“One of the objectives of the Baltimore City Department of Public Works is to correct stream channel stability problems *in order to* reduce sediment and nutrient loading from channel sources, improve in-stream habitat, protect public infrastructure, protect public and private property, and reduce the need for future channel maintenance in city streams.”
Project Reach: Drops 54 ft over 2900 ft = 1.84%  
(Average slope – all Stony Run = 1.34%)  
DA = 0.99 sq mi at D/S end  
Mid 1800s – 3 ponds in MSR;  
Most development complete 100 yrs ago  

Figure 3: Historical mapping of Middle Stony Run (1876)  

Table 3: Land use breakdown for the Stony Run watershed (STV, Inc. 2002, 2004)  

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Total Acreage by Type</th>
<th>Percent by Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential - 1 ac lot</td>
<td>80.75</td>
<td>9.8</td>
</tr>
<tr>
<td>Residential - 1/2 ac lot</td>
<td>24.17</td>
<td>9.8</td>
</tr>
<tr>
<td>Residential - 1/4 ac lot</td>
<td>265.09</td>
<td>41.4</td>
</tr>
<tr>
<td>Residential - 1/8 ac lot</td>
<td>136.29</td>
<td>21.5</td>
</tr>
<tr>
<td>Residential - 1/16 ac lot</td>
<td>56.72</td>
<td>9.2</td>
</tr>
<tr>
<td>Forest</td>
<td>37.49</td>
<td>5.9</td>
</tr>
<tr>
<td>Open Space</td>
<td>52.75</td>
<td>8.3</td>
</tr>
<tr>
<td>Total</td>
<td>688.27</td>
<td>100.00</td>
</tr>
</tbody>
</table>
VI. HYDROLOGIC ANALYSIS

One of the critical steps necessary for any geomorphic stream design project is developing accurate estimates of the flow regime, particularly the bankfull discharge. Four methods were used to develop design discharge estimates. These included:

- Project specific regional curves,
- NRCS TR-20 hydrologic model;
- Calculations using Manning’s Equation and project reach field data, and
- Regression estimates.

The goals of the hydrologic analysis are twofold: one is to determine accurate bankfull discharges and the other is to develop the range of discharge estimates including the 1-, 2-, 10- and 100-year discharges. Both sets of numbers will be used during the stream restoration design.

1. Regional curves – mix Piedmont & Coastal Plain, includes Moores Run, Dead Run, & Whitemarsh Run; yields plots of $Q_{bf}$ vs DA and $A_{bf}$ vs DA

$Q_{bf} = 194 \ (DA)^{0.79} \ (cfs, \ sq \ mi) \rightarrow 166 – 192 \ cfs \ U/S \rightarrow D/S$

**ASK:** How was $Q_{bf}$ determined in these plots? Is it really bankfull?

2. Manning – X/S & S from riffle, using D84 & Manning-Strickler (?) $\rightarrow 163 – 214 \ cfs$

**ASK:** Large uncertainty in $Q$ from Manning. Should bankfull geometry in the existing “disturbed” channel provide a template for restored channel?

3. TR-20

<table>
<thead>
<tr>
<th>Year</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>194 – 219 cfs</td>
</tr>
<tr>
<td>2</td>
<td>327 – 368 cfs</td>
</tr>
</tbody>
</table>

4. “Fixed Region Regression Estimates”

<table>
<thead>
<tr>
<th>Year</th>
<th>Discharge Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25</td>
<td>137 - 156 cfs</td>
</tr>
<tr>
<td>1.5</td>
<td>187 - 212 cfs</td>
</tr>
</tbody>
</table>

Final: 170 cfs U/S to 200 cfs D/S
The early studies show much more scatter …

- Leopold, Wolman, Miller 1964 IN, NB, MS, MD
- Kulp et al., 1964 AL, GA, NC, SC
- Wolman and Leopold, 1957 WY, MT, MD, NC, SC, CT
- Williams, 1978 CO, UT, NM, OR

75% of obs. within box
19% of obs: 1.36 < RI < 2.2 yrs

Return Period of Bankfull Flow (years)
MARYLAND STREAM SURVEY: BANKFULL DISCHARGE AND CHANNEL CHARACTERISTICS OF STREAMS
U.S. Fish & Wildlife Service, Chesapeake Bay Field Office
APPENDIX B – PROTOCOLS FOR FIELD SURVEYS AT GAGE STATIONS - DETERMINATION OF BANKFULL STAGE

Steep, confined streams in rocky canyons often lack distinguishable floodplains, so other features must be used. Where floodplains are absent or poorly defined, other indicators may serve as surrogates to identify bankfull stage.

Useful indicators include: Top of Point Bars, Change in Vegetation, Change in Slope, Change in Bank Materials, Bank Undercuts, Stain Lines.

Deposits of pine needles, twigs, and other floating materials are common along streams, but they are seldom indicators of bankfull stage.

If stream gage data is available for the stream, observations of indicators at or near the gages may help to identify the indicators most useful for a particular area.

Bankfull discharges tend to have similar flow-frequency (approximately 1.5 years) among sites in a given climatic region. Use observations of bankfull stage at local stream gages to test the reliability of the various indicators for your geographic area. Compare your calculation of bankfull discharge to the regional averages. If it is different, refer to the USGS peak flow procedures for the area to determine if a significantly different area-runoff relationship exists. In the absence of other reasonable explanations, examine your methods.

