roadway and have their own parking areas. The scenario that Larry is describing would be typical in mixed-use settings but not a suburban setting.

Christiana responded that when looking at new construction it is important to keep long term planning goals in mind. Even if a road is in a transition area between mixed-use and suburban, the eventual goal is to activate streets by providing more useful accommodations for people. She noted that her preference is for less impervious surface and that the shoulders add ten additional feet of crossing distance for pedestrians. She noted she is open to reasons why shoulders may be necessary.

Jessica asked whether it is possible to add bump-outs at corners to shorten pedestrian crossing distances. Christiana agreed that would help, especially when crossing the street with a stroller. She asked whether it would create issues for bicyclists in the shoulder. Jeff agreed that ten extra feet of crossing distance is an issue for pedestrians. He noted the shoulders are not explicitly designed for cyclists, who can use the shared use path. However, some cyclists may prefer to stay in the street because they are riding faster and may not want to slow for pedestrians using the path. In that instance curb extensions would pose a concern.

Chris commented that pedestrians and cyclists are off the street except in limited circumstances. He noted that managing speed is important for all road users including drivers.

Carl commented that the wider a roadway is the more real estate is needed and the greater the construction costs. Both issues matter to the private development community. The decision to retain a shoulder should be made only if there is a definitive purpose for it. If DPW decides they need a place to push snow that would be a valid reason, but the extra land requirement and cost is not insignificant.

Jeff noted that people are introducing more cons than pros regarding the provision of shoulders. He noted that the benefits of having a shoulder can be achieved by other means. For example, the tree zone could also be used to store snow that also provides separation between people and moving cars. However, an 8-foot shoulder would be necessary to accommodate broken down cars. If the County has not had significant issues with breakdowns on the many miles of parkways without shoulders that exist today, there is not a complete streets reason to add shoulders. Chad noted that on some parkways without shoulders it is impossible to avoid running over drainage grates.
Larry asked about the width of the medians, and whether it is important to accommodate U-turns. Jennifer B. responded that U-turns are necessary to reach driveways at a few places on Snowden River Parkway. Christiana noted she regularly uses the U-turns along Snowden River Parkway. Larry asked whether the location of driveways dictates where U-turns are necessary.

Jeff commented that several comments had been received about U-turns at past meetings. He asked whether there were typical circumstances where U-turns are required, or whether there are generally opportunities to turn left into or out of a specific driveway or side street. He noted the median could be narrowed if U-turns are not needed. Chad responded that it may depend on now long the blocks are. He agreed that it is better to not have too many U-turns, and that sending traffic to a controlled signal would be preferable. Tom Auyeung agreed with Chad, noting that on freeways a break in the median is required for emergency vehicles.

David Ramsay asked whether median minimums or maximums could be listed to provide flexibility. Jeff answered that was a possibility. For example, a four-lane parkway section should have a 30-foot median where U-turns are necessary.

Larry asked about whether it is important to have a median at all given its limited use for people. Jeff responded that the median provides a refuge for crossing pedestrians and bicyclists as well as significant safety benefits to people in cars. Larry asked whether that applies to speeds in the vicinity of 45 mph. Jeff responded that medians create safer conditions at all speeds.

Larry noted asked whether the median would ever have a “v” shape without trees. Jeff replied that curbs provide better separation for narrower medians. He noted that freeway medians often have a “v” shape for drainage, but providing curbs allows for a narrower median. A 16-foot minimum allows for a 6-foot pedestrian refuge and a 10-foot left turn lane. In circumstances where a double left turn lane is needed, the median would need to be wider.

Carl noted that there is an aesthetic benefit to the parkway design. Jeff replied that the trees also have a modest but measurable impact on travel speed. Jessica added that they have a modest reduction on the heat island effect.

Kris Jagarapu joined the meeting and asked if there was any discussion about the 5-foot shoulder and questioned its purpose. Jeff noted that the group seemed to reach consensus that shoulders are not necessary. He shared that Chad commented that a one-foot offset to the curb would keep vehicles off the drainage grates on higher-speed, higher-volume streets. John Seefried noted that 12-foot lanes are helpful in this instance.

Chris asked whether a marked 11-foot lane with a one-foot area for storm drainage could be an appropriate treatment. John affirmed that would work, or it could be shown as a 12-foot lane. Chris replied that showing 11-foot lanes may help with speed management and prevent people from driving over the grates. Jeff agreed that stripping a one-foot offset from the curb would make sense. He asked whether the edge of the drainage grate frame is flush with the edge of the gutter pan or whether it extends into the travel lane. John confirmed that the drainage grate extends into the travel lane.

Carl asked to discuss the differences between the 10-foot proposed tree zone and a 6-foot tree zone. He noted that the 6-foot tree zone has been working for the county and asked whether a wider tree zone would provide a safety improvement. A 10-foot tree zone would require more land and is not favorable from a real estate perspective. Jeff replied that the wider zone provides a qualitative benefit, and that he is not aware of any studies requiring that amount of space. He agreed that there are a lot of engineering and landscaping reasons for a 6-foot minimum, but anything wider just provides a greater degree of comfort for vulnerable users.

Carl shared he polled a significant number of developers and builders who shared that dry utilities never go into the tree zone, so it does not need to be wider for that reason. Dry utilities are usually placed under the sidewalk or outside of the sidewalk in an easement. Jeff agreed, noting the phrase “tree zone/utility zone” was changed to “tree zone” for that reason. Carl asked that the tree zone be reduced to 6 feet wide in the suburban sections to match what is shown in the mixed-use sections. Jeff asked if he would be comfortable with a 6-foot minimum requirement, so that if it was desirable to provide additional space that is allowed. John noted it should be clarified that 6 feet has to be
measured from the back of the curb. Carl agreed that six feet from the back of the curb is currently in the Design Manual. John noted that any narrower would require a root barrier, and clarified that if the measurement is taken from the face of the gutter plan the measurement would be about 8 feet if it includes the curb and gutter. Carl clarified that he was just referring to the green strip from back of curb to the sidewalk or shared use path.

Jeff noted that the tree zone dimensions will be refined based on the discussions. He asked if there were any objections, concerns, or support to that approach. Kris responded that there are locations with 6-foot-wide tree zones where the roots cause adjacent sidewalks to heave, even in newer subdivisions that are less than 10 years old. The County is already receiving requests to go back and fix the sidewalks. The current Design Manual calls for a root barrier if the tree zone is less than 6 feet wide, but if there is space it may be good if the tree zone is a little bit wider. Kris noted he understands Carl's concern with making the right-of-way wider than what is needed.

Jeff asked whether the County requires the use of a particular soil mix or has compaction requirements for the soils around street trees. In areas of retrofit it is possible to provide a looser soil mix or greater excavation of in situ soils. Longer tree trenches in a narrow space provides more space for roots allow which allows them to extend along the space. Carl responded that there is incredible variation in how street trees are installed depending on the landscaper. John replied that he is not familiar with a soil mix specified for landscaping, but would check.

Larry noted he had some questions about higher-speed roadways. He asked for clarification that roads like Little Patuxent Parkway are not being discussed. He noted medians may help with safety, but there are a lot of pedestrian crashes and deaths along roads with medians because they reduce friction between cars going in opposite directions and encourage speeding. Jeff replied that medians also provide a refuge for pedestrians, and based on 30 years of experience, it is not appropriate to eliminate medians and a pedestrian refuge for streets this wide with traffic that travels at higher speeds. It would be appropriate to note that the parkway type is intended for certain speeds and above. Larry clarified that parkway street types are not intended for places where the pedestrian zone is expected to be activated, and that these are more through routes. Jeff agreed, noting that adjacent properties will be set back from the right-of-way. Larry noted that if buildings are set back and there are pedestrian uses between those buildings, the road profile would allow for a shared use path or pedestrian zone further back from the roadway closer to the buildings. Jeff replied that is one of the purposes of the 6-foot minimum tree zone. If the designer of a roadway wants to install the path 20 feet back from the roadway, they are welcome to do so.

Jeff asked if everyone was comfortable with a 6-foot minimum tree zone. There were strong arguments in favor of this size but there is also a benefit of providing additional width to accommodate tree roots. He asked whether it possible to address damage to sidewalks without increasing the width. He asked whether the County’s inspection process for private development allows inspectors to make sure that tree pits are big enough and not highly compacted when soil is reinstalled. He noted that ensuring planting requirements are met is easy for County funded projects but more difficult for privately built streets. John replied that the County does not currently have that type of standard. Existing regulations require the tilling of the top 6 inches of soil, but there is nothing that inspectors could use in the current standards.

Jessica asked if the County differentiates between the types of trees, noting that there is a big difference between a maple tree and something that will grow to 40-50 feet. Some species have surface root growth instead of deep root growth. John replied that the County allows specific trees, but he could not speak to how regulations could mitigate sidewalk issues. Jessica noted that a 10-foot width allows for more variability in tree species, but the concerns with right-of-way requirements are understandable.

Kris noted that the County does maintain an approved tree list, and if there are problems with a certain species they are removed from the list. For example, ash trees were eliminated from the list in 2004. The County used to have the same types of trees along the roadway, but now the preference is to mix species in case of blight that impacts specific tree species. Some subdivisions only had ash trees and all the mature trees died at the same time, requiring the County to remove and replace every tree along a street.
Jeff offered to conduct more research on the issue to see if it is possible to provide a good maintainable street tree environment within a 6-foot space between the back of the curb and the sidewalk/shared use path. If that is not possible the issue will be revisited with the CSIT.

**Neighborhood Connector**

Jeff introduced the Neighborhood Connector street type as a common street type in Howard County. He noted there are many places in Columbia where there are 3-lane cross sections with a single travel lane in each direction and a two-way left turn lane or median that is either striped or an island with street trees. In most instances these streets have sidewalks on both sides as opposed to a shared use path which is proposed in Option 1 of this type. Option 2 shows an on-street buffered bike lane, but is only appropriate where speeds are less than 35 mph. These streets typically have speeds between 35 to 45 mph depending on the alignment. Today, most of these streets have shoulders, but it is unclear if shoulders exist because the streets were previously four-lane streets that were reduced to three lanes. There are on-street parking and no-parking streets proposed for each option.

Jennifer White commented that the speed limit threshold that triggers a shared use path instead of buffered bike lane should be lowered from 35 mph to 30 mph, and clarified that the threshold should refer to operating speed not posted speed. She noted she shared an updated chart from the AASHTO bike guide that could be used as a resource to guide the selection of an appropriate bicycle treatment.

Jeff clarified that Option 1 offers a fully separated treatment where bicycles use a shared use path instead of the street. Option 2 shows a buffered bike lane, which Jennifer W. suggested is not appropriate at speeds above 30 mph. Jeff agreed in principle, and noted that the Level of Traffic Stress (LTS) guidance states that a buffered bike lane would be appropriate at 35 mph, while the FHWA Bikeway Selection Guide recommends a lower threshold.

Christiana asked about the benefit of not having a buffered bike lane if speeds are in the range of 30 to 35 mph. She noted that there is a financial cost to providing a shared use path, but that a lot of the data that has been coming out lately notes that buffered bike lanes do not provide a sufficient level of safety for people on bikes or drivers.

Jeff replied that speed is what would trigger the selection of Option 2 (shared use path) instead of Option 1 (buffered bike lane). He noted if it is possible to maintain speeds below 35 mph, it is generally accepted that on-street bike lanes are appropriate. Option 1 and Option 2 do have a difference in width which also depends on whether shoulders are included for Option 1. If shoulders are eliminated for this street type, the total width of pavement for Option 1 (shared use path) is 52 feet, with a total pavement width of 56 feet for Option 2 (buffered bike lane). Chris observed that the extra width stems from the provision of the buffer.

Jessica asked if there is a difference in material that would also impact cost, noting that the shared use path would require an asphalt base which would require more frequent replacement as opposed to a concrete sidewalk which is longer lasting. Jeff replied that there is no reason to not construct a concrete shared use path other than cost. Option 1 does offer a lower LTS, accommodates a wider range of users, and maintains a similar width to Option 2. He also noted that stormwater that drains off a road surface subject to oil and grease is a worse quality than stormwater that drains off a shared use path. Option 2 could be a good approach for retrofits where the current street width is larger and the right-of-way is constrained.

Jessica asked how many curb cuts are anticipated along this type of street. She noted that a shared use path is interrupted at every curb cut or driveway, as opposed to a on-street bikeway that provides a more continuous user experience. Jeff agreed that more frequent interruptions are a tradeoff when using shared use paths. He noted that some local access would be provided along this type of street but it should not be too frequent.

Larry shared he has seen design details that show a colored bike lane adjacent to private driveways to serve as a visual reminder that a cyclist may be present. He asked when that type of detail would be available. Jeff replied that in other jurisdictions that type of treatment is applied at higher volume commercial driveways, but not at residential driveways. That type of detail will be discussed when Chapter 5 is reviewed.
Larry asked why the outside buffer changes in size between different street types. Jeff noted that is to accommodate all of the features within the proposed right of way. He noted that right-of-way number can change and does not have to be an even ten feet. He noted that Option 1 with parking may be 82 feet to allow for space to build a sidewalk.

Larry noted he was skeptical that a road of this type would have a prevailing speed of 35 mph or less given the size of the right of way and the width of the lanes, concluding Option 2 is not realistic. He also noted his objection to a wider travel lane because it will encourage higher speed motor vehicle traffic. Jeff replied in light of all of the comments received, it may make sense to retain Option 1 and eliminate Option 2. Larry agreed, but noted that Option 2 should be kept as a treatment for retrofitting existing roadways. Jeff noted that based on feedback, Option 1 would be modified by eliminating the shoulder in the no parking option.

Chris noted that Option 1 may be easier to build for developers. The shared use path on both sides may seem like a lot to construct, but if you look at overall widths and the amount of impervious surface, the path option has less impervious surface as long as shoulders are not included. Jeff added that the pavement section for the shared use path would be lighter than the pavement section for a shoulder or parking lane. The consensus of the group was to eliminate Option 2.

Kris commented that the neighborhood connector options are similar to a collector roadway in the County. Jeff noted that there is not a tight linkage between street design and functional classification, mentioning Cradlerock Way as an example. Kris replied that it is helpful to see the proposed street types, but asked whether driveways will be present on this roadway type. He explained currently, driveways do not front on major collectors but they do on minor collectors. He noted the major collector requires a 60-foot right of way, while minor collectors only require a 50-foot right of way. The dimensions on the proposed sections are 90 feet, which is more similar to a minor arterial, which requires 100 feet in terms of right of way width. The proposed street function would be more similar to a residential neighborhood street. Jeff replied that based on feedback there should not be driveways along this street type. It has been difficult to understand how street design is informed by highway classification. The guidance in the manual appears to be applied in the field differently, likely because much of the county predates the design standards. This street type can be noted as appropriate where driveways are not present.

Kris commented that the neighborhood connector would have an impact on the cross section being proposed, because if there are no driveways it may be desirable to have parking on the road. He asked about the difference in right-of-way width for the parking and no-parking options. Jeff replied that based on the discussions the right-of-way width can be reduced. In the no parking option if the shoulders are eliminated and the tree zones are reduced to 6 feet a 70-foot right of way would be required as opposed to the 90-foot right of way shown. It is likely not possible to get to an 80-foot right of way for the on-street parking option.

Kris commented that the dimensions of the two-way left turn lane seem narrow, and asked if it is even necessary. He acknowledged that if the intersections are closely spaced the two-way left turn lane may be necessary, and asked if it could be a painted median in places where left turns are not as frequent. He asked for clarification on how this roadway type would function in a residential area. Kris noted that a minor collector has 28 feet of asphalt and a major collector has 40 feet of asphalt. These cross sections propose going to 38 feet of asphalt.

Jeff showed an image of Cradlerock Way as an example of a no-parking street that influenced this proposed street type. He noted that Cradlerock is about 40 feet curb-to-curb, with striped medians and some left turn lanes. There are a few locations where there are small raised median islands. Christiana noted that residents who live off Cradlerock Way often complain about speeding and the width of the roadway. Jeff noted the section can be modified to provide a two-way left turn lane only where volume warrants. The more common condition would be similar to the neighborhood street type where the two-way left turn lane is not necessary. The neighborhood street type features on-street buffered bike lanes because there are too many driveways to realistically accommodate a shared use path. The neighborhood street would work for streets with lower volumes and lower speeds, while the neighborhood connector would need the two-way left turn lane.
Christiana requested clarification on when a two-way left turn lane is necessary. She observed that cars seem to go slower when there is no median or divider between them and the two-way left turn lane seems to facilitate an unimpeded flow of vehicular traffic. She asked what the criteria is for adding a two-way left turn lane. Jeff replied that a two-way left turn lane is required when left-turning vehicles have to wait for a gap in traffic resulting in backups for through traffic. Where traffic volumes are low that wait is not long and it will not result in significant delays. Once volumes reach a certain threshold, which is usually around 12,000 cars a day, those left turning vehicles have to wait too long to find a gap, backing up cars behind them. Basically, the decision revolves around the volume of left-turning cars and the number of gaps.

Kris added that the distance between intersections can also influence the decision to provide a two-way left turn lane. On Cradlerock, intersections are 500 to 2,000 feet apart. If a driver is on a main road trying to make a left turn onto a side street, they utilize the turn lane. If a left-turn lane is required every 500 feet, it is important to maintain a consistent width throughout the corridor. If entering the roadway from a side street you can also use the turn lane to join the flow of traffic. It is not necessary to put a two-way left turn lane between blocks located within 500 feet. It depends on the layout of the entire neighborhood. Centennial Lane is an example where block lengths are too long and there is a painted median for the entire corridor to prevent the lanes from weaving in and out.

Christiana commented that she has been looking at existing streets from a different perspective, viewing the elimination of two-way left turn lanes as a way to accommodate bike lanes. For example, McGaw Road near Wegmans would be a better street if there wasn’t a center turn lane and instead had bike lanes on either side. She agreed that it is important to have a continuous expectation from point A to point B.

Larry asked if the implication is that traffic volumes on Cradlerock may not warrant any kind of left turn lanes. Christiana asked when the studies are done to determine whether center left-turn lanes are necessary. It is important to understand what the vehicle volume thresholds are for stop signs and turn lanes.

Jeff observed that the question seems to be what are the factors that would lead to selecting a neighborhood connector street type as opposed to a neighborhood street. Traffic conditions would have to warrant a center turn lane. Neighborhood streets would not require a center turn lane and the street would be narrower, with lower speeds and bike lanes.

Christiana replied that she is used to working to get protected facilities even though money is an issue. Her preference is for the safest option for the most users, especially since the street types will be a foundational document for the Design Manual revisions.

Jennifer B. noted it is more difficult to look at the street types as a foundational document because evaluating an appropriate street type requires looking at more than just speeds and the facilities provided for cars and bikes. It also requires looking at the origins and destinations of who is using the facility. She pointed to Homespun Drive as a street frequently used as a cut through to provide insight into DPW's decision making.

Jessica acknowledged that from DPW's perspective, the goal is for the curb-to-curb dimension to be consistent along a corridor. She noted that on Cradlerock this approach results in a lot of striped median that is not use for turning. She asked if that striped median presents an opportunity for plantings, or some other way to ensure the space does not encourage speeding. She noted she only sees medians on larger high-speed roadways. Kris replied that medians are possible if block lengths are longer. The guidance could suggest the use of grassy medians instead of a planted median. DPW has installed a lot of grass medians as part of retrofit capital projects, but the preference is to install them up front if possible. The comment to install a grassy median would be provided as part of the plan review process, but the Design Manual could provide guidance. For example, if block lengths are longer than 1,000 feet, a two-way left turn lane should be considered along with a raised median instead of a painted median.

