1. Introduction
Negative impacts from runoff can be seen on various locations around the University of Delaware campus, including deep gullying in the woods directly behind parking lot 6 on Laird Campus. Proper stormwater management can lessen overland and direct pipe flow in ways that decrease runoff and reduce negative impacts from rainfall events.

2. Objectives
1.) To use the Environmental Protection Agency’s Stormwater Management Model (EPA SWMM) to determine how the current stormwater system handles precipitation in the Fairfield Run Watershed.
2.) To determine possible system modifications that would reduce negative stormwater impacts.

3. Methods
1.) Create a system of pipes, nodes and outfalls over a backdrop of the Fairfield Run stormwater system in SWMM. Field verify the location and orientation of unclear pipes, nodes, and outfalls. Divide subcatchments according to overland flow and topography.
2.) Input parameters for subcatchments, conduits, nodes and outfalls. Calculate conduit slopes and collect pipe diameters and node invert elevations from an existing stormwater map. Calculate subcatchment slopes based on LiDAR mapping.
3.) Input rain gages for 3 real storm events and 2-year, 10-year and 100-year design storms. Collect hourly rainfall data for real storms events from the Delaware Environmental Observing System. Obtain 24 hour total rainfall values for New Castle County from TR-55. Divide total rainfall into half hour increments according to Type II Distribution described by NRCS.
4.) Run model for different storms and analyze results. Utilize the SWMM time series tool to create hydrographs of precipitation and runoff and the animation tool to view changes in flooding and runoff over the length of the storms. Perform further analyses using Microsoft Excel.
5.) Improve upon model results for current conditions in subcatchments F07, F08, F10A, F10B and F10C by changing the amount of impervious area through reforestation.

4. Results

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Total Precipitation (in)</th>
<th>Nodes Flooded</th>
<th>Total Flood Volume (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year Design Storm</td>
<td>3.20</td>
<td>5</td>
<td>151,000</td>
</tr>
<tr>
<td>10-year Design Storm</td>
<td>4.80</td>
<td>7</td>
<td>300,000</td>
</tr>
<tr>
<td>100-year Design Storm</td>
<td>8.00</td>
<td>12</td>
<td>674,000</td>
</tr>
<tr>
<td>March 14, 2015 Storm</td>
<td>1.10</td>
<td>2</td>
<td>5,000</td>
</tr>
<tr>
<td>Hurricane Sandy</td>
<td>4.52</td>
<td>4</td>
<td>494,000</td>
</tr>
<tr>
<td>Hurricane Irene</td>
<td>6.23</td>
<td>7</td>
<td>1,020,000</td>
</tr>
<tr>
<td>10-year (North Campus Reforested)</td>
<td>4.80</td>
<td>7</td>
<td>279,000</td>
</tr>
</tbody>
</table>

5. Conclusions
At a minimum, stormwater systems are designed to withstand flooding during 10-year design storm events. Fairfield Run’s current stormwater system does not perform to this standard. The current system floods during the much more frequent 2-year storms, and flooding increases significantly as storms become more intense. These flooding problems contribute to runoff, erosion, and pollution of White Clay Creek, a source for drinking water for Newark residents. Using EPA SWMM, it was determined that a 30.4% increase in forest cover in the Laird Campus parking lot would have decreased runoff by 30.3% during Hurricane Sandy.

Future work includes:
• Expansion of stormwater modeling to the entire city of Newark
• Exploration of best management practices and their effect on runoff and gullyng
• Exploration of design changes to the system, such as flow redirection

6. References
City of Newark Department of Public Works and Water Resources
USDA Natural Resources Conservation Service, Soil Survey
Delaware Environmental Observing System