# Stormwater Modeling in the Fairfield Run Watershed in Newark, Del.

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## 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 storm events. Collect hourly rainfall data for real storm 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

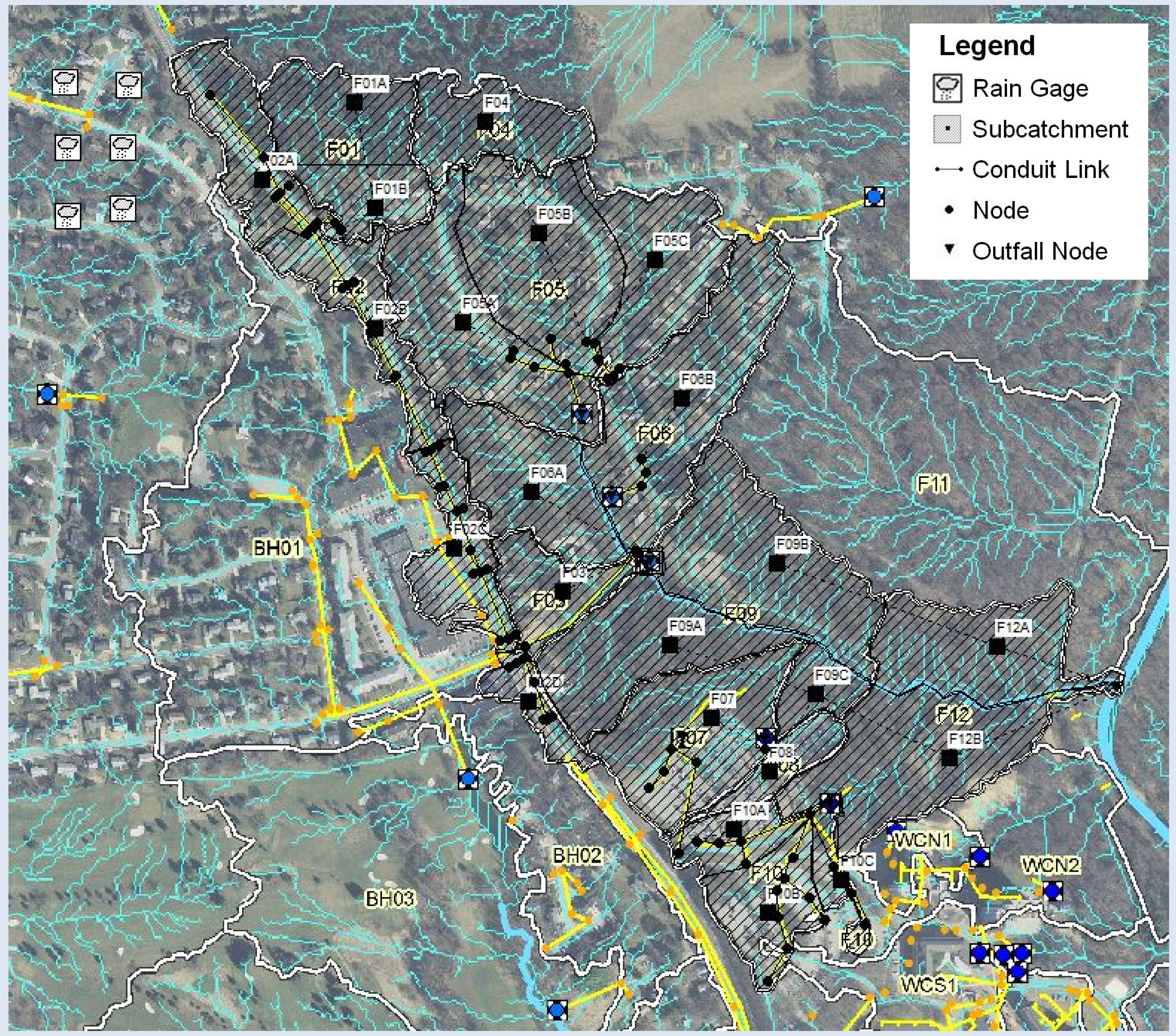