Jeff cautioned that if shoulders are not provided, it is important to make sure that there is significant space for emergency vehicle access between the curbs. Jessica asked if it would be possible to provide a rolled curb so that people could pull up and get out of the way of an emergency vehicle. She also asked if a one- or two-foot shoulder would suffice. Jeff replied that the team will explore options.
Neighborhood Street

Jeff introduced the Neighborhood Street type, a two-lane roadway where speed and volume is low enough that a buffered bike lane would provide an acceptable LTS. This street type also includes sidewalks on both sides of the street and parking and no-parking options. If there isn’t enough traffic to warrant a three-lane section, this is what the street might look like.

Jennifer W. observed that buffered bike lanes are the recommended bicycle treatment and asked for more details about why they are appropriate instead of separate bike lanes or conventional bike lanes. Jeff replied that the team has been using federal design guidance including the Bikeway Selection Guide as well as the LTS criteria, designing in most cases for LTS 2 or better. Both sets of guidance indicate that a buffered bike lane is acceptable at a lower speed. The Bikeway Selection Guide sets that threshold at 30 mph or less and the LTS criteria sets it at 35 mph or less. This street would be designed for 30 mph or less, which means a buffered bike lane would work. If greater separation is required, a shared use path would be preferred for new construction because it is more comfortable for new users than a separated bike lane. For retrofit situations a separated bike lane may make more sense due to right of way constraints.

Larry asked whether the neighborhood street buffered bike lanes would be considered LTS 1 or 2. Chris responded they would be considered 2, and that 1 would require a separated bike lane or shared use path. Larry asked what would be used to provide physical separation. Jeff replied it could be a curb, flex post, or raised median. Larry asked whether it could be provided by vertical separation or colored pavement markings. Jeff replied that colored pavement markings would not decrease the LTS, and vertical separation is extremely expensive and difficult from a drainage perspective. There are a number of different design treatments that would work including concrete curbs, plastic segments that have flex posts that stick up from them, and plain flex posts.

Larry observed that one of the fundamental issues is that if a proposed neighborhood street connects residents to schools, libraries, or neighborhood centers, a way for the least skilled bike user to get from their home to the destination should be provided. If there is an alternate way to access those destinations, for example, via a Columbia path, the on-street buffered bike lanes are sufficient. However, if the neighborhood street is the only available connection, it should be LTS 1. Christiana agreed with Larry and asked whether there is a plowable bike lane delineator. Jeff replied that there is not, and physical separation would require DPW to have smaller plows and street cleaners. Alternately, the separators could be removable when plowing is needed. Some municipalities buy equipment to perform that maintenance. Montreal, for example, removes all separated bike lane delineators each winter. Larry asked how Montgomery County handles Naval Street. Chris responded that they have a small plow.

Larry noted he was speaking for himself and not all cyclists, but he would prefer physical protection 350 days of the year and allow snow storage in the bike lanes during snow events.

Chris observed that an option that provides physical protection in the 2-foot buffer or shows a shared use path may be necessary for school zones or wherever LTS 1 is necessary. Jeff noted that flex posts might suggest a 3-foot buffer zone especially because vehicular lanes are 10 feet wide. He noted that a wider buffer would still fit within the 60-foot right of way shown.

Kris asked whether the neighborhood street is supposed to be a minor collector or a local road. If it is a local road there will be a lot of driveways and houses where parking might be preferred to a physically protected bike lane. A shared use path would allow for LTS 1 and on-street parking. He asked why a shared use path was not shown as an option. Jeff replied that a shared use path was not shown because it was not needed to provide LTS 2, but a shared use path option can be developed. This street type is more analogous to a minor collector, which means there would be a number of driveways. Shared use paths crossing over driveways do present some concern, since drivers are less likely to see a cyclist traveling along a path. There is not a strong opinion for or against buffered bike lanes as opposed to shared use paths in this circumstance but that is one downside of a shared use path. Kris noted that buffered bike lanes would still have the same issue with driveways. Jeff replied that often, drivers look in the direction that they expect a car, which would be the same direction a cyclist using a buffered bike lane would be traveling from. Cyclists using a shared use path could be coming from either direction. It is not a fatal flaw, it is just something to consider.
Larry asked what the warrant is for a yellow line in the middle of neighborhood streets. The line can make cyclists feel less safe in situations with limited space because drivers are hesitant to cross over the line. Jeff responded that this is a concern in places where bikes share the roadway with motor vehicles, but when there is a designated bike lane that is less of an issue because cars can safely overtake cyclists. Larry asked whether there are some instances where showing the center line is not necessary. Jeff replied that the team has not gotten to that level of detail.

Chris proposed showing an additional two-way street type with a shared use path that would be LTS 1. Kris agreed. Larry noted it would be preferred if the path did not cross over multiple driveways, and asked whether it would be possible to provide a path behind adjacent development. Chris noted that it would be impossible to show that type of connection on the proposed sections. Larry asked if it could be shown as a footnote. Chris agreed that those back connections work very well, but are also often dictated by local constraints.

Jeff asked whether people want to see an alternative with a shared use path instead of buffered bike lanes.

Christiana noted she shared concerns about the effectiveness of bike lanes that are not physically protected. Neighborhoods have a lot of people, which is why it is important to prioritize safety. There are sidewalks on both sides of this street type. Although a shared use path may not be necessary, traffic speed should be thought of something to mitigate rather then something to plan around. Motor vehicles should be able to get in and out of a neighborhood, but safely moving around a neighborhood without a car should also be prioritized.

Larry agreed that providing options with guidance about how to choose a preferred treatment makes sense. Jeff agreed with that approach, noting that driveway frequency could be one consideration. Larry responded that physical protection whether by curb or flex post could also be a valid treatment option.

Carl noted that if the bike lane from the no-parking neighborhood street is shown as a shared use path, the street will only be 20 feet curb to curb which is too narrow. Jeff replied that moving towards a narrower street is not necessarily a bad idea if on-street parking is not allowed. The conversation at the last CSIT meeting regarding lane width was in consideration of on-street parking issues. There are circumstances today where on-street parking is prohibited, such as the example Larry provided of a two-lane street where parking is prohibited with a high tree canopy. Chris noted that West Running Brook Road south of Centennial Park is a similar street. Jessica noted that one of the primary features of West Running Brook is that it does not have a lot of cul-de-sac streets. Larry agreed that West Running Brook is very comfortable to ride on with children since people do not park on the street, there is a full tree canopy, and there is no double yellow line. Kris noted that this roadway has a long history and required an agreement that residents would not park on the street. The road was not originally built this way, it was modified. Chris asked whether the roadway was narrowed, and Kris said it was but not due to traffic issues, but because of issues with the trees. Chris replied that it is a great example of a street that works well for all road users. It is well sized for slow speed use by all modes and the trees make a big difference. Kris replied that speed was a complaint. There used to be traffic circles along the roadway which were eliminated about 8 years ago. Speed humps were also added at that time.

Carl commented that Howard County is not the first jurisdiction to implement bicycle facilities and asked whether it is possible to draw from the literature and experience from other places as to whether what is shown would work. The idea of going to a lower LTS than 2 is not something that seems to be pursued by many other jurisdictions. There is a body of knowledge about what creates a safe situation given the amount of traffic and roadway geometry. He expressed concern that there may be a situation where costs are being weighted against providing additional safety. Jeff agreed that following the existing literature is important, and that the LTS methodology and bicycle design guidance has been derived from the experiences of agencies across the country. The industry has determined that some type of bike facility is necessary once prevailing speeds exceed 25 mph. Physical separation should be considered at a 30 or 35 mph threshold. Above 35 mph physical separation is desirable. The issue with bicycle facility design is that it is not as mature a field as traffic engineering for cars, which as been around for 100 years. Bicycle facility design has not gotten into this level of detail until 20 years ago. It is impossible to guarantee that what is discussed now will be appropriate 10 years from now. Guiding documents are being followed for all the bicycle facility recommendations.
Alley

Kris asked if the alley is intended to be private. Jeff asked whether all alleys are currently private in the county. Kris replied that the county does not maintain any alleys, but that the use in common driveway requires a 24-foot easement, which is wider than the 20-foot easement being shown. Chad noted that for residential properties the pavement width is 16 feet which also fits within the 24-foot right of way.

Carl noted they used a lot of alleys in Maple Lawn. The geometry is a 24-foot HOA owned space. In most cases the alley is 16 feet edge to edge, but there are places it needs to be widened for trash trucks. There are no curbs and an inverted crown so drainage runs down the center. He confirmed they are owned privately.

Industrial Street

Jeff introduced the Industrial street type. He noted that the current standard for Howard County is 40 feet curb-to-curb. In looking at a number of examples of industrial streets, there were also 42-foot wide streets. There is a lot of variation in how the streets are used. In some places they are striped as two-lanes wide with no on-street parking. While parking may not be prohibited it did not seem to happen in practice. Some streets were striped as 3 lane roadways. Other streets featured 2-lane roadways with heavily used on-street parking. Flexibility seems to be a requirement of this street type. A single shared use path is also being recommended which will allow access for employees to get to and from their jobs.

Christiana agreed with the provision of a single shared use path. She noted that in the Guilford area a safe way to walk to lunch or access transit would be a big improvement. Larry observed that lower-paid workers in some industrial areas rely on walking and biking.

Kris asked whether it would be possible to provide a shared use path or sidewalk on both sides. He noted the current configuration is off-center, and there could be businesses without sidewalk access. If there is on-street parking it would be nice if the sidewalks are tied into the industrial buildings as opposed to limiting that access to one side of the roadway.

Paul Walsky noted that turning radii also need to be considered since trucks often drive over the curbs. Jeff replied that would be addressed during through the intersection design section of the Design Manual. The design vehicles for industrial streets will be larger than in non-industrial areas.

Jeff recommended adding a sidewalk opposite the shared use path to address Kris’s suggestion. Kris replied that it could be a 5-foot sidewalk. He observed the right of way increased from 60 feet to 70 feet, which should provide sufficient space for a shared use path and a sidewalk.

Jeff showed the other option, which does not allow for on-street parking. He noted that there are not many industrial streets in Howard County without parking, but it is very common in other jurisdictions. He asked the CSIT if there is a need for 24-foot industrial streets without on-street parking.

Jessica replied that she lives and works in Columbia, but generally the changing business types in industrial land use areas tend to include retail and service use, citing warehouse brew pubs as an example. These types of uses generate more pedestrian and bicyclist use than often considered in industrial zones. Those uses also support on-street parking. Christiana added that it is also important to consider adjacent land uses. An industrial area between two residential neighborhoods has different types of traffic than roads like Dorsey Run Road which is exclusively industrial.

Jeff noted the preference for on-street parking option which allows for more flexibly respond to changing land use patterns is preferred. Larry agreed, noting that the 42-foot width gives a lot of flexibility.
Country Road and Rural Development Street

Jeff briefly mentioned the Country Road and Rural Development Street types. Rural development streets are local streets in rural areas. They feature an open section and are 24 feet wide. Since development is lower density on-street parking should not be an issue. Jeff requested comments via email.

Kris noted that the country road type should have 12-foot wide lanes since farm equipment could be present. He recommended changing the swale to 10 feet on each side and using 8-foot shoulders to maintain a 50-foot right of way.

Jeff observed that pedestrian use is likely to be infrequent in rural locations due to the distance between origins and destinations. A wide shoulder is a typical accommodation for walking and biking in these circumstances.

Paul noted that when there are new residential developments along country roads it presents an opportunity to provide a shared use path that runs with the contours into the site. That would separate walkers and cyclists from the primary road section. Jeff replied that a shared use path option could be shown.

Kris noted that both options do not show trees since trees would be located outside of the right of way.

Paul noted that if the path was located outside of the right of way the county would have an easement. There also could be an easement for trees if necessary. Every road is unique, and the designer should have the flexibility to do something that fits the site.

Next Steps

Jeff noted that there is not sufficient time to review the comment log and asked that CSIT members review it on their own time. A number of comments have already been addressed or are no longer valid because the team has refined or modified the street types over time. He requested CSIT members send an email by the end of the week with any further issues.

Action items from this meeting include:

- CSIT members are to review the comment log and provide comments via email by March 12
- WRA will modify street types based on feedback received at the March CSIT meetings for the April CSIT meeting

The next regularly scheduled CSIT meeting is scheduled for Wednesday, April 7 at 3:00 pm. An additional April CSIT meeting will be scheduled ASAP.

Leah Kacanda, AICP
### CHAPTER 4
Design of Bridges, Retaining Walls and Small Structures

#### Static Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Subsections</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 INTRODUCTION</td>
<td>A. Responsibility of the designer</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Limitation of Topics Presented in the Design Manual</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Abbreviations</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Definitions</td>
<td>4-X</td>
</tr>
<tr>
<td>4.2 GENERAL FEATURES OF DESIGN</td>
<td>A. Coordination with Road and Street Planning</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Design Specifications</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Technical Reference for Design</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Basic Information Required for Design</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Selection of Retaining Wall Type</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>F. Selection of Bridge Type</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>G. Selection of Culverts</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>H. Structures Over Waterways</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>I. Clearances</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>J. Bridge Roadway Section</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>K. Horizontal and Vertical Alignment</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>L. Subsurface Investigations</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>M. Foundation Reports</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>N. Scour Reports</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>O. Bridge Inspection</td>
<td>4-X</td>
</tr>
<tr>
<td>4.3 DESIGN LOADING – HIGHWAY STRUCTURES</td>
<td>A. General</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Dead Load</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Live Load</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Wind Loads</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Thermal Forces</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>F. Force of Stream Flow</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>G. Earth Pressure</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>H. Earthquake Forces</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>I. Distribution of Loads</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>J. Constructability</td>
<td>4-X</td>
</tr>
<tr>
<td>4.4 SUBSTRUCTURES AND RETAINING WALLS</td>
<td>A. Retaining Walls</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Abutments</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Piers</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Foundations</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Substructure Protection</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>F. Slope and Bank Protection</td>
<td>4-X</td>
</tr>
<tr>
<td>4.5 BRIDGE SUPERSTRUCTURE</td>
<td>A. Slab on Beams and Girders</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Beams and Girders</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Steel Beams and Girders</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Prestressed Concrete Beams</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Bridge Drainage</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>F. Expansion Joints</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>G. Bearings</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>H. Drainage Troughs</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>I. Elevations</td>
<td>4-X</td>
</tr>
<tr>
<td>4.6 SHARED USE PATHWAY BRIDGES</td>
<td>A. General</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Loading</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Clearances</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Profile and Grade</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Railings and Fencing</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>F. Lighting</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>G. Aesthetics/Structure Type</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>H. Hydraulics</td>
<td>4-X</td>
</tr>
<tr>
<td>4.7 BOX CULVERTS</td>
<td>A. Analysis</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Design Guidelines</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Bottomless Box Culverts (Rigid Frames)</td>
<td>4-X</td>
</tr>
<tr>
<td>4.8 PIPE CULVERTS</td>
<td>A. Geometry</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. End Treatment</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Foundation Requirements</td>
<td>4-X</td>
</tr>
<tr>
<td>4.9 UTILITIES ON BRIDGES</td>
<td>A. Telephone Lines &amp; Cable</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. All Other Utilities</td>
<td>4-X</td>
</tr>
<tr>
<td>4.10 REHABILITATION OF EXISTING STRUCTURES</td>
<td>A. Introduction</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Superstructure Repairs</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Substructure Repairs</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>D. Retaining Walls</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>E. Maintenance of Traffic</td>
<td>4-X</td>
</tr>
<tr>
<td>4.11 LOAD RATINGS</td>
<td>A. Introduction</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>B. Methodology</td>
<td>4-X</td>
</tr>
<tr>
<td></td>
<td>C. Posting</td>
<td>4-X</td>
</tr>
<tr>
<td>4.12 PLAN PREPARATION GUIDELINES</td>
<td>A. Introduction</td>
<td>4-X</td>
</tr>
</tbody>
</table>
B. Sheet Layout and Order .................................. 4-X

4.13 REFERENCES ................................................... 4-X
4.1 Introduction

A. Responsibility of the designer

This chapter addresses the selection and use of design and evaluation criteria and practices applicable to the design and maintenance of Public Works structures including bridges, retaining walls and small structures in Howard County. The subject matter presented herein includes specifications and guidelines for the selection, analysis and design of Public Works structures and their individual subcomponents. While the requirements described for the various aspects of design will include and cover the majority of conditions encountered, there is no intention to relieve the designer of the responsibility to recognize when conditions are not favorable for the application of these design guidelines. The designer shall be continually alert to those conditions that cannot be satisfied by the application of these design guidelines.

The design specifications to be used for various types of Public Works structures are identified and referenced herein. Guidance and interpretations of the design specifications and specific standard design requirements of the Bureau of Engineering are also presented in this Chapter.

B. Limitations of Topics Presented in the Design Manual

It is not possible to include in this manual all features and topics of design and drafting necessary to accomplish the development of structure designs and construction documents for all projects incorporating bridges, retaining walls and small structures. The topics addressed herein are limited to those that will assist the designer in performing most engineering design tasks in an efficient manner and comply with currently accepted engineering practice as well as Howard County practice. Although it is the designer’s responsibility to exercise professional judgment in the acceptance and/or use of the design guidelines included herein, the designer shall recognize that they are being provided to assist in the development of the project in the manner preferred by Howard County. However, projects that are funded by Federal and/or State Aid may require compliance with the design criteria and standards set forth by the funding agency. Projects may also be subject to current, future and evolving regulations set forth by various local state and federal regulatory and resource agencies which may require deviation with or expansion of the criteria and standards herein. Any deviations from these design guidelines shall be brought to the attention of Howard County immediately. Any waivers of this design manual shall be justified to Howard County in writing, from an engineering evaluation, and shall include relevant considerations of life cycle costs and/or maintenance requirements. Approval or denial of the waiver requests will be by return letter signed by the Chief of the Bureau of Engineering.

C. Abbreviations

For standard abbreviations, refer to Section 1.2, “Abbreviations”, of this design manual.

D. Definitions

Bridge: A structure designed to carry vehicular, pedestrian and/or bicycle traffic having a roadway surface comprised of a structural element such as reinforced concrete or timber.

Culvert: A structure designed to carry vehicular, pedestrian and/or bicycle traffic having a roadway surface placed atop earthen fill and/or a structure designed as a continuous unit between the superstructure and substructure.

Small Structure: Any bridge or culvert structure that measures less than 20’ clear between abutments (measured parallel to the roadway centerline).

Retaining Wall: Any structure that is built to retain a fill section or a roadway as a means to eliminate or minimize impacts to adjacent properties or structures, with greater than 3’-0” exposed.
4.2 General Features of Design

A. Coordination with Road and Street Planning

Bridges, small structures and retaining walls are required for grade separations, stream crossings and earth retention usually as elements of a road or street facility. Planning and design of these structures must be coordinated with the road or street planning for overall project purpose as well as agreement in alignment, grade and typical section. For structures in historic districts and along scenic roads, aesthetics is also an important design consideration.