A. Rationale
Stream stability is morphologically defined as the ability of the stream to maintain, over time, its dimensions, pattern and profile in such a manner that it is neither aggrading or degrading and is able to effectively transport the flows and sediment delivered to it by its watershed. Morphologic stability permits the full expression of natural stream characteristics.

Stream potential is defined as the best condition, based on quantifiable morphological characteristics, for a given stream type. Streams functioning at full potential exhibit a desired or preferred set of stability or condition characteristics that may be quantitatively described in terms of channel size and shape, bed stability, vertical control, and bank stability/levee control - low bank erosion potential and gradual lateral migration rates.

Stream classification as a morphologic stream assessment technique permits a quantitative analysis of the degree to which existing conditions differ from an accepted range of morphological values documented for different stable stream types. The degree to which a stream’s existing condition differs from a stable or fully functioning potential can be determined by comparison to geomorphic databases, historical photographs or surveys of the same reach, and stable reference reaches of the same stream type at different points in the watershed or adjacent watersheds.

Stream bank and streambed erosion is currently the most significant problem along the Middle Story Run. The altered hydrologic and sediment regimes of the upper watershed, as well as the impounding effects of the old ponds and historic channel “improvements” are significant factors contributing to the current instability problems along the project reaches. In its current condition Middle Story Run is a significant source of sediment to downstream reaches.

Knowing what stage an unstable reach is in the evolutionary process allows us to predict the direction it will go in the future as well as determine the appropriate strategy for restoring stability. The reaches along Middle Story Run are at various stages in the channel evolution process.
C. Existing Condition Summary

Table 7 contains the morphological summary table for the Middle Stony Run study reach. Bankfull discharge estimates range from 190 to 214 cfs based on Manning's n estimate. Bankfull discharge estimates based on the upstream regional curves range from 195 to 192 cfs at the beginning and the end of the study reach. These values compare well with the Manning's n estimates.

Cross section areas range from 34.9 to 28.4 square feet using regional curves and from 39.6 to 41.4 from field estimates. These values show that the field estimates are consistent with the urban regional curves.

ASK: does it need fixing?

Existing Qbf and X/S area match regional curves. Consistent with regional relations. Restoration design will preserve these dimensions.

A. Rationale

This morphological stream assessment provides information on the current condition or state of an unstable stream reach and its direction of adjustment toward a more stable form. Valley type, bankform characteristics, and the working stream type can alter the potential form or most probable form that an unstable reach will achieve. If the reach is in a stable reach, then the most probable reach is identified. If a mobile reach at a mobile stream type, it can be identified directly. The detailed morphologic data obtained from the survey of a reach in each stream provides dimensionless values for channel cross-sections, patterns, and profile that can be utilized to develop a geometric stream design for the restored reach.

B. Identifying and Surveying a Reference Reach for Middle Stony Run

After determining the targeted stream type (i.e., stable form for the reach to be restored), the morphologic assessment was conducted to identify stable reaches in the upper and lower Stony Run watershed. Three reaches were identified, the evaluation was conducted of these reaches in Baltimore City and Baltimore County. The evaluation was focused on reaches with local use and geology similar to those that were unstable. To facilitate this evaluation, mapping developed as part of geomorphic assessment conducted by other groups was utilized. The geophysical maps, a field reconnaissance was necessary to eliminate reaches that were obviously not the right stream type or were unstable. The stream types were confirmed by conducting a local geomorphic description survey of candidate reaches. The initial evaluations focused on the Potomac watershed including Patapsco Mill Run and Long Run, City and County reaches, and Middle Stone Run. The evaluation was expanded to include Williams Run, Cooper's Branch, and Sweetwater Branch in Baltimore County. Although Williams Run and Cooper's Branch were relatively stable, they represented only a single stream type and were relatively short reaches.

ASK: how does one predict the "appropriate stream type"?

At this point in the study, the determination was made that finding a stable reaches of the appropriate stream type was more critical than replacing the unstable reach with reaches with similar geology. After evaluating Sweetwater Branch and Long Creek, it was determined that a reach at Sweetwater Branch in the Northern watershed at Baltimore County was a suitable reference for Stony Run. Although Sweetwater Branch has a completely different hydrologic regime than Middle Stony Run, the Sweetwater Branch reference reach will be used to determine a range of geometric parameters to be considered during the detailed stream restoration design.

ASK: If hydrologic regime is completely different, why should it work?
In the end, did an uncertain bankfull discharge, and ill-fitted reference reach, and untested transport capacity, make a difference?

“Two main principles of natural channel design are the use of reference reach data to create a design model and bankfull discharge as the channel design discharge.”

Results:
No bankfull indicators could be found – so 2 yr flood was used.

Value based on the average of several different estimates.

No good reference reach could be found; a poor match (Whitemarsh Run) was found for of the reach, but “The measurements from the reference reaches gave stream parameters that could not be obtained in the study reach because of the severely [de]graded nature of Mine Bank Run” “It was not always possible to utilize reference reach parameters in the design”
Some intermediate points – all of which we will return to ….

- Bankfull, effective, dominant discharges are a rat’s nest of circular reasoning.
- and in the end, how can you say that the stream will be stable, unless one estimates the future water and sediment supply and evaluates channel performance
- Concepts like “fully functioning potential” have little predictive meaning
- Bankfull discharge hard to find – does not exist – in many cases
- Streams must carry sediments at the rate at which they are supplied
- No method for determining dimension, pattern, and profile is wrong – they all have to be tested for transport competence and capacity