Figure 1. SWMM model of the stormwater system for Fairfield Run

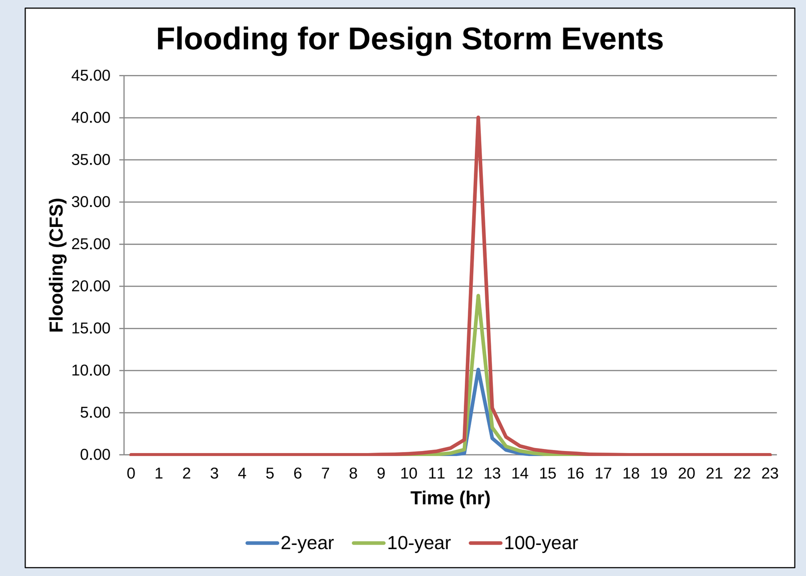


Figure 2. Flooding over a 24-hour period for 2-year, 10-year and 100-year design storms in Fairfield Run

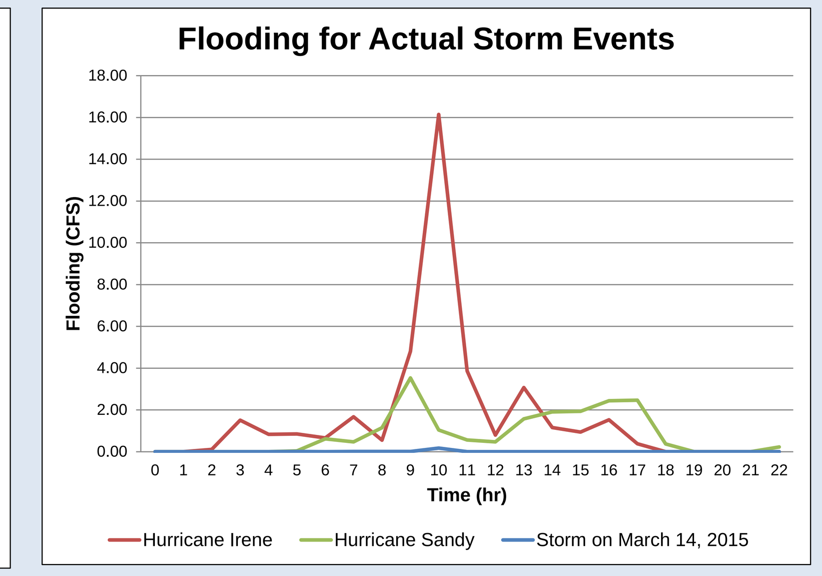


Figure 3. Flooding over a 24-hour period for real storm events that impacted the Fairfield Run Watershed