B. Design Specifications

1. A.A.S.H.T.O.

For highway and pedestrian bridges, retaining walls and small structures, the basic design specifications to be used are those of the latest edition of the “LRFD Bridge Design Specifications” of the Association of State Highway and Transportation Officials (A.A.S.H.T.O., Ref. 1), including subsequent interim specifications.

2. A.R.E.M.A.

The basic specifications to be followed in the design of railroad bridges or walls retaining railroad embankments are the current specifications of the American Railway Engineering and Maintenance-of Way Association (A.R.E.M.A., Ref. 2).

3. Howard County Storm Drainage Design Manual

Hydrologic and hydraulic design of structures shall be in accordance with the “Howard County Storm Drainage Design Manual Volume I” (Ref. 7).

4. Maryland Department of Transportation, State Highway Administration, Office of Structures (MDOT SHA OOS) Manual for Hydrologic and Hydraulic Design

Scour analyses and countermeasure design shall also be in accordance with the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12).

C. Technical References for Design

1. Capital Projects

Capital projects will be designed using Maryland Department of Transportation State Highway Administration Office of Structures Structural Guidelines and Procedure Memorandums (Ref. 10) Structural Details Manual (Ref. 11), and the Aesthetic Bridges - Users Guide (Ref. 26)

2. Other Projects

Other projects shall be designed similarly as Capital Projects unless written authorization is granted by the Chief of the Bureau of Engineering.

D. Basic Information Required for Design

1. General Information

To determine the overall configuration of a structure, the designer must obtain or establish the project alignment, profile and typical section and impose them on the existing physical topography.

2. Studies and Reports

Previous studies, engineering reports and preliminary plans, if any, shall be reviewed before beginning any new work on the project.

3. Record Plans

Records of utilities, existing structures, stream flow, and subsurface investigations at or near the proposed structure must be obtained.

4. Topography

Existing topographic maps such as those available from the United States Coast and Geodetic Survey and the Howard County Department of Public Works may be used for preliminary studies. Hydrologic studies shall be based upon the best available topographic mapping. Existing mapping must be supplemented by aerial photogrammetry and/or
E. Selection of Retaining Wall Type

The type of retaining wall to be constructed usually is determined by the cost of construction. However, some other factors such as critical clearances or right-of-way cost may affect the decision. The most economical type of wall to construct is primarily a function of the height of the wall. A gravity type wall is the most economical for low walls, a cantilever type wall for intermediate heights and a counterfort type for high walls. Other factors that shall be considered in the comparison of alternate wall types are the lateral earth pressure, the type of foundation, the depth of piles, and the allowable bearing pressure. The simplicity of construction and the durability of a gravity wall must also be considered in the final decision. See Section 4.4.A.1 for a description of retaining wall types.

In the historic districts and on scenic roads the aesthetics of a stone facing, colored and impressed concrete brick or wood trim may merit consideration. The approval of aesthetic amenities and/or special landscaping shall be subject to the review and approval by Chief of the Bureau of Engineering.

1. Proprietary Walls

Proprietary walls are patented systems for retaining soil. Depending on conditions, they can be more economical when compared to conventional retaining wall types. These walls are often more economical for long abutments and where high wall heights are dictated by field conditions. This type of wall construction can also save on bridge superstructure costs by reducing span lengths.

The detailed design and associated drawings are the responsibility of the proprietary wall firm, and wall products are typically provided through licensed regional manufacturers. The Maryland State Highway Administration requires that proprietary walls considered for use on capital projects must be on the list of Approved Proprietary Retaining Walls provided in the MDOT-SHA Structural Guidelines and Procedure Memorandums (Ref. 10).

a. MSE

Mechanically stabilized earth (MSE) walls are comprised of a reinforced soil mass and modular precast concrete facing panels which are vertical or near vertical. MSE walls may be used where conventional gravity, cantilever, or counterforted walls are considered, and are well suited for supporting fills and where substantial total and differential settlements are anticipated. The precast facing panels are adaptable to a variety of architectural finishes. MSE walls should not be used where utilities other than highway drainage would be constructed in the reinforced soil zone, where erosion or scour may undermine the reinforced soil zone, or where galvanized reinforcements may be exposed to surface or ground water contaminated by pollutants characterized by low pH and high chlorides or sulfates.

b. Precast Gravity

Precast gravity walls, also known as segmental or modular retaining walls, consist of interlocking, soil-filled concrete units, and depend on dead weight for stability. The precast units can also be used with soil reinforcements to construct taller walls than those that resist loads by gravity alone. The stacked prefabricated units offer fast, easy installation, with the flexibility of curved and corner alignments and terraced walls. The concrete units may be colored and the wall face fabricated in a variety of shapes and textures.

Precast gravity walls should not be used on curves with a radius of less than 800 ft unless the curve can be substituted as a series of chords, or where the longitudinal differential settlement along the face of the wall is greater than 1/200.

c. Gabions

Gabions are stacked, stone-filled wire baskets that are interconnected to form gravity-type walls. Gabion walls are simple to install and are well suited for use as slope protection, low-height retaining walls and, in some cases, channel linings. They are permeable, which allows for backfill drainage.
and also permits the growth of natural vegetation. Once vegetation has been established, these walls blend well into the natural environment. Gabion walls are inherently flexible and are able to tolerate differential settlement that may result from unstable foundation soils. Consideration as a stream channel lining or stream bank stabilization technique shall only be made after considering the potential for debris lodging which can damage and accelerate failure of gabions.

F. Selection of Bridge Type

1. Site Conditions

Since no two bridge sites are exactly equivalent, the designer must develop a particular span arrangement and bridge type for each individual site. Conditions at the proposed site such as existing grading, type of crossing and subsurface conditions must be taken into consideration. The constraints of limited right-of-way are relevant to some sites. Bridges in historic districts and on scenic roads should be designed to preserve or enhance the appearance of the road and to afford passengers views from the bridge.

2. Materials

The type of material to be used in construction will depend on a variety of factors including suitability of material to load requirements, availability of material, construction procedures, maintenance of traffic, construction time, unusual site conditions and relative life cycle cost of the various types of materials. The County precludes the use of prestressed concrete box beams and planks without the expressed written permission of the Chief of the Bureau of Engineering due to the difficulty in maintaining these types of structures. Wooden bridges in County park property may be acceptable subject to the review and approval by both the Chief of the Bureau of Engineering and Director of the Department of Recreation and Parks.

3. Cost

Since the relative economy of structure types cannot be generalized, it will be necessary to prepare economic comparisons of alternate bridge types suitable for a given situation in order to determine which type is most suitable from a cost standpoint. Future maintenance costs should be considered in addition to initial costs to ensure that the structure with the lowest life cycle cost is used.

To prepare these economic comparisons, it is first necessary to determine the structure quantities that are associated with each type of bridge. These may be obtained from preliminary designs, from quantity charts, from historical data, or by a combination of these methods.

Unit prices for application to the estimated quantities should be determined based on recent bid tabulations for comparable projects in the Howard County area. These unit prices must be adjusted by judgment on the basis of project size, location and construction difficulties.

4. Safety and Aesthetics

Important considerations are safety and aesthetics. Maximum traffic safety is provided by deck type overpass structures with adequately designed safety barriers and open span underpass structures without piers or other structural elements adjacent to the roadway.

Bridges on scenic roads or in historic districts merit special design consideration. The width of the deck should be consistent with the adjacent roadway. Barrier parapet walls should incorporate open railings at passenger eye level to permit views of the river crossing and adjacent scenery. Abutment embankments/slopes and piers shall be positioned to retain the natural stream channel adjacent to the bridge. If erosion is of concern, consider bio-engineering rather than riprap, gabions or a concrete channel.

Architectural treatment and other embellishments such as wider sidewalks for pedestrian use, bicycle lanes, open railing and special lighting should be considered where it is appropriate to improve the appearance and utility of the bridge to make it more compatible with the other elements of the surrounding community especially in historic districts along a scenic road. Modest use of special treatment can be done without a significant increase in cost, but such aesthetic requirements as an increase in span
lengths, special finishes and special structural shapes can result in significant cost increases. The added cost resulting from special treatment must be evaluated to determine that the improved aesthetics are worthy of the increased cost.

5. Maintenance Requirements

Future maintenance is another important consideration in the design of new bridges and existing bridge rehabilitations. All bridge components must be accessible for routine biennial inspection as well as maintenance, either by a snooper or some other means. Designs should provide for superstructure jacking to facilitate servicing, repair, or replacement of bridge bearings.

Key items to minimize future maintenance include:

- Minimize the number of expansion joints.
- Design sealed joints to prevent deck runoff from draining onto the bearings and beam seats below.
- Provide joint components that can be maintained.
- Avoid unusual joint details.
- Avoid details that trap dirt in splices, joints or other components.
- Locate scupper outlets below the bottom flange of beams to prevent water damage from splash-back.
- Provide downspouts and/or splash blocks where scupper outlets would cause erosion or dump water on roadways from overpasses.
- Eliminate or minimize the existence of deck drainage systems. If required, design deck drainage systems with sufficient size and adequate slope to prevent clogging and ponding. Provide clean-outs and avoid sharp bends in piping.
- Protect stream channels from erosion and piers and abutments from scour.
- Provide roadway drainage at abutments and wing walls to prevent erosion.
- Provide adequate vertical and horizontal clearances to prevent vehicle damage.
- Consider the feasibility of painting structural steel and evaluate the suitability of weathering steel.

- Consider using precast prestressed concrete structural members.
- Investigate the feasibility of using integral or semi-integral abutment construction.

G. Selection of Culverts

1. General

Culverts are generally cost-effective solutions for relatively small stream crossings. A single culvert can be used for the smallest crossing. Larger stream crossings can utilize multiple cell box culverts or a battery of pipe culverts. In each case, all factors of hydraulics, topography, economics and environmental factors must be considered before a culvert alternative is selected. It will be necessary to comply with the policies of all permitting agencies concerning the need for permits and the maintenance of the natural environment. Design of culverts shall meet all the requirements of bridges, including those for foundation design and scour design. For small culverts with inverts, subsurface borings taken for the roadway will usually be sufficient for the foundation design.

Box culverts are generally made of concrete with mild reinforcing. These can be cast in the field or precast at a factory in units which are then shipped and placed in the field. When precast concrete box culverts are used, the box culvert ends and all wing walls, headwalls and toe walls shall be cast in place; refer to Volume IV Design Manual.

Pipe culverts are available in a large range of shapes, sizes and materials. Steel pipes can consist of pipes rolled at the mill such as corrugated metal pipes (CMP’s, etc.) or pipes made from steel plates assembled at the job site such as structural steel plate pipes (SPP’s, etc.). Steel pipes less than 4’ in diameter may be either the CMP or the SPP type. Steel pipes larger than 4’ in diameter must be of the SPP type.

Culverts without paved inverts, such as structural plate pipe arches and precast concrete arches, are also commonly available. These types of structures are very dependent on the foundation conditions and their use may require extensive foundation and scour investigation work.
Chapter 4: Design of Bridges, Retaining Walls and Small Structures

Refer to Volume I Design Manual for additional information concerning culverts.

2. Advantages

For streams of a size within the hydraulic capacity of a culvert, the culvert is usually less costly to design, construct and maintain than a bridge. A culvert structure is less susceptible than a bridge to structural defects due to differential settlement, undermining and scour.

3. Disadvantages

In most cases, culverts tend to have the following disadvantages:

- The design opening is wider than the existing channel requiring undesirable channel modifications.
- Silting occurs during low flow.
- Multiple cells tend to obstruct flow and accumulate debris during flood flow.
- Water velocity increases in the culvert cause downstream scour.

H. Structures over Waterways

1. Hydrologic Studies

Hydrologic studies shall be performed for all structures crossing waterways. Flow rates and hydrographs associated with these studies shall be developed in accordance with procedures described in the “Howard County Storm Drainage Design Manual”, Vol. I (Ref. 7) for typical roadway culverts or the MDOT SHA “Manual for Hydrologic and Hydraulic Design” (Ref. 12) for Small Structures or Bridges. Existing stream gauging data, observed high water marks and observations of local residents shall be used to check and calibrate hydrologic calculations based on empirical methods, including those noted in Reference 12.

2. Hydraulic Studies

a. Bridges

Analysis of the effect of bridges on the stream flow and establishment of the design high water at the bridge site or at other critical points shall be in accordance with the procedures described in the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12).

A freeboard of one (1) foot from the design high water to the underside of the superstructure shall be maintained. Refer to the “Howard County Storm Drainage Design Manual” (Ref. 7) for specific freeboard requirements.

d. Box Culverts

The effects and characteristics of flow in box culverts shall be analyzed in accordance with the procedures described in the Federal Highway Administration Circular “Hydraulic Design of Highway Culverts” (HDS–5) (Ref. 8) or similar publications. Due consideration shall be given to both inlet control and outlet control.

3. Hydraulic Design Criteria

a. Highwater Elevation

A stream crossing structure shall be designed to interfere as little as possible with the natural stream channel and shall conform to the “Howard County Storm Drainage Design Manual”, Vol. I (Ref. 7) and other State and Federal requirements.

b. Maximum Velocities

Discharge velocity shall be consistent with channel materials. For maximum and minimum velocities, refer to the “Howard County Storm Drainage Design Manual”, Vol I (Ref. 7), the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12) and applicable environmental regulations.

I. Clearances

1. Horizontal Clearances - Highways

a. Bridge Roadway Width

The roadway width of bridges shall preferably be the full width of the approach roadway section including the shoulders. Minimum bridge roadway widths are
discussed in the MDOT-SHA “Structural Guidelines and Procedure Memorandums” (Ref. 10) for various classifications of highways. These minimum widths shall be adhered to unless written authorization is provided by the Chief of the Bureau of Engineering. If the approach roadway section includes a sidewalk, the sidewalk shall be carried across the bridge. If the approach roadway sections does not include a sidewalk, consideration should be given to providing sidewalks on bridges in areas that may develop within the bridge’s service life.

e. Underpass Clearance

For an open section roadway or a bridge, the piers or abutments shall be set to provide clearance for the full shoulder plus a guardrail or concrete barrier. The roadway face of the guardrail shall be at least 5'-0" from the face of the pier or abutment. The face of the guardrail or barrier shall be at least 2'-0" outside of the normal shoulder line. For closed section roadways, the face of pier or abutment shall be set a minimum of 8'-0" back of the curb line. Piers and abutments shall be protected by guardrail or crash walls.

2. Horizontal Clearances - Railroads

Horizontal clearances from railroad tracks to piers, abutments or walls of an overpass structure shall be in accordance with the requirements of A.R.E.M.A. (Ref. 2) and the policy of the particular railroad for the class of track involved. In the case of privately owned spurs, the clearances shall be at least equal to the requirements of the Maryland Public Safety Laws and meet the approval of the railroad operating over the spur.

3. Vertical Clearance

a. Highways

Vertical clearance to highway or railroad structures over highways shall be 16'-9", which provides for 16'-0" minimum over any usable portion of the roadway and shoulder and 9" of future surfacing.

b. Railroad

Vertical clearance over railroads shall be 24'-3" (top of rail to underclearance) for electrified railroads, and 23'-0" for all others. Clearance shall be approved by the railroad owner.

c. Pedestrian

Vertical under clearances for pedestrian bridges shall be: 24'-3" over electrified railroads and 23'-0" over other railroads. Vertical clearances for pedestrian bridges over streets or highways shall be in accordance with the requirements of A.A.S.H.T.O. (Ref. 1) and provide an additional 1'-0" clearance of that required for highway bridges.

J. Bridge Roadway Section

1. Curbed (Closed) Section

The flow line of a curbed roadway section shall be continuous across the bridge. If the approach roadway section includes sidewalks, the sidewalks shall be carried across the bridge. If the approach roadway section does not include sidewalks and there is 3' minimum between the curb and edge of traffic lane, then a traffic barrier shall be located at the flow line. However, consideration should be given to carrying the sidewalk across the bridge in areas that may develop within the bridge’s service life. If the approach roadway section does not include sidewalks and there is less than 3' between the curb and edge of traffic lane, then a sidewalk shall be carried across the bridge.

2. Rural (Open) Section

The shoulder of a rural section shall be carried across the bridge. The cross-slope configuration shall conform to that of the approach roadway except that the cross slope in the shoulder area on the bridge shall be an extension of the adjacent traffic lane (i.e., no shoulder breaks on bridge). The approach roadway shoulder slope shall be transitioned to meet the shoulder slope of the structure beginning at a minimum distance of fifty (50) feet from the ends of the structure.
3. Barriers

All barriers on bridges and approaches, including transitions, shall meet or exceed MDOT-SHA and A.A.S.H.T.O. specifications, including crash testing requirements based on the roadway classification. The MDOT-SHA “Bridge Railing Manual” (Ref. 25) provides guidance on railing selection and shall be adhered to for capital projects unless written authorization is provided by the Chief of the Bureau of Engineering. Selection of the appropriate barrier, with or without metal railing, should be made with consideration given to the type of roadway facility (controlled access or non-controlled access), whether pedestrians and/or cyclists are expected to use the bridge, and whether sidewalks are required on bridge. Safety fence shall be provided in accordance with MDOT-SHA requirements. Decorative barriers/railings or bridge lighting appurtenances shall be subject to the approval of the Chief of the Bureau of Engineering.

Careful attention shall be given to the treatment of railing at the bridge ends. Exposed rail ends, posts and sharp changes in the geometry of the railing shall be avoided. A smooth transition by means of a continuation of the bridge barrier, flared end posts, roadway guardrail anchored to the bridge barrier, continuation of bridge guardrail, or other effective means shall be provided to protect the traffic from direct collision with the bridge rail ends. Guidelines for these transitions are specified in the MDOT-SHA “Book of Standards for Highway and Incidental Structures” (Ref. 15).

K. Horizontal and Vertical Alignment

1. Bridges

The horizontal and vertical alignment of the bridge must be coordinated with the overall plan and profile of the approach roadway. Geometric design requirements concerning sight distances, minimum curve radii, superelevation, etc., shall be in accordance with Chapter 3, “Road and Street Design”. Methods and criteria for maintenance of traffic are contained in Chapter 5, “Traffic Engineering Design”.

2. Horizontal Alignment of Box Culverts

a. Alignment with Waterway and Road

Culverts shall generally be located and aligned as closely as possible to the natural drainage course for which they are being designed. The skew angle shall be kept as close to 0 degrees as possible, while providing a minimum stream relocation, if any.

b. Maintenance of Flow

The designer must consider the requirements for maintaining stream flow during construction. It may be necessary to provide a temporary channel in order to provide for maintenance of flow. Maintenance of stream flow plans shall be prepared in accordance with the latest edition of the MDE “Maryland Waterway Construction Guidelines” (Ref. 9).

L. Subsurface Investigations

In order to determine the type of foundation and allowable bearing pressures, borings will be required at the proposed locations of walls, culverts and bridge foundations. The information obtained should include elevation of the existing ground at the boring, a description and depth of the material encountered, number of blows per six (6) inches on the sampling spoon, recovery of cored rock, total depth of boring, the water table level and the time of observation. For small culverts with inverts, subsurface borings taken for the roadway will usually suffice for the foundation design.

Standard penetration borings through soil are required to be performed in accordance with AASHTO T206 and ASTM D1586. The number of blows required for each 6 inches of penetration or fraction thereof shall be recorded. The first 6-inch penetration is considered to be a seating drive. The number of blows required for the second and third six inches of penetration added together is considered the penetration resistance, N.