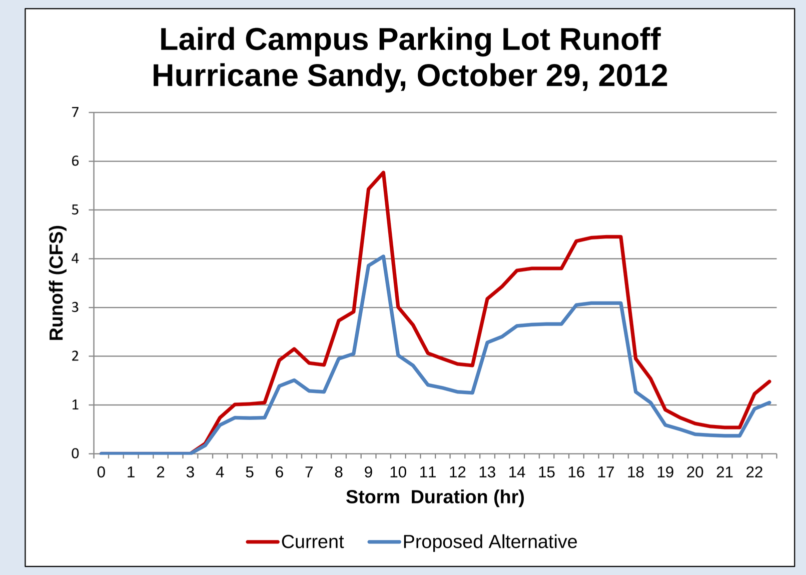


Figure 4. Runoff (cubic feet per second) caused by Hurricane Sandy compared to the theoretical runoff with a reforestation management strategy implemented

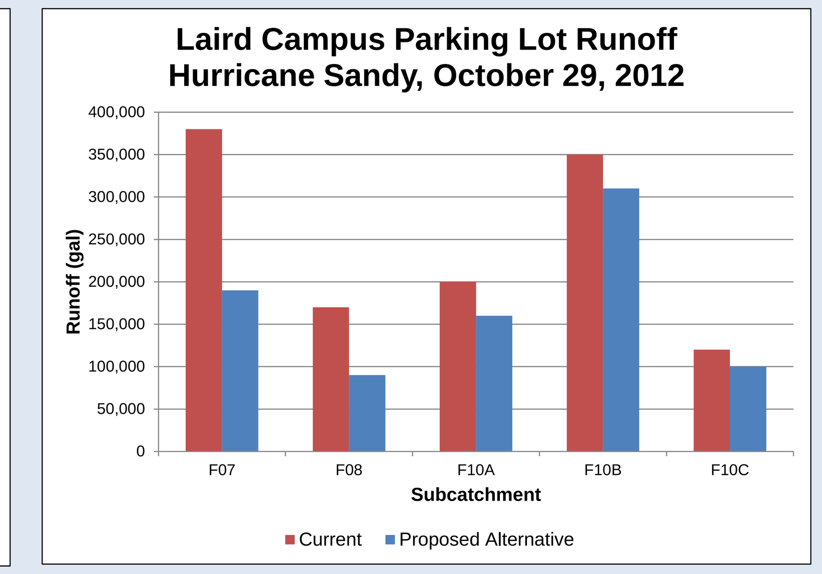


Figure 5. Runoff (gallons) caused by Hurricane Sandy compared to the theoretical runoff with a reforestation management strategy implemented

Table 1. Quantitative data gathered from SWMM model simulations

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

Table 2. Quantitative data for the proposed reforestation of parking lots 6 and 7

| | F07 | F08 | F10A | F10B | F10C | Total |
|---|---|---|---|---|---|---|
| Total Area (acres) | 6.56 | 1.46 | 1.71 | 3.35 | 1.03 | 14.11 |
| Original Impervious (acres) | 3.28 | 1.46 | 1.71 | 3.02 | 1.03 | 10.50 |
| Original Impervious (%) | 50 | 100 | 100 | 90 | 100 | 74.38 |
| Proposed Impervious (acres) | 1.64 | 0.80 | 1.37 | 2.68 | 0.82 | 7.31 |
| Proposed Impervious (%) | 25 | 55 | 80 | 80 | 80 | 51.84 |
| Difference (acres) | 1.64 | 0.66 | 0.34 | 0.34 | 0.21 | 3.19 |
| Difference (%) | 25 | 45 | 20 | 10 | 20 | **30.4** |

## 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 gullying
- 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

Sustainable UD water
WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

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