Split spoon samples shall be taken at every change in material at intervals not exceeding five (5) feet. All borings should be drilled to refusal and cored a minimum of 5 feet into rock. Refusal is defined as 50 blows or more per inch or less of penetration.
Foundation borings shall generally be located as follows: one boring at each end of each substructure unit for multibeam bridges; one boring at each end minimum with intermediate borings as required to maintain 100’ maximum c/c spacing for culvert type structures and retaining walls.

All the boring log information must be shown on the plans.

M. Foundation Reports

A formal Foundation Report is required for all retaining walls 4’ or greater in height measured from the top of wall to the ground line at the front face of wall; all box culverts; all pipe culverts with individual spans greater than 8’ measured perpendicular to the pipe; all hydraulic structures without inverts; and all bridges. For structures not meeting these requirements the designer shall perform sufficient subsurface investigations and analysis to ensure the stability of the structure. The depth and number of borings shall be in accordance with AASHTO LRFD Bridge Design Specifications requirements.

The formal foundation report shall provide all information and calculations documenting that the subsurface investigations and foundation design have been made in accordance with the requirements of this Volume III Design Manual and A.A.S.H.T.O. LRFD Bridge Design Specifications. In addition, the foundation report shall address the impact of settlement of approach fill embankment on bridge foundation design as well as pertinent foundation construction control and construction considerations. The Foundation Report shall be accompanied by boring logs plotted on a plan sheet and preliminary structure plans.

For all new or replacement bridges, detailed Foundation Reports shall be prepared for review and approval by the Chief of the Bureau of Engineering. Foundation Reports shall include copies of all boring and laboratory testing information including a project map noting the location of all test borings. For Capital Projects, Foundation Reports shall be prepared in accordance with applicable sections of the MDOT-SHA “Structural Guidelines and Procedure Memorandums” (Ref. 10).

N. Scour Reports

Current regulations require that the construction, replacement or rehabilitation of any bridge structure which uses either full or partial funding from the Federal Government be accompanied by an approved Scour Analysis Report. Reports for such projects will be reviewed by the Maryland State Highway Administration Office of Structures (OOS). All scour reports shall be developed in accordance with the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12), in particular Chapter 11.

All scour reports shall be prepared and sealed by a registered professional engineer in the state of Maryland. Personnel involved in the evaluation of scour need to possess the technical qualifications, including practical experience, education and professional judgment, to perform the individual tasks assigned. Interpretation of results and conclusions of scour analyses shall be accomplished by registered engineers qualified in the appropriate disciplines. Because of the complexity of bridge scour, the evaluations shall be performed by an interdisciplinary team of engineers with the requisite knowledge in structural, hydraulic, river mechanics and geotechnical engineering.

For non-federally funded projects, scour reports may not be required if any of the following criteria applies:

- The project scope is limited to the rehabilitation of the bridge superstructure and/or minor rehabilitation of the substructure. Minor rehabilitation of the substructure shall be limited to abutment (or pier) repair and shall not include any changes to the overall geometry of the substructure units, with the exception of minor fascia treatments that do not reduce the total waterway opening by more than 10%.

- The project is a replacement or rehabilitation of a bridge or bottomless culvert where evidence of scour is minimal either through inspection or previous inspection reports and where the proposed abutment footings, or deep foundations such as piles, are founded in non-erodible rock. Rock where borings indicate a Rock Quality Designation (RQD) less than 50% shall be assumed to be erodible (FHWA Memorandum on Scourability of Rock – June 19, 1991).

- The project is a new, replacement or rehabilitated bridge or culvert along a private road or drive not
Chapter 4: Design of Bridges, Retaining Walls and Small Structures

O. Bridge Inspection

Howard County maintains an inventory of bridges and small structures. To assist the County, designers are required to provide the following information for culverts with spans greater than 10’ and for all bridges:

- Design Storm Year
- Runoff Q in cfs
- Drainage area in acres
- High Water Elevation for the Design Storm
- Year of Maryland State Highway Specification used

P. Design Life

All bridges must be designed to achieve a minimum service life of 75 years or a longer period (e.g., 100 years), if so directed by the Chief of the Bureau of Engineering, for applicable capital projects.
4.3 Design Loading – Highway Structures

A. General

Loads and loading combinations shall be in accordance with the provisions of A.A.S.H.T.O. (Ref. 1). The limit states described in the A.A.S.H.T.O. specifications (Ref. 1) shall be investigated for the design and analysis of bridge components.

B. Dead Load

1. Future Wearing Surface

In addition to the dead load of the structure, an allowance shall be made in the design analysis for a future wearing surface. This shall be 25 lbs./sq. ft. for all except moveable spans and exceptionally long spans. The additional deck load for these spans shall be determined on an individual basis depending on the type of construction.

2. Unit Loads on Culverts

The dead load on culverts shall include the dead load of the box and the weight of earth above the box. Loads shall be calculated in accordance with A.A.S.H.T.O. Specifications, (Ref. 1). Except for box culverts on piles, the dead load of the bottom slab and water within the box should be neglected in design of slabs and walls. These dead loads shall, however, be included when determining foundation pressures. In the absence of more exact information, the density of the soil shall be taken as 120 lbs./cu. ft. and 150 lbs./cu. ft. shall be used for the weight of the concrete.

3. SIP Forms

An additional allowance shall be made in the design analysis when the use of steel stay in place forms is required. This loading shall be 15 lbs./sq. ft. of deck form plan area. This value includes the weight of the forms plus concrete in the corrugation valleys of the forms.

C. Live Load

1. Design Loadings
Weep holes will be provided to insure a low ground water elevation at the rear face of the structure.

If conditions are such that it is not possible to control the water table behind the structure, the structure shall be designed taking into account, below the water level, the full hydraulic pressure in conjunction with pressures of the submerged soil.

A sloping finished grade line behind the structure may be accounted for by computing the pressure on the basis of the depth of earth in a vertical plane at the heel of the footing.

1. **Water Pressure**

   If conditions are such that it is not possible to control the water table behind the structure, the structure shall be designed taking into account, below the water table, the full hydraulic pressure in conjunction with pressures of the submerged soil. Below the water table the unit weight of the retained soil is reduced to its submerged or buoyant value. As a result, the lateral earth pressure below the water table is reduced, while the retained water exerts a horizontal hydrostatic pressure.

   When ground water levels differ on opposite sides of a retaining wall, the upward buoyant force beneath the wall foundation tends to overturn the wall. Unequal ground water levels also result in seepage beneath the wall. The effect of seepage forces is to increase the load on the back of the wall (and decrease any passive resistance in front of the wall). Pore pressures in the backfill soil can be approximated through the development of a flow net or other analytical methods, and then added to the horizontal earth pressures acting on the wall.

**H. Earthquake Forces**

Structures shall not be designed to resist earthquake forces.

**I. Distribution of Loads**

For distribution of loads refer to A.A.S.H.T.O. (Ref. 1)

**J. Constructability**

Constructability checks shall be completed in accordance with the provisions of the A.A.S.H.T.O. Specifications (Ref. 1). The wind load provisions specified in the "Guide Specifications for Wind Loads on Bridges During Construction" of the Association of State Highway and Transportation Officials (A.A.S.H.T.O., Ref. 22), including subsequent interim specifications shall be used for wind loading on steel and concrete superstructures before the deck has been placed.

The load factors for construction loads shall be taken as the minimum specified in A.A.S.H.T.O. (Ref. 1).
4.4 Substructures and Retaining Walls

A. Retaining Walls

The primary structural function of a retaining wall is to counteract the lateral forces caused by earth pressure. These forces have two principle effects on the wall. First, they tend to overturn the wall and secondly, these forces tend to push or slide the wall. Before designing specific parts of the wall, such as the footing, stem, etc., overall stability of the wall and the earth mass must be satisfied. The total earth mass containing the wall and its foundation must be in equilibrium. A subsurface investigation should be made to determine the possibility of a slip plane failure that would affect the global stability of the entire installation. The overturning moment about the toe of the footing, caused by the earth pressure and surcharge, must be resisted by the stabilizing moments of the dead load forces. Unless a structure is keyed into rock or is restrained by an adjacent structure, the horizontal earth pressure force must be resisted by friction between the footing and the foundation. Retaining walls used in subdivisions and site development plans shall use the retaining wall checklist when submitting designs.

Reinforced fills and proprietary retaining walls will be considered on a case by case basis. No consideration for use shall be given unless the system has been approved for use by the MDOT State Highway Administration.

Retaining walls are primarily either fill walls or cut walls. Fill walls are typically constructed from the bottom up and consist of placing material behind the face of the wall. Cut walls are typically constructed from the top down and consist of removing material in front of the face of the wall.

1. Fill Retaining Wall Types

There are six principal types of fill retaining walls: gravity walls, semi-gravity walls, cantilever walls, counterfort walls, buttress walls and MSE walls. Table 1 provides general guidelines for fill retaining wall selection.

a. Gravity Walls

Gravity Walls resist sliding and overturning by means of their mass, the resultant of all forces being within the middle third of any horizontal section through the wall. Reinforcing is required only to resist shrinkage and temperature forces and shall be the minimum required by the governing design specification.

As a guide for initial design, the width of the base of the wall should be approximately 0.45 times the total height. The final size used varies with the type of material, the slope of the backfill surface, the surcharge and the allowable bearing pressure.

<table>
<thead>
<tr>
<th>Retaining Wall Type</th>
<th>Cost Effective Height Range (ft)</th>
<th>Typical Required Right-of-Way</th>
<th>Tolerable Differential Settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Gravity Wall</td>
<td>Up to 10 feet</td>
<td>0.5 – 0.7H</td>
<td>1/500</td>
</tr>
<tr>
<td>Concrete Cantilever Wall</td>
<td>Up to 20 feet</td>
<td>0.4 to 0.7H</td>
<td>1/500</td>
</tr>
<tr>
<td>Concrete Counterfort Wall</td>
<td>30 feet to 60 feet</td>
<td>0.4 – 0.7 H</td>
<td>1/500</td>
</tr>
<tr>
<td>Gabion Wall</td>
<td>5 feet to 20 feet</td>
<td>0.5 – 0.7 H</td>
<td>1/50</td>
</tr>
<tr>
<td>MSE wall with precast facing</td>
<td>10 feet to 40 feet</td>
<td>0.7 to 1.0H</td>
<td>1/100</td>
</tr>
<tr>
<td>MSE wall (modular block facing)</td>
<td>5 feet to 20 feet</td>
<td>0.7 to 1.0H</td>
<td>1/200</td>
</tr>
<tr>
<td>MSE wall (geotextile/ geogrid/ welded wire facing)</td>
<td>5 feet to 40 feet</td>
<td>0.7 to 1.0H</td>
<td>1/50</td>
</tr>
</tbody>
</table>
Gravity walls may be used under any condition where foundation material is reasonably good and are often the most economical type for use where the wall is quite low. Because of its massive construction, this type of wall is more resistant to destructive agents and partial disintegration of the concrete is not as serious as for the heavily reinforced types.

b. Semi-Gravity Walls

By introducing a relatively small amount of reinforcing steel in the back face of a gravity wall, a slenderer stem can be used. This type of wall is commonly known as a semi-gravity wall. The semi-gravity wall is more economical than the solid gravity wall and has the same advantage of durability due to massive construction, although to a lesser extent.

c. Cantilever Walls

Cantilever walls consist of a continuous stem supported on a continuous footing. Resistance to overturning results from the stabilizing action of the weight of concrete in the wall and the block of earth supported directly over the heel of the footing. The stem, the heel of the footing and the toe of the footing act as cantilever slabs resisting the applied loads.

The stem shall be designed to resist the moments and shears caused by the earth pressure above the top of footing and the surcharge applied to it. The weight of the stem itself shall be considered and the critical sections designed for direct stress and bending.

The heel of the footing shall be designed to resist its own weight and the total weight of the earth supported directly on it, with or without a reduction for upward foundation pressures.

The toe shall be designed to resist the foundation pressure acting on it, less its own weight, but no reduction is to be made for backfill over the toe.

Cantilever walls are the most widely used type and can be used in heights to approximately 30 feet. This type of wall is by nature more flexible than the other types, and considerable deflection can be expected at the top of the higher walls. Consequently, cantilever walls should not be tied to other types of walls with shear keys. Rather, architectural offsets or pilasters should be incorporated into the design at such junctures so that differential deflection will not be noticeable.

For the most economical arrangement, a cantilever wall stem should be located over the point where the resultant of the loads pierces the plane of the footing. This means the toe of the footing for the typical wall should be about one-third the total width of the footing. However, the stem may be located anywhere on the footing as required by right-of-way requirements, conflict with structures and utilities, or for other reasons.

As a guide for initial design, the footing width normally ranges between 0.5 and 0.7 the total height of the wall, depending on allowable bearing pressures, desirable bearing differentials and superimposed loads.

d. Counterfort Walls

Counterfort walls consist of a face wall spanning continuously between counterforts which extend into the backfill. Counterforts are spaced at some constant interval, usually in the range of from 8 feet to 16 feet and are supported on either individual or continuous footings.

The face wall may be either full height or, in the case of deep footings, extend only 2 ± feet below finished grade at the front of the wall.

Face walls shall be designed as continuous slabs in increments of height. Each increment shall have the proper thickness and/or reinforcement to resist the average earth pressure over that increment. If the face wall is tied to the footing, the bottom...
increment can be designed for vertical and horizontal bending.

The heel portion of continuous footings shall also be designed as continuous slabs. The toe, which commonly is rather short, shall be designed as a cantilever as previously described. Counterforts shall be designed as tee-beams to resist the overturning forces for the full counterfort interval.

Counterfort walls are usually most economical for heights over 30 feet and in instances where the footing must be placed very deep.

Widths of counterfort footings to satisfy stability requirements are usually at least 0.5 the height of the wall. The heel dimension is normally governed by the counterfort design.

It is necessary that counterforts be of sufficient size to permit proper placing and vibrating of the concrete and to permit proper cleaning prior to placing the concrete. They should not be less than 2 feet in thickness.

e. Buttress Walls

A variation of the counterfort wall is the buttress wall. This type of wall resembles the counterfort wall except that the members supporting the face slab are on the exposed face of the wall and are called buttresses rather than counterforts. The face slab is designed in the same manner as a counterfort wall and the buttresses are designed as rectangular beams. Since the buttresses are exposed and therefore reduce the clearance in front of the wall, the buttress wall is rarely used.

f. MSE

Mechanically stabilized earth (MSE) walls consist of facing elements connected to layers of soil reinforcement that are embedded within a select backfill. These walls resist lateral loads through the dead weight of the reinforced soil mass behind the wall facing. Wall heights of up to 40 ft can be constructed. MSE walls are often used at bridge abutments, with a stub abutment supported on piles behind the wall.

MSE wall systems are designed to meet the requirements for overall stability (global stability), external stability including overturning and sliding, bearing capacity, and settlement, as well as the internal stability requirements including the strength of the reinforcement element, pullout resistance and connection strength. Lateral pressures are determined from active earth pressure acting on the back of the reinforced soil mass. The analysis of the overall and external stability is the responsibility of the design consultant. The analysis of the internal stability is the responsibility of a proprietary retaining wall company.

The reinforced soil mass consists of select granular backfill placed in layers between reinforcement, which is comprised of either inextensible (deformation of the reinforcement at failure is less than deformability of soil – includes steel strip and bar mat reinforcement) or extensible (deformation of reinforcement at failure is comparable to or greater than deformability of soil – includes geogrid, geotextile and woven steel mesh reinforcement) reinforcement. Metallic reinforcement typically consists of mild steel and nonmetallic reinforcements typically consist of polymeric materials consisting of polyester or polyethylene. Steel soil reinforcements and connection hardware shall be galvanized. The soil reinforcement length is a minimum of 70 percent of the overall wall height and is uniform throughout the entire height of the wall.

Facing elements are designed to resist the horizontal force of the reinforcement. Facing materials consist of precast concrete panels, full height panels, modular block wall units, and welded wire mesh facing. Segmental, precast concrete panels are typically between 5 inches and 8 inches thick, 5 feet high and have a front face width that is 5 feet or 10 feet. Panels are typically square or rectangular; however, cruciform, diamond and hexagonal face geometry are also available. Typical dimensions of full-height
concrete panels are 6 inches to 8 inches thick 8 feet to 10 feet wide. Modular block wall face units (also known as segmental retaining wall units) are typically 4 inches to 15 inches high, 8 inches to 18 inches in exposed face length and 8 inches to 24 inches in depth. Welded wire mesh facing is typically used for temporary walls. Galvanized steel is used for permanent walls with welded wire facing. Hot dip galvanizing of at least 2 oz/ft$^2$ is expected to protect the steel in atmospheric conditions for up to 50 years. A corrosion rate of 1.0 mil/year should be considered for temporary, non-galvanized steel facings.

Internal drainage must be provided to prevent saturation of the reinforced backfill and infiltration of damaging elements from the surface. In cut areas, drainage blankets are provided behind and below the reinforced soil mass. For roadways subject to chemical dicing agents, an impervious membrane above the first layer of reinforcement may be necessary.

General design guidelines for MSE retaining walls are as follows:

- Publication No. FHWA-NHI-10-024, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volumes I and II, 2009
- AASHTO LRFD Bridge Design Specifications, Volume II

h. Gabions

Gabion walls are constructed from stone filled wire mesh boxes, which are stacked and wired together. The backfill can be placed behind the wall as each level of boxes is installed. Gabion walls can be economically constructed to about 30 feet in height. Gabions can also be used as a wall facing with soil reinforcements, typically galvanized wire mesh, for wall heights up to 45 feet.

Gabion boxes are constructed from hexagonal mesh woven from soft galvanized wire. The wire may be PVC coated to protect from acidic soils or marine environments. The nominal size of the mesh openings is three to four inches. The boxes are usually constructed with internal wire mesh diaphragms or wire cross-ties for increased strength. Standard gabions are available with the following dimensions:

- Nominal Length – 6, 9, or 12 feet
- Nominal Width – 3 feet
• Nominal Height – 1, 1.5, or 3 feet.

The stone used to fill the gabion baskets should be non-friable, weather resistant, and preferably high density. Gabions may be filled by hand or machinery, but in either case it is important that they be filled carefully to maintain the box shape to ensure proper alignment of the wall.

Gabion walls are designed to resist lateral earth loads as a mass gravity structure, in which the additional tensile resistance of the wire mesh is ignored. Gabion structures are permeable, allowing for free drainage, and are not designed for water pressure loads. While gabion walls are self-draining, it is advisable to provide a backfill drain above footing level to collect drainage and protect the wall foundation. Smaller height gabions are used at the base of walls, and the boxes are arranged such that the longest dimension is perpendicular to the wall to reduce shear deformation. The front wall face may be either stepped or flush, but a stepped front face is preferable, especially for taller walls. Gabion walls are constructed tilted back toward the retained soil at about a 6-degree angle for stability.

i. Noise Abatement Walls

Noise Abatement Walls shall be designed and constructed in accordance with the MDOT-SHA Noise Abatement Planning and Engineering Guidelines and Chapter 15 of the MDOT SHA OOS Design Guides. All components shall meet or exceed the requirements set forth in these policies and guidelines and will be subject to the same level of review and design standard. General design guidelines and references for noise abatement walls are as follows:

FHWA Guidelines for Noise Abatement Walls:
- FHWA Highway Noise Fundamentals, 1980
- FHWA Highway Traffic Noise Sources, 1980
- FHWA Measurement of Highway-Related Noise, 1996
- FHWA Highway Construction Noise: Measurement, Prediction; and Mitigation, 1977
- AASHTO Guide on Evaluation and Abatement of Traffic Noise, 1993
- FHWA Noise Barrier Design Handbook, 1975
- LPILE by Ensoft, Inc., Latest Version
- FHWA Measurement of Highway-Related Noise, 1996
- FHWA Highway Construction Noise: Measurement, Prediction; and Mitigation, 1977
- AASHTO Guide on Evaluation and Abatement of Traffic Noise, 1993
- FHWA Noise Barrier Design Handbook, 1975
- LPILE by Ensoft, Inc., Latest Version
- FHWA Traffic Noise Model (TNM), Latest Version

MDOT-SHA Guidelines for Noise Abatement Walls:
- MDOT SHA Standard Specifications for Construction and Materials, July 2020
- MDOT SHA Highway Noise Abatement Planning and Engineering Guidelines – April 2020
- MDOT SHA Noise Barrier Standards
- MDOT SHA Pavement & Geotechnical Design Guide
- Guidance contained in any memos and letters published by the FHWA/MDOT SHA

2. Cut Type Retaining Walls

There are four principle types of cut retaining walls: sheet pile walls, pile and lagging retaining walls, soil nail walls and permanent tieback retaining walls.
Table 2 provides general guidelines for cut retaining wall selection.

### TABLE 2 – CUT RETAINING WALL TYPES

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Cost Effective Height Range (feet)</th>
<th>Required Right-of-Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Pile Wall</td>
<td>Up to 16 feet</td>
<td>Minimal</td>
</tr>
<tr>
<td>Soldier Pile and Lagging Wall</td>
<td>Up to 18 feet</td>
<td>Minimal</td>
</tr>
<tr>
<td>Tieback Wall</td>
<td>15 feet to 45 feet</td>
<td>15 feet minimum unbonded length + anchor bond length</td>
</tr>
<tr>
<td>Soil Nail Wall</td>
<td>10 feet to 40 feet</td>
<td>0.6 to 1.0H</td>
</tr>
</tbody>
</table>

a. Sheet Pile Walls

Sheet pile walls are often used for support of excavation systems. These walls are constructed in one phase in which interlocking sheet piles are driven to the required depth below the final grade. These walls may not be feasible for construction in hard ground conditions or where obstructions exist due to potential difficulty obtaining the required embedment depth or potential problems maintaining proper alignment during installation.

Sheet pile walls act as both vertical and horizontal wall elements. Because these walls are relatively continuous, water pressure behind the wall must be considered in the design.

b. Soldier Pile and Lagging Walls

Soldier pile and lagging walls use discrete vertical wall elements that are spanned by lagging, which typically consists of timber. This wall system can typically be constructed in most subsurface conditions; however, cohesionless soils and soft clays may cause construction problems due to limited stand up time for lagging installation.

Vertical soldier beams may either be installed into predrilled holes or driven to their required depth. After installation of the soldier beams, the soil in front of the wall is excavated in lifts (typically 4 feet to 5 feet), followed by the installation of horizontal lagging. Once the lagging reaches the final depth, prefabricated drainage elements may be placed at predetermined spacings and connected to a collector at the base of the wall.

Support is provided through the shear and bending stiffness of the vertical wall element and passive resistance of the soil below the finished grade elevation.

c. Tieback Wall (Anchored Wall System)

Tieback walls are retaining walls that utilize top down construction methods that consist of nongravity cantilevered walls with one or more levels of tiebacks (ground anchors) anchored to the ground to aid in stability.

Nongravity cantilevered walls consist of either discrete (soldier beam, typically piles or drilled shafts) or continuous (sheet piles) vertical wall elements that can be either driven or drilled to depths below finished grade. Support is provided through the shear and bending stiffness of the vertical wall element and passive resistance of the soil below the finished grade elevation.

Tiebacks consist of a steel rod, wire or tendons that are anchored in the ground by drilling a hole into the soil or rock behind the wall face and encasing a portion of the rod or tendons in a grout mixture that forms a bond with the surrounding soil or rock to provide lateral resistance to resist horizontal pressures acting on the wall. If a tendon is used, the wire is typically prestressed to a desired tension. The rod or tendon are typically inclined at an angle. The installation of tiebacks requires specialized equipment and construction methods and post-installation testing.

Tieback walls have the following advantages:

- Potential incorporation of temporary excavation support in the permanent retaining wall;
• Reduction of construction disturbance and right-of-way acquisition required;
• Reduction of excavation needed when compared to other retaining wall systems;
• Adaptability to various site and subsurface conditions.

The following are some disadvantages of the wall system:
• Permanent underground easements are required;
• Groundwater drainage systems may be difficult to construct;
• Creep can affect long-term performance and displacements in clayey soils;
• Pull-out capacity may not be able to be economically mobilized in soft soils.

All production anchors shall be subjected to load testing and stressing in accordance with the provisions of AASHTO LRFD Bridge Construction Specifications.

Additional information on Tieback (Anchored) Retaining Walls can be found in:
• AASHTO LRFD Bridge Design Specifications, Volumes I and II (Ref. 1).

d. Soil Nail Walls

Soil nail walls are constructed using top down construction methods. In soil nail construction, the ground is excavated in 3 foot to 5 foot lifts. Soil nails and an initial shotcrete construction facing are placed at each lift to provide support prior to progressing to the next left. A final cast-in-place (CIP) concrete facing is installed when the lifts are complete. Typical vertical and horizontal nail spacings are 3 feet to 6 feet. The vertical spacing is dependent on the height that the site soils can temporarily remain stable after excavation of each lift.

Typically, dense to very dense granular soils with apparent cohesion, weathered rock (depending on orientation of weakness planes), stiff to hard fine grain soils, engineered fill and residual soils that are above groundwater are ideal for soil nailing. Non-engineered fill and residual soils that contain mica or shale may pose difficult soil conditions for soil nailing. Poorly graded cohesionless soils, areas with high groundwater, soils with cobbles and boulders, soft fine-grained soils, corrosive soils or groundwater, expansive soils and karst conditions are generally not suitable for soil nail walls.

In general, the soil nails support the soil and transfer loads behind the wall. The construction shotcrete and final CIP facings support the soil between the nails.

A drainage system is installed behind the soil nail walls to direct groundwater away from the wall and collect perched groundwater and/or infiltrated surface water that is present behind the facing.

The following failure modes should be evaluated for the design of soil nail walls: internal stability, global stability (temporary at each lift and final stability), lateral sliding, pull-out capacity, nail tensile strength, and facing bending, punching shear and headed stud in tension.

Design procedures and requirements are provided in the following reference:


Verification and proof load testing are performed during construction. Verification load tests are conducted on sacrificial nails to verify the pullout resistance resulting from the Contractor’s installation methods are consistent with the values of pullout resistance and bond strengths used in design. Proof tests are conducted on a minimum of 5% of the total production nails that are installed to verify that there are no significant variations in soil nail performance throughout wall construction.
a. General Items

The purpose of these guidelines is to establish the minimum requirements necessary to provide plans and details for the construction of retaining walls in Howard County.

These guidelines shall be adhered to when practical and applicable, but the responsibility of providing a complete design ultimately belongs to the design engineer. Innovative designs are not meant to be discouraged by these guidelines. Common sense and good engineering judgment are essential elements of any good design.

In order to facilitate the review process, these guidelines are intended to promote consistency and expediency by standardizing the requirements that are necessary in order to provide acceptable retaining wall construction documents.

If a retaining wall exceeds three feet in height at any point, the following criteria will apply, otherwise it is exempt from review by the Development Engineering Division and only the Department of Inspections, Licenses, and Permits (DILP) and the Division of Land Development (DLD) regulations apply. The height of a retaining wall for this purpose is measured from the finished grade at the front of the wall to the top of the wall. Grades above or below the wall shall not exceed a 2:1 slope.

All horizontal dimensions in the plan view shall be taken from the bottom face of the wall at the proposed grade.

Retaining walls shall not be constructed upon fill materials. Exceptions may be granted via the Design Manual Waiver Request process.

All retaining walls, regardless of height, shall not be constructed within a Howard County Right of Way or Easement. The only exception is if written permission has been granted by the Director of Public Works.

All construction documents for retaining walls three feet in height or higher shall be designed, signed, and sealed by a Registered Professional Engineer.

b. Construction Drawings – Plan Views

All retaining walls shall be shown in plan view showing all of the proposed conditions at a maximum scale of 1” = 50’.

Show enough grading around the retaining wall to clearly demonstrate all flow patterns in the vicinity of the retaining wall. Provide spot elevations every 50 feet along the length of the wall at the top and bottom of the wall.

Provide flow arrows along the top of the wall to indicate flow paths along the length of the wall. It is not desirable for run-off to be allowed to cascade over the top of retaining walls. This will be permitted if run-off approaching the wall is sheet flow and adequate scour protection is provided.

For all walls, a minimum ten foot wide construction easement/setback shall be required from the face of the wall. If the wall is greater than ten feet in height the width of the easement shall be equivalent to the height of the wall. This easement shall be clear of floodplains, buffers, wetlands, property boundaries, structures and/or other environmentally sensitive areas. 4:1 is the maximum slope allowed within this easement in front of the wall.

A permanent wall maintenance easement shall be provided behind each wall that is equivalent in width to the height of the wall plus the length of the geogrid. No structures may be placed within this easement.

For “CRITICAL” walls ten feet or more in height, the design engineer shall appropriately address the issue of global stability for the slope and provide an acceptable maintenance easement based upon the conclusions of the analysis.
For all block and timber retaining walls, a ten-foot-wide “NO TREE” planting zone shall be delineated behind the top of the wall.

Under no circumstances shall the maintenance easement for any wall encroach upon the building envelope of any residential lot.

c. Construction Drawings – Elevations

The elevation, or front view, of the proposed retaining wall is considered to be the most important detail for the purposes of constructing the wall.

The following scales are recommended, but good judgment is necessary to ensure that this detail is readable and reasonably drawn.

- **VERTICAL:** 1” = 1’ to 1” = 5’;
  1” = 2’ preferred

- **HORIZONTAL:** 1” = 5’ for lengths up to 50’

- 1” = 10’ or as appropriate over 50’ in length

Provide a vertical scale bar and horizontal stationing across the bottom of the elevation.

For the purpose of constructability, the front view shall have each typical section identified by a letter or a number. Provide section breaks shown as heavy vertical lines indicating where each section begins and ends. Variation from one section to the next should be minimized in order to reduce the number of typical sections.

Essential elements of the elevation are as follows:

- A complete outline of the wall
- Show the finished grade line superimposed over the wall at the top and at the bottom
- Show the locations of the weep holes (40’ on center) and other utilities in proximity to the wall
- The vertical placement of the geogrid must be identified by which block layers the geogrid is to be inserted between
- Indicate the required allowable bearing strength for each typical section or as it varies
- Show with a dimension the maximum height allowed by design for each typical section

d. Construction Drawings – Cross Sections

Show a typical cross-sectional detail for each section of the wall as it varies by height and geogrid placement and/or other significant design features. The maximum vertical scale is 1” = 5’; 1” = 2’ is preferred.

Show the maximum height of the wall for each typical section.

For block or timber walls, show the number of blocks or timbers, vertically placed, graphically.

For reinforced concrete walls, show the typical reinforcement design including notes to indicate proper horizontal spacing along the length of the wall.

Indicate the maximum slope above or below allowed by the design. The maximum slope allowed is 2:1.

For each typical section show the allowable bearing strength that is required for the soil beneath the base of the wall

Show the drain placement behind the base of the wall, entrenched in stone for at least one foot of depth, then covered with filter fabric to prevent clogging. More stone should then be placed in a one foot wide vertical layer to 90% of the walls height to facilitate water flow to the drain. Weep holes must daylight through the wall every 40 feet.

Geogrid placement by layers and length for manufactured block walls must be shown in the cross sectional detail
e. Construction Details – Fences/Guardrails

Retaining walls that exceed thirty inches in height at any point and present an inherent falling hazard require a fence along the entire length of the wall.

The fence must be a minimum of thirty-six inches in height, and the openings in the fence or rail must be small enough to prevent the passage of a four-inch sphere.

Fences must be stable enough to withstand 200 lbs. of concentrated loading applied horizontally at any point.

A typical footing detail shall be provided.

If the fence is set back from the face of the wall, the fence shall be tapered at the ends of the wall to prevent children from accessing the ledge.

If the fence is not directly above the wall, show its location in the plan view.

For walls in proximity to vehicular traffic, guardrails, per the Howard County standard guardrail details are required.

For roadways and parking lots, the face of the curb must be a minimum of two feet in front of the face of the guardrail or the retaining wall. The Howard County standard 7” curb is required.

The location of a guardrail, if required shall be three feet from the face at the top of the wall to the side of the guardrail facing the wall.

f. Design Calculations / Failure Analysis

All retaining walls shall be designed to resist the possible modes of failure, including sliding, overturning, and bearing failure. Sufficient analysis shall be provided to confirm that the resistance factors have been applied and that the design of the retaining wall meets AASHTO design specifications (Ref. 1).

Any likely or anticipated surcharge loads shall be included in the failure analysis. If none are included in the design, add a note to the cross-sectional details stating, “this wall is not designed for surcharge loads”.

For manufactured block walls, supplemental design booklets may be submitted to satisfy the failure analysis requirement, but they may not be considered as part of the construction drawings. The plans shall contain all of the relevant information required to construct the wall.

For reinforced concrete walls, provide a complete set of design calculations for the wall, including the placement and spacing of steel reinforcement.

g. Construction Drawings – Required Notes

"Retaining walls shall only be constructed under the observation of a Registered Professional Engineer and a (NICET, W ACEL or equivalent) certified soils technician."

"The required bearing resistance beneath the footing of the wall shall be verified in the field by a certified soils technician. Testing documentation must be provided to the Howard County Inspector prior to the start of construction." The required test procedure shall be the Dynamic Cone Penetrometer Test ASTM STP-399."

"The suitability of fill material shall be confirmed by the on-site soils technician. Each eight-inch lift must be compacted to a minimum of 95% Standard Proctor Density and the testing report shall be made available to the Howard County Inspector upon completion of construction."

"For "CRITICAL" walls, one soil boring is required every 100 feet along the length of the wall, copies of the boring reports shall be provided to the Howard County Inspector upon completion of construction."
All other miscellaneous information required for the construction of the retaining wall shall be included somewhere on the construction drawings. Items may include material specifications, recommendations from the manufacturer of block wall systems, notes from the design engineer, specific instructions for non-typical designs, etc.

Each design package shall include the designer's seal and signature on the cover page along with the name, address, and telephone number of the consulting firm he represents. Also provide the name, address, and telephone number of the owner/developer.

h. Policy On Retaining Walls In Stormwater Management Facilities

The Howard County Design Manual Volume I requires under section 5.2.5.A.1. that "A pond buffer shall be provided for all stormwater management facilities in accordance with the criteria set forth in the MDE Design Manual. The minimum distance from the end of the outlet structure, including the riprap exit channel, or the edge of an underground facility, to the downstream property line shall not be less than 25 feet. Along other parts of the facility, the minimum distance from the toe of the embankment or top of cut to the property lines, public easements, rights-of-way, and structures shall be 25'. For structures adjacent to the facility where the top of cut cannot be defined and the grading condition encroaches onto a residential lot, the distance from the 100-year water surface elevation within the facility or edge of underground facility shall be 25 feet minimum horizontal and two feet minimum vertical to the lowest floor elevation of a habitable structure."

This specification applies for all new retaining wall construction plans to be submitted for review. Through the Alternative Compliance request procedure, the following provisions will govern.

1) For all facilities, both public and private, retaining walls shall not be allowed within the embankment area, either inside or outside the facility, unless the toe of the retaining wall and any tiebacks are beyond the phreatic line of the facility. These walls shall have a height not to exceed three feet. Tiered walls shall not be allowed unless they are designed so that the influences of the upper walls do not impact the lower walls.

2) For publicly owned and maintained facilities or privately owned and jointly maintained facilities, minor retaining walls, less than three feet in height, measured from the top of the wall to the ground along the face, shall be allowed on cut slopes above the uppermost maintenance bench of any stormwater management facility. These walls shall not be located in the ponding area of the facility. These walls shall be privately owned and maintained. The construction and maintenance of these walls shall be made part of a developer agreement for the facility.

3) For privately owned and maintained facilities, the maximum height of any wall, whether single or tiered, shall not exceed ten feet. These walls may be located in or adjacent to pooling areas provided the walls are reinforced concrete and shall be designed to withstand the hydrostatic pressure and saturated ground conditions on the footing of a flooded condition.
4) All retaining walls in excess of thirty inches in height shall have an appropriate safety railing or fence.

i. Tiered Walls

For tiered walls where the total cumulative height of the tiers is ten feet in height or greater, the provisions for “CRITICAL” walls apply.

The set back from one wall to the next in a series of tiers shall be equivalent to the height of the lower wall or greater.

The slope between tiered walls shall not exceed 4:1.

3. Wall Thickness

The thickness of the top of a wall shall be sufficient to accommodate any railing or appurtenance to be placed on it. However, for ease in placing concrete, it shall not be less than 1 foot.

4. Passive Pressure

Passive pressures on the front face of a wall are unpredictable and shall be neglected for normal wall footing depths. Shear keys shall be similarly avoided. Passive earth pressure shall not be considered in any case if the cover in front of the wall may be subject to scour or if the ground slopes at more than 4:1 rate.

5. Wall Elevations

Top of wall elevations shall be computed at joints and alignment breaks and at vertical curve control points. The elevation shall be tied to Howard County control where available within one mile.

6. Batter

For walls over 15 feet in height, consideration shall be given to provide a batter on the front face of wall. The back face of the wall shall be battered if required for the stem design.

7. Joints

Walls shall be detailed with expansion points through the portion above the footing at approximately 90 ft. intervals. Gravity, semi-gravity and cantilever walls shall have two equally spaced contraction joints located between the expansion joints. The face walls of counterfort and buttress walls are designed as continuous beams and they cannot have contraction joints within a continuous unit. Counterfort and buttress walls shall be designed in continuous units not over 60 feet in length with expansion joints between units.

8. Drainage and Weep Holes

Drainage systems should be provided behind retaining walls to reduce hydraulic pressures, which could result in failure of the wall. Retaining walls are typically drained by means of either continuous back drains or weep holes, along with porous backfill, which allows water to flow behind the wall. Weep holes extending through the wall stem with a pocket of gravel backfill on the back, are inexpensive, but often become clogged. Continuous back drains are preferable to weep holes and may be outlet into nearby storm drainage systems, if available, to minimize aesthetic impacts.

For retaining walls and larger wing walls, sloped perforated PVC pipe drains shall be placed along the back face of walls. The perforated pipe drains are placed below a full height porous backfill blanket and are supported on a continuous concrete ledge extending from the back of the wall. Drain outlets, consisting of 4 in. non-perforated PVC pipe, spaced at no more than 15 ft along the wall, are located 1 ft above the finished groundline at the front of wall. Outlet drain pipes are to be extended 3 in. from the face of wall, where visible to the public, to minimize staining. Where sidewalk areas are located along the front of walls, outlet drain pipes are to be placed below the sidewalk and outlet into the adjacent gutter.

For box culvert wing walls and wing walls less than 30 ft. long and 16 ft. tall, use weep drains with 2 cu. ft. of porous backfill behind each drain. The requirements for outlet drain pipes are the same as for the continuous back drains.

B. Abutments
Abutments support the ends of the bridge beams and provide for the transition from the bridge structure to the approach roadway pavement. All abutments retain the earth of the adjacent roadway and are subject to live load surcharge. Some types of abutments retain substantial amounts of fill. The abutment design must satisfy the requirements of a retaining wall. In addition, the overall stability and the foundation loads must be checked both with and without the dead and live loads from the superstructure. Provision shall be made for surcharge due to construction loads.

1. Types of Abutments

a. Gravity Abutments

As with gravity retaining walls, gravity abutments resist loads imposed on them by means of their mass. The resultant of forces must be within the middle third of any horizontal section through the abutment, both with and without the loads imposed by the superstructure.

b. Spill-Through Abutments

This type of abutment is designed with openings between the supporting legs to allow the embankment material to spill through and form a slope in front of the abutment. The abutment must be designed for the earth pressure on the backwall and cap and on the fill face of the supporting legs. The area of the legs shall be multiplied by a shape factor, usually 2.0, to allow for arching of the soil. If the embankment slope in front of the abutment is not subject to scour, passive earth pressure may be considered on the front face of the legs. The legs and cap shall be designed as a frame to support the loads imposed by the superstructure.

c. Stub Abutment on Piles

This type of abutment is similar to a spill-through abutment except that the piles are very flexible compared to the stiffness of the concrete stub. The piles shall be considered pinned at the footing and shall be designed for axial load only. Batter piles shall be provided to resist horizontal forces. The lateral resistance of the soil surrounding the piles will provide lateral stability and can resist an unbalanced shear which will depend on the nature of the soil.

d. Cantilever and Counterfort Abutments

Cantilever and counterfort abutments resist loads in a manner similar to their retaining wall counterparts.

e. Integral and Semi-Integral Abutments

Integral abutments eliminate the need for abutment roadway joints and hence provide a structure that will require minimal, if any, maintenance to the abutments and associated bearings. Integral abutments should be considered for new bridges when the project site conditions and geometry are suitable for these types of elements. Key considerations to be evaluated include soil type and profile, span alignment, length and skew, superstructure type and the presence of utilities on the bridge. In general, for integral abutment design to be considered, the soil type shall be a reasonably graded cohesionless soil with no defined rock line. Soil profiles suitable for driven pile foundations are also suitable for the installation of integral abutments. Integral abutments shall not be used when there is the possibility of pile downdrag forces. Integral abutments shall only be considered for use on tangent superstructure alignment with a change in vertical grade less than 5% between abutments. Maximum span length for use with integral abutments is 200’ and maximum skew (measured as the angle between the centerline of beam and a line normal to the centerline of bearing) is 30 degrees. Superstructure types that may be used with integral abutments include concrete slab supported by a redundant steel beam system or adjacent or spread prestressed concrete I-beams, box beams or slab beams. The use of timber superstructure components shall not be used with integral abutments. Normally, integral abutments are discouraged when the bridge carries utilities due to the required opening in the abutment stem to facilitate
utility conduit expansion. This opening is a potential source of future deterioration and should be avoided, if possible.

Only cast-in-place concrete piles or steel H-piles shall be considered for use with integral abutments. If steel H-piles are selected, they shall be installed with the weak axis parallel to the centerline of bearing (i.e., driven to allow bending from thermal movements to be about the weak axis). Depending on the soil type and profile, consideration shall be given to pre-auguring a hole that extends a minimum of 10 feet below the bottom of abutment. The pre-augured hole shall be at least two times the pile diameter and filled with well-graded sand or a bentonite slurry mix. Piles shall extend to a sufficient depth to provide adequate structural stability (i.e., no “stilting” effect) and end fixity even when the adverse effects of scour are considered. A minimum of one pile per steel girder or spread prestressed concrete beam member shall be used.

Bearings shall be selected to resist the temporary loading imposed by the superstructure prior to encapsulating the ends of the beams and bearings with the deck closure pour. Minimalist bearings such as plain elastomeric pads should be considered.

Concrete approach slabs shall be used with all integral abutment designs and shall be structurally tied to the bridge deck slab and abutment stem via hinge reinforcement. If the end of the approach slab abuts rigid roadway approach pavement, provisions for expansion shall be implemented at this location. If the roadway approach pavement is flexible, the ends of the approach slabs may butt up against the section without expansion provisions being provided. The ends of approach slabs adjacent to flexible pavement shall be protected by steel angle armoring embedded in the slab with studs. Approach slabs shall be poured atop well graded aggregate and dual layers of polyethylene curing sheeting.

Semi-integral abutments also eliminate the need for abutment roadway joints, but since they are founded on a rigid foundation (e.g., spread footing, multiple rows of piles, etc.), expansion bearings will be required. Criteria for the use of semi-integral abutments are similar for that specified for integral abutments. Semi-integral abutments should be considered when the soil profile is not favorable (i.e., presence of rock, clayey soils, etc.) or if span lengths, geometry or alignment issues preclude the use of integral abutments.

2. Design Guidelines

a. Lateral Earth Pressure

The lateral earth pressure shall be computed in the same manner as for a retaining wall.

b. Other Loads

In addition to lateral earth pressure, the abutment shall be designed to withstand the dead load of the abutment and superstructure, live load over any portion of the superstructure or approach fill, wind forces, longitudinal forces from the superstructure when the bearings are fixed and longitudinal forces due to friction or shear resistance of the bearings when the bearings are not fixed. The design shall be investigated for all combinations of these forces which may produce the most severe loading case.

c. Drainage

It is not necessary to provide drainage behind the stems of perched abutments when they are placed atop granular fill.

C. Piers

1. Types of Piers

a. Rigid Frame Piers

Rigid frame piers consist of a continuous pier cap, columns and a continuous footing or independent footings. Rigid frame piers are generally used on bridges spanning highways and railroads.
b. Single Column Piers

Single column piers, or hammer head piers, consist of a pier cap supported by a single column. Single column piers are generally used for bridges spanning rivers or streams or where they are necessitated by space requirements.

c. Solid Stem Piers

The cap and column of a solid stem pier is a single unit supported by a continuous footing. They are used for short or narrow piers.

d. Pile Bents

Pile bent type piers consist of a single or double row of piles driven to act as both foundation and substructure elements. Superstructure loads are distributed to the piles via a rigid structural pile cap. Pile types normally considered in a pile bent type pier include timber, steel H-pile and cast-in-place concrete. A structural cap, normally constructed of reinforced concrete, encases the top portion of the piles to distribute superstructure loads. Pile bent piers shall be designed to account for the adverse effects of scour as it may create a longer unbraced pile length. Pile bents shall be checked against the ultimate scour condition. Both structural stability and pile stresses should be investigated.

Pile bent piers are normally utilized for stream crossings to minimize the impacts to the waterway during and after construction as well as minimize the reduction in the available hydraulic opening. Appropriate scour countermeasures shall be incorporated into the detailing of this pier type as required by the existing or proposed conditions.

D. Foundations

1. Depth

Footings of all piers in the floodplain shall be founded on rock or on piles driven to rock, except as approved by the Chief of the Bureau of Engineering.

All other footings in the floodplains, including those for abutments, wing walls, and culverts shall be founded below the estimated depths of scour, or 3' below the thalwag, whichever is lower.
Footings outside the floodplain shall be founded on a suitable uniform foundation below the frost line and not less than 3'-0" below finish grade. Refer to the A.A.S.H.T.O. LRFD Bridge Design Specifications (Ref. 1) for footings on slopes.

Footings on rock shall be keyed into the bedrock a depth of 12 inches when they are designed to transfer lateral forces. When a bedrock foundation is required for scour protection or design bearing pressure, footings shall be carried into bedrock a minimum of six inches. Spread footings on soil shall have the lower 1' in depth poured against undisturbed earth.

Plan sheets on which footings are shown shall include a note giving the allowable soil pressure or pile loads.

2. Loads

Footings shall be designed to transmit to underlying stratum all forces transmitted to and acting on the substructure component.

3. Pile Foundations

a. Types

Available pile types that may be considered for use include timber, cast-in-place concrete, steel H-pile, and steel pipe pile. Each pile shall be evaluated for the project site conditions based on the available soil information, drivability, loading and structure location.

4. Drilled Shafts

Design of concrete drilled shaft foundations shall be done in accordance with AASHTO “LRFD Bridge Design Specifications” (Ref. 1) and utilizing LPILE by Ensofl, Inc. or another industry acceptable drilled shaft design program.

5. Design Guidelines

a. Location of Resultant Loads on Spread Footings

Footings founded on materials other than bedrock shall be proportioned so that the resultant intersects the bottom of the footing within the middle third. The resultant force on footings founded in bedrock may be outside of the middle third provided that the maximum allowable bearing pressure is not exceeded.

b. Pile Foundations

Pile foundations shall be so proportioned that no pile receives more than the maximum allowable pile load and no pile is subjected to uplift under any combination of design loads. All pile foundations shall have batter piles to resist horizontal forces transmitted to the foundation and to increase the rigidity of the entire structure. Plumb piles may be assumed to resist 2 kips of lateral load per pile.

Resistance factors used to determine the nominal pile bearing resistance shall be selected based on the method used for determining the pile driving criteria in accordance with A.A.S.H.T.O. LRFD Bridge Design Specifications.

E. Substructure Protection

The selection and design of substructure protection to resist the effects of scour shall be in accordance with MDOT SHA guidelines and FHWA circulars and memorandums associated with scour countermeasure design. FHWA Hydraulic Engineering Circular 23 (HEC-23) (Ref. 18) shall be used in the design of countermeasures at piers and abutments.

Class II riprap is the preferred material for scour countermeasures. The $D_{50}$ of the riprap shall be confirmed in accordance with HEC-23. Velocities used in the design of countermeasures shall be based upon the 100-year or incipient overtopping storm event, whichever yields a higher velocity, and shall be derived by using the hydraulic modeling techniques described in the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12). Configuration of the riprap blankets, including depth, distance from abutments/piers, toe dimensions, etc., shall be in accordance with MDOT-SHA memorandum “Scour Countermeasures at Bridges” (November 25, 1992).

F. Slope and Bank Protection
Slope and bank protection (revetments) for roadway approach embankments, retaining walls and stream channel banks shall be selected and designed in accordance with FHWA Hydraulic Engineering Circular 23 (HEC-23) (Ref. 18). Class II riprap is the preferred material for revetments.

Where applicable, revetments shall be designed to accommodate wave interaction as described in HEC-23. For the purpose of determining the total height of the revetment, the engineer should assume that the maximum wave height occurs coincidentally with the maximum water surface elevation generated by the design storm.
4.5 Bridge Superstructure

The bridge superstructure includes the slab, beams or girders and bearings. The function of the superstructure is to distribute and transmit loads to the substructure. Bridge superstructure shall be designed in accordance with A.A.S.H.T.O. Specifications (Ref. 1).

A. Slab on Beams and Girders

1. Concrete

All superstructure concrete including parapets, abutment backwalls and parapet portion of wingwalls but excluding concrete overlay shall be air entrained concrete with a minimum 28-day compressive strength of 4500 psi. Slab concrete shall be low slump concrete.

2. Wearing Surface

Concrete slabs shall have an extra 1/2-inch concrete which will serve as a wearing surface. This wearing surface shall be considered sacrificial and shall not be included when determining member strength.

3. Reinforcing

Epoxy coated reinforcing bars shall be used for the entire superstructure, including top and bottom mats of slabs, abutment backwalls and parapet portion of wingwalls.

4. Forms

Concrete slabs shall be poured on stay-in-place metal forms.

5. Concrete Cover

Slabs shall have 2 1/2 inches of cover over the top reinforcing mat (which includes a 1/2-inch concrete wearing surface) or 1 inch of cover between the bottom reinforcing mat and the stay-in-place forms. Parapets and backwalls shall have 2 inches of cover.

6. Slab Thickness

Slabs shall be designed to carry the dead and live load loading in accordance with the A.A.S.H.T.O. Specifications (Ref. 1). The minimum slab thickness including the concrete overlay shall be 7-1/2 inches.

7. Deck Pour Sequence

Construction plans shall include a suggested pouring sequence including the order and limits of each pour. For conventional superstructures (i.e., non-integral or non-jointless), positive moment regions of the superstructure shall be poured first followed by the pours in the negative moment region(s). For integral abutment bridges, the pouring sequence shall be configured to minimize dead load rotation at the abutment to prevent unwanted transverse deck cracking.

In developing the pour sequence, consideration shall be given to accounting for the temporary stresses on the in-place portions of the structure that may not have been considered such as lateral flange buckling of the longitudinal girders supporting the wet concrete. Individual concrete pours shall not exceed 100 cubic yards per day without written authorization of the Chief of the Bureau of Engineering.

B. Beams and Girders

1. Composite and Non-Composite Design

In superstructures consisting of concrete slabs supported on prestressed concrete beams or steel beams or girders, composite designs shall be used for simple spans exceeding 35 feet, and generally for continuous spans exceeding 50 feet. Because of the effect of span ratios, no specific limits for composite design can be established for continuous construction.

Continuous steel beam or girder spans shall be designed as composite for positive movement regions only; however, shear connectors shall be provided at maximum allowable spacing through the negative movement regions even though composite action is not considered.

2. Camber

a. Spans Less than 50 Feet

Steel beams with a span of less than 50 feet shall not be cambered for dead load deflection or vertical curve corrections. If the
beams are not rolled exactly true, they shall be fabricated and erected with their natural camber up.

b. Spans 50 Feet or More

Steel beams and girders with spans of 50 feet or more shall be cambered to compensate for dead load deflection and vertical curve correction. Camber tolerance shall be zero (0) inches under to one-half (1/2) inch over.

3. Bearing Stiffeners

Stiffeners shall be placed at all bearings. The stiffeners shall be designed to carry the total reaction acting as a column.

C. Steel Beams and Girders

Steel plate girders shall be designed, where economically feasible, to eliminate transverse and longitudinal web stiffeners. The use of A.A.S.H.T.O. M270 Grade 50W steel must be approved on a case by case basis by the Chief of the Bureau of Engineering.

D. Prestressed Concrete Beams

In lieu of steel beams or girders, precast prestressed concrete beams may be used for simple spans. The length and weight of any prestressed concrete member shall not exceed the State of Maryland limitations for highway shipment without permits.

E. Bridge Drainage

Scuppers on bridges shall be avoided if possible. On closed systems inlets shall be placed immediately off the bridge at the upgrade end of the bridge to prevent accumulated gutter flow from entering the structure. On open section roadways inlets shall be placed immediately off the bridge at the downgrade end to control water accumulated on the bridge. On closed section roadways, inlets shall be placed downgrade from the bridge as required by the gutter flow design.

Scuppers shall be placed on the bridge only if the ponding encroachment exceeds the limit permitted by the Howard County Storm Drain Design Manual, (Ref. 7). Where required, scuppers shall be MDOT SHA standard scuppers. Scuppers shall be a minimum of 10’ from any substructure unit. Downspouts shall extend 8” below adjacent stringers and shall outlet into streams, slope protection or splash blocks.

F. Expansion Joints

Watertight roadway expansion joints shall be provided at all abutments and at all piers supporting simple spans. These joints shall provide for the total thermal movement for a temperature range of 0 F to 120 F.

Abutments integral with the superstructure should be considered where appropriate in lieu of expansion joints.

G. Bearings

The selection of bearings shall consider length of span contributing to expansion, superstructure material type, applied loading, bridge skew and degree of curvature (if applicable). Consideration should be given to selecting bearings that require minimal maintenance including plain and steel laminated elastomeric pad bearings with or without polytetrafluoroethylene (PTFE) – stainless steel sliding surfaces. Bronze sliding bearings shall be considered for steel structures. Refer to the MDOT-SHA “Structural Details Manual” (Ref. 11) for suggested bronze sliding bearings. The use of steel rocker bearings is prohibited.

Elastomeric bearings are generally used to support precast prestressed concrete slabs or beams. Plain pads are preferred unless structure rotation and thermal translation require steel laminated bearings. Elastomeric bearing shall be adequately attached to the bearing seat via an appropriate epoxy bonding compound. Provisions shall also be considered to prevent the elastomeric pads from “walking” by using restrainer bars, plates or angles or by inserting an anchor dowel through the ends of the precast prestressed concrete member and embedded into the beam seat.

H. Drainage Troughs

Drainage troughs shall be investigated for use on new structures or rehabilitated structures where open joints (e.g., finger joints) are located in the bridge deck. Troughs shall also be considered as a way of providing a redundant system to protect specific bridge elements if the roadway joints begin leaking. Fiberglass drainage troughs shall be used underneath
all open joint systems and shall be installed using a
cross slope no less than 1” per foot. Adequately sized
catch basins shall be incorporated into the system to
collect all drainage water and efficiently disperse it
away from the structure by means of downspout
piping. Suitable caulking material shall be used along
the interface between the structure and the trough to
prevent water seepage.

Neoprene drainage trough material may be used in
other locales assuming that the anticipated drainage
flow will not exceed the capacity of the trough.
Troughs placed underneath closed joint systems shall
be installed at a cross slope of no less than \(\frac{1}{2}\)” per
foot. Stiffening bars shall be incorporated into the
system to keep the neoprene material flush up
against the structure to prevent water seepage.

Stainless steel hardware shall be used to affix the
drainage trough to the structure. Downspout piping
shall be incorporated into the drainage trough
systems when necessary to convey drainage away
from the structure. PVC conduit shall be used for the
piping material and it shall be adequate
attached/braced against the structure to maintain the
integrity of the system. Stainless steel hardware shall
also be used to brace the downspout piping.
Discharge from any downspout piping shall be
directed away from structure foundations and/or
adjacent roadway surfaces. Refer to the MDOT-SHA
Structural Details Manual (Ref. 11) for suggested
drainage trough details.

I. Elevations

Bridge deck elevations shall be computed and
indicated on the plans at each girder centerline, PG/L
of the roadway, at any roadway break lines and along
the gutter flow lines. Elevations shall be provided in
accordance with MDOT-SHA Structural Guidelines
and Procedure Memorandums (Ref. 10).
4.6 Shared Use Pathway Bridges

A. General
Shared use pathway bridges carry users such as bicyclists, pedestrians, equestrian riders and light maintenance vehicles.

1. Design Specifications
   a. A.A.S.H.T.O.

   The design of shared-use pathway bridges shall be in accordance with the “LRFD Bridge Design Specifications” (A.A.S.H.T.O., Ref. 1), including subsequent interim specifications, except as modified by the “LRFD Guide Specifications for the Design of Pedestrian Bridges” of the Association of State Highway and Transportation Officials (A.A.S.H.T.O., Ref. 21), including subsequent interim specifications.

   Shared use pathway bridges shall also be in accordance with the “Guide for the Development of Bicycle Facilities” of the Association of State Highway and Transportation Officials (A.A.S.H.T.O., Ref. 23), including subsequent interim specifications.

   b. A.D.A.

   The provisions of A.A.S.H.T.O. (Ref. 23) either meet or exceed those recommended in the accessibility guidelines under the Americans with Disabilities Act (A.D.A.) and shall be followed unless a more stringent local restriction applies.

2. Design Life
Unless otherwise directed, shared use pathway bridges shall be designed to achieve a minimum 75-year service life.

B. Loading

1. Live Load

   Live load shall be in accordance with A.A.S.H.T.O. (Ref. 21). Whenever vehicle access is not prevented by permanent physical methods, shared-use pathway bridges shall be designed for H5 vehicle live load, or a different vehicle depending on the needs of the owner or jurisdiction.

C. Clearances

1. Horizontal Clearance

   A shared-use path shall have a 10’ minimum clear path width unless written authorization is provided by the Chief of the Bureau of Engineering.

2. Vertical Clearance

   The minimum vertical clearance from the top of path to an overhead obstruction shall be 10 feet.

D. Profile and Grade

The deck of the bridge should maintain the cross-slope of the approach path. Refer to Chapter 3, Section 3.3 and the provisions given by A.A.S.H.T.O. (Ref. 23) for profile and grade requirements.

E. Railings and Fencing

All railings on bridges and approaches, including transitions, shall meet or exceed MDOT-SHA and A.A.S.H.T.O. specifications, including crash testing requirements. Pedestrian and bicycle railings shall conform to the “Bridge Railing Manual” by MDOT-SHA (Ref. 25), however, if a railing type is selected that is not included in the “Bridge Railing Manual”, it shall meet all geometric criteria of the A.A.S.H.T.O. specifications. Railings should be considered as specified in the A.A.S.H.T.O. specifications (Ref. 23) where a bicyclist’s handlebar may come into contact with a railing or barrier. Railings should not impede stormwater runoff.

If the shared-use path bridge crosses a high volume or high-speed roadway, or objects are likely to be thrown from the structure, fencing shall be considered. Fencing shall meet MDOT-SHA “Structural Details Manual” (Ref. 11). Fencing installed on structures crossing over railroads shall meet the minimum requirements of the respective railroad.

F. Lighting

Refer to the “Guide for the Development of Bicycle Facilities” (A.A.S.H.T.O., Ref 23) for lighting requirements.

When lighting for shared-use pathway bridges is provided on poles, it should be independent of the bridge structure where possible.
G. Aesthetics/Structure Type

The Aesthetic Bridges - Users Guide (Ref. 26) provides recommendations for design suggestions and considerations.

H. Hydraulics

Refer to Appendix D in Chapter 10 of the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12).
4.7 Box Culverts

A. Analysis

Box culverts shall be analyzed as closed rigid frames. The dead and superimposed earth loads, the lateral earth pressures and the live and impact loads are to be analyzed separately. The results of these separate loading conditions shall be assembled in various combinations to give maximum moments and shears at the critical points; i.e., the corners, and the positive moment areas. Appropriate live load positions shall be used to produce maximum positive or negative moments. A maximum of one-half of the moment caused by lateral earth pressure, including any live load surcharge, may be used to reduce the positive moment in the top and bottom slabs. The weight of the bottom slab of a box culvert will be resisted by an equal and opposite soil pressure and the weight of the slab will cause no bending in the structure. The structure should therefore be analyzed for a net soil reaction, excluding the reaction to the weight of the bottom slab.

B. Design Guidelines

1. Minimum Thickness

The thickness of walls and slabs of a box culvert shall be not less than 8 inches for members with single reinforcing and not less than 12 inches for members with reinforcing in both faces.

2. Minimum Reinforcing Cover

The minimum cover shall be as follows:

a) Bottom of bottom slab - 3 inches
b) Top slab used as riding surface - 2 1/2 inches (including 1/2-inch concrete wearing surface)
"no less than 12 inches"
c) All other faces — 2 inches

a. Epoxy Coated Reinforcing

When the distance from the riding surface to the top slab is less than 2", all reinforcing in, or extending in, the top mat of reinforcing steel for the entire length of the culvert shall be epoxy coated.

3. Wearing Surface

If the top slab is to be used as a roadway riding surface, it shall have a 1/2" integral concrete wearing surface. This wearing surface shall be considered sacrificial and shall not be included when determining member strength. When the top slab is not the riding surface, the earth cover provided shall be no less than 9 inches (in addition to paving) at the minimum point.

4. Contraction and Expansion Joints

Contraction joints shall be provided at a spacing of approximately thirty (30) feet. Expansion joints shall be provided at approximately ninety (90) foot intervals. Reinforcement shall be stopped two (2) inches clear of joints.

5. Headwalls

Headwalls shall be provided at the exposed ends of box culverts, to retain the earth cover and to act as edge distribution beans on skewed alignments. The headwall shall be constant height.

6. Cut-Off Walls

In order to provide for effects of scour, cut-off walls, a minimum of three (3) feet deep, shall be provided at the exposed ends of the culverts. Wing wall footings shall be set at the elevations of the bottom of the cut-off walls and securely tied to them with reinforcement.

7. Provisions for Future Extension

If the culvert is to be placed under a roadway which could be widened in the foreseeable future, provisions shall be made for extension of the culvert by placement of appropriate joint keys on the exposed inlet and outlet faces.

C. Bottomless Box Culverts (Rigid Frames)

Bottomless culverts may be considered when it is desirable from a permitting standpoint to put in a culvert with a natural channel and the span length is such that using a structural plate pipe arch is uneconomical. Since the foundation loads on a bottomless culvert are relatively higher than a four-sided box, the existing subsurface information must be closely analyzed to determine if the culvert can be supported by spread footings. If the resultant bearing
pressure is too high when compared to the allowable, or the adverse effects of settlement is a possibility, placing the structure on piles should be considered. Regardless of the foundation system, the bottom of footing for any rigid frame shall be placed a minimum of 3 feet below proposed groundline.

Bottomless culverts shall be analyzed for scour in accordance with current MDOT SHA guidelines. The designer should consult with the MDOT SHA Office of Structures for guidance on the selection of bottomless culverts and the preferred scour analysis and countermeasure design procedures.
4.8 Pipe Culverts

The hydraulic design and analysis of roadway cross culverts should be performed in accordance with the guidelines contained in the Howard County Storm Drainage Design Manual, FHWA HDS-5, MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12) and applicable MDE and USACE regulations. This section deals specifically with larger culvert crossings of waterways with base flow.

A. Geometry

Pipe culverts shall be designed to carry the full ultimate roadway section including safety grading, guardrail backing, etc.

The layout of any pipe culvert shall be configured primarily to preserve existing drainage patterns and watercourses, while integrating the overall geometry of the roadway embankment. Significant guidance is available in Chapter 13 of the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12) and in HDS-5 regarding the optimal configuration of the culvert to accommodate different channel types.

When culverts are used singularly at crossings, the pipe invert shall be set 1' below the planned bottom of stream bed. When multiple pipe culverts are used in a single crossing, one pipe shall be considered the low flow cell and have its invert set 1' below the planned bottom of stream bed; the remaining pipes shall have their inverts set 1' above the low flow invert. Natural siltation will fill the bottom of the pipe to the planned stream bed level.

For pipe culvert crossings of Non-Tidal Wetlands and Waterways, including Water of the U.S., the designer shall be thoroughly familiar with the regulations of COMAR Section 26.17.04.06, Bridges and Culverts. The engineer should be aware that, for any such crossing, culvert lengths are typically limited to 150 feet by COMAR 26.17.04.06.B.3. In addition, this section of COMAR also requires that culverts conveying such waters have inverts buried by at least 1 foot. For any such crossing, the designer shall coordinate with regulating agencies at the concept stage in order to confirm the basic type, size and location of the culvert prior to proceeding with final design.

B. End Treatment

Steel pipe culverts derive their strength from the interaction of the soil with the pipe. At pipe ends, this interaction no longer applies and the end treatment must be detailed to stiffen the pipe as well as to protect against hydraulic and erosion forces.

1. Headwalls

For culverts with greater than 5’ of fill measured at the start of the fill slope, headwalls shall generally be the minimum height possible. There shall be 9” of cover from the top of the pipe to the ground line at the back face of headwall and there shall be 9” freeboard from the ground line to the top of headwall at the back face of wall. Regardless of whether the headwall is perpendicular to the culvert or parallel to the roadway, the top of the headwall shall be level.

For culverts with less than 5’ of fill measured at the start of the fill slope, the headwall shall generally be placed so that the barrier on the headwall lines up with the traffic barrier on the approach roadway.

The front and back faces of the headwall shall extend a minimum of 1’ horizontally beyond the pipe prior to the start of the wingwall. The portion of the headwall over the pipe shall be designed as a horizontal beam carrying the horizontal loads to either side of the pipe. The portions of the headwall immediately beside the pipe shall be designed as a cantilever, fixed at the footing, and shall carry the horizontal loads from the area over the pipe as well as loads placed on it directly. The pipe shall be attached to the headwall by J bolts at 18” c/c around the perimeter. No load from the headwall shall be assumed to be carried by the pipe.

Details of the headwall shall include a plan view drawn to a scale of 3/8” = 1'-0” or larger depicting placement of the headwall reinforcing.

The bottom of the headwall and wing wall footings shall be a minimum of 3’ below the low flow pipe invert elevation. A toe wall may be placed below this if required but a bottom of footing less than 3’ below the low flow pipe invert in conjunction with a toe wall shall not be acceptable. Shear keys and/or passive pressure
to increase the sliding resistance shall not be considered.

Headwalls on large pipe culverts should generally be oriented parallel with the roadway embankment. For smaller culverts and headwalls not visible from the roadway, headwalls may be oriented perpendicular to the centerline of the pipe.

Headwalls for large culverts should have the edges beveled at a minimum angle of 45 degrees around the entire pipe circumference. The use of flared wingwalls may be required to reduce erosion at culvert inlets and outlets. In general, upstream wingwalls should be flared at 1:1 from parallel with the direction of flow. A 4:1 flare is recommended for downstream wingwalls (4 in the direction of flow to 1 perpendicular to the direction of flow).

Culvert headwalls that are to be used for earth retaining in excess of standard dimensions (i.e. greater than 6 inches above the top of the pipe) will require special design. The concept of using a standard headwall in conjunction with a smaller diameter pipe, such as a 36-inch pipe used with a standard headwall for a 48-inch pipe, will not be acceptable. The designer shall have the responsibility of designing such retaining-type headwalls in accordance with the A.A.S.H.T.O. "LRFD Bridge Design Specifications" (Ref. 1).

2. Other End Treatments

End treatments other than head walls are generally allowed if they conform to the pipe manufacturer’s recommendations. Step beveled ends are preferred over fully beveled ends for their added stiffness however both require concrete collars/slope protection with J bolts at 18” c/c and toewalls extending 3’ below the low flow pipe invert. Particular care must be taken with beveled ends for pipe arches due to their stiffness requirements.

It is structurally preferred for pipe ends to be on an axis perpendicular to the pipe centerline. For pipes not perpendicular to the centerline of the roadway, this may require warping the fill slopes. This structurally preferred solution may entail excessive cost for large culverts, may present aesthetic concerns for culverts with limited fill or may be impractical due to the right of way limitations. Each culvert site shall be examined in terms of end treatment.

Exposed square ends are not permitted except as temporary structures for aesthetic considerations.

Reinforced concrete or corrugated metal end sections are acceptable for use on single pipe culverts up to 36-inches in diameter, depending upon the application. When riprap is specified in conjunction with an end section, the riprap shall extend to the intersection of the end section and the pipe. End sections shall not be substituted for headwalls if the skew of the pipe is greater than 60 degrees to normal or if the pipe carries base flow.

Large-diameter culverts with extremely high outlet velocities (typically in excess of 20 feet per second) may require the design of specialty energy dissipaters. These dissipaters are typically cast-in-place or precast concrete. The methodologies presented in FHWA Hydraulic Engineering Circular 14 (HEC 14) (Ref. 19) shall be used in the design of any such dissipaters. The structural design of these units shall be in accordance with the A.A.S.H.T.O. “LRFD Bridge Design Specifications” (Ref. 1).

3. Stream Protection

Where required due to high outlet velocities or stream instability, channel protection shall be designed in accordance with the methodologies of FHWA Hydraulic Engineering Circular HEC 20 (Ref. 20) and the guidance presented in Chapter 10 of the MDOT SHA OOS “Manual for Hydrologic and Hydraulic Design” (Ref. 12). Severe stream instability at culvert outlets should be assessed by qualified engineers experienced with fluvial geomorphology and Rosgen stream restoration techniques.

C. Foundation Requirements

Large culverts in excess of 48 inches in diameter shall be bedded in a concrete cradle which will support the pipe for at least 10 percent of its overall height.
Multiple-cell pipe culverts shall be spaced so that adjacent outside surfaces are as follows:

- Diameter less than 48 inches: Not less than 2 feet apart.
- Diameter greater than 48 inches: One-half the diameter or 3 feet apart, whichever is less.

This section applies to steel pipe culverts with spans greater than 8’ measured perpendicular to the pipe.

A normal foundation report shall be required, refer to Section 4.2.M.
4.9 Utilities on Bridges

A. Telephone Lines & Cable

Galvanized steel conduits will only be allowed to be placed in the sidewalk slab of the bridge.

B. All Other Utilities

No utilities other than telephone conduits will be permitted to be placed on a bridge. No conduit shall be placed closer than ten (10") inches from the face of the curb and three (3") inches from the inside face of the parapet or twelve (12") inches from the edge of the slab if no parapet is provided.
4.10 Rehabilitation of Existing Structures

A. Introduction

This section addresses the rehabilitation of existing structures as part of an overall program to repair various Public Works structures. The goal of rehabilitation is to maintain the safety and structural integrity of the structure as well as extend its useful service life. The focus of any rehabilitation program is to effect repairs to key or critical structure elements in a timely manner to eliminate the need to replace the entire unit.

Structures designed per A.A.S.H.T.O. LRFD (Ref. 1) shall be evaluated using A.A.S.H.T.O. LRFD (Ref. 1). Structures designed by Load Factor Design (L.F.D.) or Allowable Stress Design (A.S.D) methods may be evaluated with either the A.A.S.H.T.O. Standard Specifications (Ref. 24) or A.A.S.H.T.O. LRFD (Ref. 1). It is appropriate and acceptable to analyze older structures with the A.A.S.H.T.O. Standard Specifications (Ref. 24). However, in some cases, an LRFD analysis may yield more favorable results due to more refined methods of live load distribution or structural capacity. The intent of this provision is to not preclude the use of LRFD in these situations. A structure found to meet the minimum performance criteria when checked with either code should be considered acceptable. When projects in this category require the design of a new element or retrofit, it is preferred to use A.A.S.H.T.O. LRFD (Ref. 1), when practical.

The design of temporary works (e.g., falsework) shall be performed in accordance with applicable sections of the latest edition of the A.A.S.H.T.O. “Guide Design Specifications for Bridge Temporary Works” (Ref. 16) and the A.A.S.H.T.O. “Construction Handbook for Bridge Temporary Works” (Ref. 17).

As part of any rehabilitation design of an existing structure, consideration should be given to retrofits to accommodate pedestrians and bicyclists via sidewalk or shared use pathway, for immediate or future use.

B. Superstructure Repairs

Superstructure repairs include rehabilitating those bridge elements located above the abutment or pier beam bearing seat. The elements to be addressed include decks, roadway barriers and sidewalks, roadway joints (transverse and longitudinal), drainage devices (including scuppers, troughs and downspout pipes), approach slabs, structural framing systems and bearings.

1. Bridge Decks

In general, the rehabilitation of bridge decks will consist of maintenance repairs of the roadway surface (or soffit), removal of the top portion of the deck and placing a specialized concrete overlay or a complete deck replacement. The scope of rehabilitation should be based on the latest inspection information and all available testing data as appropriate. If inspection and testing information is unavailable, it is desirable to obtain this data through an in-depth inspection of the bridge deck and an adequate testing program. The in-depth inspection should focus on determining areas containing concrete defects that require repair including delaminations, spalling and cracking. All areas shall be thoroughly documented by defect type and location. The in-depth inspection shall include visual and tactile inspection methods including hammer tapping, chain drag and other nondestructive tests to evaluate the deck condition. Based on this information, concrete cores should be taken to evaluate, at a minimum, the compressive strength and chloride ion content of the deck concrete. Cores shall be taken in areas containing observed deterioration as well as areas in relatively good condition (as a control). A minimum of two (2) cores shall be taken for any bridge including a minimum of one (1) per span for multi-span structures. Cores shall not be taken directly over any main longitudinal or transverse structural members. Pending the results of the in-depth inspection and testing, a rehabilitation scheme can be recommended to repair the deck in place, install an overlay or replace the deck.

An estimate of the remaining service life should be made accounting for the current age of the deck, its current strength as compared to the original design strength, chloride ion content, location and extent of any observed structural cracking and the location and extent of concrete deterioration. The remaining service life estimate should be considered in the final decision to rehabilitate or replace the deck.
Concrete deck repairs involve placing an adequate concrete patching material in an area that has been first properly cleaned and prepared. Any area to be repaired shall have all deteriorated and loose concrete removed, exposed reinforcing steel cleaned of all rust (and replaced if it has lost more than 20% of its original section), and the area air blast or water-jet blast cleaned. Concrete patch material shall be chosen based on factors including durability, suitability of the material for the repair location, curing time (as it relates to opening lanes back to traffic) and cost.

If it is determined that the deck has adequate overall strength and some remaining service life left, a specialized concrete overlay may be considered. A concrete overlay will help to protect the remaining portions of the deck as well as extend the remaining service life of the bridge deck. Generally, only 1" to 2" of the existing concrete deck surface is removed (where the potential for delaminations or a high concentration of chloride ions exist) and the surface prepared to receive the overlay material. As part of the surface preparation process, localized concrete repairs may be required to ensure that the rehabilitated deck is a sound and integral element. Material(s) used in the patching process discussed previously are suitable for this repair. The overlay material shall be a dense cementitous type material suitable for placing in relatively thin applications. Materials such as latex modified concrete, micro-silica concrete and very early high strength latex concrete should be considered depending on the application needs. The structural capacity of the deck should be verified if more than 2" of concrete is removed from the top surface.

If the selected rehabilitation alternative is for complete replacement of the concrete deck, several issues shall be evaluated, including, but not limited to, studying and developing stages of construction for maintenance of traffic, need to maintain pedestrian and/or bicycle traffic, maintenance of utilities, checking the existing framing system for the new deck weight including the consideration of the effects of composite action and differential camber in adjacent beams (as a result of staged construction) and the rehabilitation needs for the substructure and those superstructure elements to remain.

Other rehabilitation work associated with the bridge deck will be the repair or replacement of existing roadway joint systems. The failure of transverse (and longitudinal) roadway joints may lead to substructure deterioration, bearing failure and section loss at the ends of the main superstructure supporting members. Depending on the severity of the joint deterioration, only the replacement of the seal may be required. Field measurements of the joint opening should be taken along with the ambient temperature to ensure that the correctly sized seal is installed. If the condition of the joint system is such that replacement is required, the existing joint configuration should be confirmed in the field and checked against available plans. If plans are unavailable, field measurements and details of the existing joint system shall be recorded for subsequent use in preparing joint replacement plans. As part of any joint modification scheme, consideration should be given to installing drainage troughs in accordance with Section 4.5.H of this Design Manual. The replacement joint system chosen (armored compression or strip seal, asphaltic plug, silicone, elastomeric, etc.) shall take into consideration such factors as cost, serviceability, durability (i.e., resistance to truck traffic) and constructability. Where feasible, the elimination of transverse joints should be investigated to extend the service life of bearings, beam ends, and other bridge components historically affected by failing joints. An appropriate structural analysis of the existing structure should be completed to determine the applicability and suitability of installing link slabs at intermediate pier roadway joints and/or a conventional deck-over system at each abutment. The ability of existing bearings to accommodate link slabs and/or deck-over details shall also be confirmed and the replacement of same evaluated to determine if their replacement is cost-effective in conjunction with the removal of transverse joints.

As part of a deck maintenance program, consideration should be given to eliminating bridge scuppers. If feasible, eliminating scuppers will minimize the deterioration of the deck from standing water/debris resulting from clogged scuppers. An analysis of the scupper(s) shall be
performed and if the design spread for a ten-year storm event does not encroach more than 6 feet into the traveled way. Scuppers to be eliminated shall be filled with a lean concrete mix.

2. Barriers

Traffic barriers include railings and parapet systems. Barriers inadequately attached to the superstructure (as a result of deterioration, accident damage or substandard design) shall be rigidly connected to the deck and/or fascia beams to provide sufficient strength to resist vehicular impacts.

3. Girders/Beams/Trusses

These repairs encompass many different types of repairs and will include all work to rehabilitate girders, beams and trusses.

There are many types of repairs that may be performed on steel beams/girders. Rusted webs can be repaired by welding or bolting plates across the deteriorated areas. Deteriorated flanges may be repaired by welding or bolting cover plates across the deteriorated or damaged areas. Care must be taken when welding to ensure that allowable fatigue stresses are not exceeded and that weld quality can be obtained under field conditions.

For bridges with high volumes of truck traffic, repairs may involve the retrofitting of beams/girders at intermediate diaphragms or cross frame connections to prevent and/or mitigate problems at fatigue-sensitive connection details. Cracks in welds, as well as, cracks in the web and connection plates, have resulted from these fatigue-sensitive connection details. Retrofit details to consider include bolting angles or tees to the connection plates and flanges to prevent and/or mitigate out-of-plane bending or high-stress concentrations. In addition to this retrofit, welds may be repaired via grinding, drilling crack ends and replacing any cracked connection plates. Each situation must be carefully studied to ensure that the retrofit detail can be properly constructed in the field and that it will be achieving its intended purpose of eliminating and/or reducing out-of-plane bending or high-stress concentrations.

Although most projects will involve the repair and/or replacement of select members, in some cases, it may be desired to upgrade the load-carrying capacity of a structure. This can be accomplished by several methods, including applying more advanced analysis methods, rating the structure using load and resistance factor design, replacing the deck with lightweight concrete or a different type of lightweight deck (e.g. exodermic, etc.), making multiple simple spans continuous over the piers, post tensioning, or adding shear studs to make non-composite beams composite. When adding studs for the development of composite action, the type of steel being stud welded must be carefully evaluated. Older steels (e.g., A7) are not as ductile as current steel and special care must be utilized when attaching any element via welding.

Trusses often need to be strengthened because of deterioration at the lower chord and connections. Strengthening can be accomplished by the addition of stressing cables or splicing of the chords themselves. Care must be taken in these repairs because of the lack of structural stability when a lower chord member is disconnected. On many trusses, the floorbeam/stringer framing system, including connections, may need rehabilitation and/or upgrading. Many of these repairs can be handled as stated above for steel beams/girders.

Timber beams deteriorating as a result of decaying wood or insect attack can be rehabilitated by replacing individual members or strengthening by thru-bolting galvanized steel channels to each side.

Rehabilitation of concrete tee-beam bridges typically involve beam repairs to address spalling, cracking and any exposed reinforcing steel that has lost cross sectional area. If the extent of deterioration does not compromise the ability of the member to safely carry load, cosmetic repairs using pneumatically applied mortar may be utilized to halt further deterioration. If the extent of corrosion adversely affects the load carrying capacity of the member, and the bridge cannot be load restricted, external reinforcement such as carbon fiber reinforced polymer sheets can be bonded to the sides and bottom of the beam to upgrade the live load capacity.
Prestressed members with concrete spalling can be repaired after cleaning of the strands. Some preloading of the beam may be necessary to prevent future cracking of the concrete patch. If prestressing strands are damaged or severed to a point where the load-carrying capacity of the member is inadequate, the member can be repaired by providing external post-tensioning. This method can also be used to increase the strength of under-designed prestressed beams. In addition, the use of external reinforcement such as carbon fiber reinforced polymer sheets can be bonded to the sides and bottom of the beam to upgrade the live load capacity in shear and/or bending.

4. Bearings

Deteriorated bearings may need to be cleaned and painted, reset or replaced with a similar or better functioning bearing device. To reset or replace bearings, the bearing load must be released through the use of hydraulic jacks and temporary jacking beams supported by the existing girders. Steel columns anchored to the face of the substructure may also support the jack(s). Or, if space allows, the jack(s) can be placed on the beam seat behind the end of a girder. The design plans shall clearly state the limits of the jacking system with respect to load, the amount of girder displacement that can be tolerated and whether traffic can be maintained on the bridge during the jacking operations. The existing structural components must also be checked to confirm their ability to withstand the jacking forces.

For bearings exhibiting extensive and advanced paint deterioration and base metal corrosion, complete cleaning and repainting may be necessary to restore full operational capacity to the bearings. In addition, these bearings may have to be jacked and temporarily supported to facilitate a more thorough cleaning. Reference the following section for the cleaning and painting of steel bearings.

5. Painting

The painting of steel superstructure elements (beams, girders, diaphragms, bearings, etc.) encompasses the cleaning and painting of all exposed surfaces as part of a maintenance or rehabilitation project. Depending on the condition of the paint system, either spot cleaning and painting or complete removal and replacement of the paint system may be required. However, if the paint system condition is relatively good, minor cleaning and overcoating may be a more economically viable alternative to full removal and coating. Spot cleaning shall extend a minimum of 10’ from the beam ends on simple spans and 10’ from the centerline of bearing on continuous spans. Steel bearings and associated end diaphragms should be included within these limits. Other areas of additional spot cleaning (e.g., exterior sides of fascia girders) shall be included as necessary.

The existing paint system should be evaluated for adhesion in accordance with ASTM D4541 as well the coating thickness and the compatibility of the existing coating with the new coating. Evaluation of the paint system shall be in accordance with the current edition of the “SSPC Painting Manual, Volume 2” (Ref. 13).

Prior to cleaning and painting, the existing paint system shall be evaluated for the presence of lead paint. If lead paint is present, contract specifications shall be prepared for proper and adequate lead paint removal and containment and worker protection (reference Volume 4 – Specifications for more information). 100 percent containment of blast by-products shall be contained. The design of the containment system shall be borne by the Contractor performing the work.

The new paint system(s) shall be in conformance with the Volume 4 Specifications assuming that it is compatible with the existing paint system.

C. Substructure Repairs

Substructure repairs include rehabilitating those bridge elements located at or below the abutment or pier beam bearing seat. The elements to be addresses include beam seats (and pedestals), abutments and wing walls, piers, slopes and foundation elements.

1. Concrete Repairs
The repair of concrete substructures generally involves both cosmetic and structural rehabilitation. Cosmetic repairs include superficial concrete deterioration such as shallow spalling (defined by no exposed reinforcement) and delaminating concrete (i.e., incipient spalling). Structural repairs include flexural or shear cracking, cracks wider than 1/16” and deep spalling where reinforcement is exposed (regardless of the condition of the reinforcement).

Concrete repair limits shall be based on the latest field inspection documentation. This information shall be field verified if it is older than one year or if the limits of concrete deterioration are not well defined. When determining the limits of repair for both shallow and deep spalling, the outside dimensions of the defect shall be increased by a minimum of 6” on all sides to ensure that the deteriorated portion is encapsulated within the repair.

All concrete repairs shall include provisions to remove all loose and deteriorated concrete and thoroughly clean the remaining surfaces prior to placing the repair material. Any exposed reinforcement shall be blast cleaned and inspected for section loss. Any bar reinforcement that has sustained more than 20% section loss shall be replaced by reinforcement of equal size and adequately lapped/spliced to develop the full strength of the bar.

The material used to repair deteriorated concrete shall be selected based on the location, type and volume of the proposed repair.

2. Pile Repairs

Repairs to piles will consist of a combination of structural enhancement and/or protection. For existing steel piles with section loss resulting from corrosion, steel plates or rolled channel section shall be field bolted to increase the capacity of the pile. Unless the pile has significant section loss, the addition of these steel elements can be affixed under full traffic load. The length of these newly bolted members shall extend well beyond the limits of the deteriorated portions so that the bolted connection is fully developed within the full original section of the pile. For concrete piles, additional concrete section may be added in a similar manner utilizing reinforcement doweled into the existing pile and tremie concrete placed. Repairs to timber piles that have lost section can be accomplished using timber pile splices. Concrete and steel pilings shall be repaired by cleaning the exposed surfaces and placing fiberglass jackets from the channel bottom to up above the splash zone, or just in the vicinity of the splash zone if that distance is prohibitively long. Grout or a specialized concrete mix shall be placed between the existing pile and the jacket, with reinforcement added as needed to provide additional strength. Substantial cross-sectional losses can be strengthened by adding material to the pile and extending the concrete pile strut to the mudline. The foundation unit must be analyzed with this additional dead load to ensure that none of the piles are being overstressed by this additional weight.

3. Scour and Undermining

Channel degradation and/or scour can advance to the point of exposing the piles. In addition, strong waterway currents or wet/dry cycles can reduce the cross section of the piling at the channel bottom or mudline or water surface (common to timber piles and steel pipe piles). The foundation should be analyzed to determine the pile/soil interaction affects from lateral and vertical loadings and incorporate this information into a structural model to determine the overall structural integrity and/or stability of the foundation unit in question. Inspection observations and measurements or subsequent structural analyses will dictate if pile repairs should be performed in accordance with the previous section.

If scour countermeasures are deemed necessary, scour computations and evaluations shall be performed in accordance with the MDOT SHA OOS "Manual for Hydrologic and Hydraulic Design" (Ref. 12), in particular Chapter 7 and 11. In addition, an underwater inspection (including soundings) should be performed as well as a review of previous underwater inspection reports and other scour evaluation reports. Generally, scour countermeasures for bridges over streams, creeks and rivers will include riprap or grout bag blankets placed around piers and abutments. Stream instability countermeasures, if required, shall include riprap or gabion bank protection,
spur dikes and check dams. Scour countermeasures for bridges over tidal waterways will include riprap aprons around pile bents and riprap revetments around abutments and approach roadways.

During the development of scour countermeasures, all permitting requirements shall be determined and applied for at the Preliminary Design phase.

4. Underpinning

In extreme cases of undermining, a substructure unit may lose sufficient bearing, which could result in the structure collapsing. In the case where a substructure unit has rotated or settled, it may be necessary to jack the substructure unit back into proper position prior to underpinning the foundation. The method used to underpin a foundation depends greatly upon the amount of undermining and whether the underpinning is required to provide structural support. For severely undermined foundations, the underpinning must be performed in such a manner as to provide bearing. This can be accomplished by placing either a temporary form or a permanent fiberglass jacket around the substructure footing and pumping concrete or grout in the void between the substructure footing and the form. Reinforcing steel shall be doweled into the existing foundation or a rock foundation below. The form shall be high enough to provide sufficient head pressure so that the concrete or grout is forced into all voided areas and up against the bottom of the existing foundation. Since gabion walls can tolerate substantial settlement and/or rotation prior to failure, repairs may only be necessary when the wire basket cages corrode or break. Retying the wires is an acceptable measure to repair the baskets. Gabion walls with substantial settlement and/or rotation shall be analyzed for stability to determine if the wall can remain or if reconstruction is required.

D. Retaining Walls

The rehabilitation of retaining walls should consider the material and type of wall. For concrete retaining walls, repairs will generally only be made to the surface areas unless wall alignment is in question. Concrete repairs for retaining walls shall generally follow those stipulated for bridges under Section 4.10.C.1.

For the repair of MSE or other proprietary type precast walls, rehabilitation measures should be discussed with the wall manufacturer prior to implementing repairs. Typical problems involving MSE walls include the failure of the soil reinforcement strap attached to the wall facing panel. Grouted tie-back anchors may be considered to stabilize the wall panel and eliminate future local erosion of the fill.

E. Maintenance of Traffic

Maintenance of Traffic (MOT) for the rehabilitation of existing structures shall conform to applicable portions of Section 5.5 as contained later within this volume.
4.11 Load Ratings

A. Introduction

This section addresses the calculation of load ratings for new or existing structures as part of a design project to rehabilitate or replace an existing bridge. Load ratings may also be required for existing structures that have incurred structural deterioration observed during routine biennial inspections. Load ratings shall be calculated for all bridges carrying traffic including culvert type structures covered with less than 8 feet of earthen fill. As part of the final design of new or replacement bridges, the designer shall compute the load ratings for the structure and include these with the Final Plans submittal to the County.

B. Methodology

Load ratings shall be calculated in accordance with Chapter 6 of the latest edition of the A.A.S.H.T.O. “Manual for Condition Evaluation of Bridges” (Ref. 14) and MDOT-SHA Structural Guidelines and Procedure Memorandums” (Ref. 10). At a minimum, the four standard Maryland legal live load vehicles shall be rated, including the H-15 (15 tons), HS-20 (36 tons), Type T-4 (35 tons), and 3S-2 modified (40 tons) trucks. In addition, load ratings may be required for the eight (8) special vehicles (e.g., school buses, emergency vehicles, special permit vehicles, etc.) as directed by the County.

Both inventory and operating load rating values shall be computed for each truck considered. Material values shall be based on any available record plans or field testing, as applicable. If no plan or testing information is available, material properties shall be estimated based on the provisions contained within Chapter 6 of the latest edition of the A.A.S.H.T.O. “Manual for Condition Evaluation of Bridges” (Ref. 14).

The inventory load rating value shall be considered as the load level that can safely cross the structure for an indefinite time period assuming that the structure remains in its current condition. The operating load rating value shall be considered as the maximum load level that can safely cross the bridge. Allowing this maximum load to cross the bridge indefinitely may compromise the structural integrity and limit the service life of the bridge.

Load ratings shall be computed based on the known section properties of each member accounting for any section loss or member deterioration that could adversely affect the load rating values. Load ratings may be hand-calculated or computed using appropriate computer software written specifically for structural load ratings. For rigid frames and box culvert type structures, structural models based on plane frame analysis methodologies shall be used. In addition to the application of dead and live loads, earth pressure loads (vertical and horizontal) shall be also be applied. Earth pressure loads shall be additive to the dead loads when computing the available member capacity to resist the applied live loads. For paved inverts that are structurally connected to the side walls (e.g., four-sided box culvert), the structural model shall incorporate the effects of the bottom slab loading on the subbase by utilizing spring constants in the model. These spring constants shall be based on an evaluation of the existing soil conditions to determine an appropriate coefficient of subgrade reaction. Each member within a four-sided culvert structure (i.e., walls, top slab and invert slab) shall be analyzed and load rated.

Headwalls on rigid frame, four-sided culverts and pipes need not be load rated.

C. Posting

Structures that do not rate out for the minimum vehicle weight at the inventory level (i.e., the rating factor, RF < 1.0) shall be recommended for posting to the Chief of the Bureau of Engineering. All postings shall include both the Gross Vehicle Weight (GVW) for the H-15 and Type T-4 trucks and the Gross Combination Weight (GCW) for the HS-20 and Type 3S-2 modified trucks. The acceptance and implementation of the recommended load posting shall be at the discretion of the Chief of the Bureau of Engineering.
4.12 Plan Preparation Guidelines

A. Introduction

This section provides guidance on the proper manner to prepare plans for bridge replacement and/or rehabilitation projects. CADD guidelines related to the production of plan sheets using Microstation is covered under applicable sections of Chapter 1. Plan preparation guidelines for retaining wall projects are covered under Section 4.4.A.

B. Sheet Layout and Order

Bridge plan sheets shall be generated and prepared using commonly accepted engineering and drafting techniques and practices. In general, plan sheet layout shall be developed to include only those views, sections and details pertinent to a particular bridge component. Mixing of various details from different portions of the structure (e.g., substructure and superstructure) shall be avoided wherever possible.

The order of bridge plan sheets for new structures shall conform to the following:

- General Plan and Elevation
- Hydraulic and Hydrologic Data Sheet (if applicable)
- Geometric Layout (for substructure footings or piles)
- Substructure Unit Plan and Elevation (for abutments, wing walls and piers)
- Substructure Typical Sections (of abutments, wing walls and piers)
- Bridge Typical Section(s)
- Framing Plan Layout
- Beam/Girder Details (includes elevation, camber information, splice details, etc.)
- Diaphragm Details (end and intermediate)
- Bearings
- Deck Elevations
- Roadway Joint Details (includes plan layout, sections and any necessary details)
- Bridge Railing Details
- Approach Slab Layout and Sections (if applicable)
- Miscellaneous Details
- Boring Logs (including plan layout of locations)

The order of plan sheets for a rehabilitation project will follow this general order as applicable. Highway plan sheets and any necessary maintenance of traffic plan sheets shall be placed ahead of the bridge plans when they are made a part of the project.
4.13 References

(1) "LRFD Bridge Design Specifications", American Association of State Highway and Transportation Officials (A.A.S.H.T.O.)


(3) "Manual of Steel Construction", American Institute of Steel Construction (A.I.S.C.)

(4) "ACI Manual of Concrete Practice", American Concrete Institute (A.C.I.)

(5) "Structural Welding Code", AWS D1.1, American Welding Society (A.W.S.)


(7) "Howard County Storm Drainage Design Manual", Department of Public Works, Bureau of Engineering, Howard County, Maryland

(8) "Hydraulic Design of Highway Culverts", Hydraulic Design Series No. 5, U.S. Department of Transportation, Federal Highway Administration

(9) "Maryland Waterways Construction Guidelines", Maryland Department of the Environment

(10) "Structural Guidelines and Procedure Memorandums", Maryland Department of Transportation, State Highway Administration, Office of Structures

(11) "Structural Details Manual (Maryland Department of Transportation, State Highway Administration, Office of"

(12) "Manual for Hydrologic and Hydraulic Design", Maryland Department of Transportation, State Highway Administration, Office of Structures

(13) "SSPC Painting Manual, Volume 2", Society for Protective Coatings


(15) "Book of Standards for Highway and Incidental Structures", Maryland Department of Transportation, State Highway Administration, Office of Highway Development


(18) "Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance", Hydraulic Engineering Circulars No. 23, U.S. Department of Transportation, Federal Highway Administration


(20) "Stream Stability at Highway Structures", Hydraulic Engineering Circulars No. 20, U.S. Department of Transportation, Federal Highway Administration


(22) "Guide Specifications for Wind Loads on Bridges During Construction", American Association of State Highway and Transportation Officials (A.A.S.H.T.O.)


(25) "Bridge Railing Manual" Maryland Department of Transportation, State Highway Administration, Office of Structures
(26) “Aesthetic Bridges - User's Guide” Maryland Department of Transportation, State Highway Administration, Office of Structures