Emerson High School Stormwater Management

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Abstract

The Emerson Junior-Senior High school is located in northern New Jersey. The high school is surrounded by creeks and streams that flow along the school's property and can react poorly to large rain events. During intense rain flow, Main Street, the road adjacent to the school, is in danger of overtopping. In order to combat this, the team thought of different design solutions that could manage the stormwater. When examining the watersheds, there is discharge coming from the school, and from the surrounding neighborhoods. The hydrologic study shows, the peak discharge at the junction for 2, 10, and 100-year storms to be 124.2 , 254.7, and 489.7 cfs, with a volume of 34.4, 70.7, and 149.7 acres-ft, respectively. With careful consideration, the most prevalent solution was to construct a stormwater detention basin along with other additional hydraulic designs. A stormwater retention basin and other solutions would be designed according to the Borough's design specifications of 2, 10, and 100-year return periods. The additional solutions include the redesign of the existing culvert, as well as keeping the culvert how it is and adding relief culverts to the existing design. Through these designs, the team will find the ideal solution to the flooding issue and prevent the overtopping of the road while meeting the standards specified by the Borough of Emerson. The engineering cost estimate was put together as $28,050.

Design/Methods

Rainfall Analysis

- Delineated watersheds at accumulation points in Streamstats and obtained watershed characteristics and shapefiles.
- Found Hydrologic soil groups from Web Soil Survey to find curve number in watersheds from land use tables
- Used 10-foot elevation DEM file and watershed shapefiles. Calculated lag time and watershed slope.
- Peak flows and volumes were found from running 2, 10, and 100–year storm simulations on HEC-HMS.

Modeling Water Systems

- Performed a culvert inspection in order to obtain culvert geometry with respect to roadway elevation
- Terrain data developed in ArcMap was imported into HEC-HMS
- Computed simulations on our existing culvert to find flooding and overtopping from 100-year storm.

Culvert Redesign

- Replaced existing culvert with a new larger box culvert.
- Added channels to the existing culvert.

Stormwater Retention Basin

- Inflow hydrographs inputted in basin design program.
- Basin designed using space available in front of school and inputted into VTPSU.
- Outlet structures designed to reduce 2, 10, 100-year storms. by 20%.

Existing Site Map

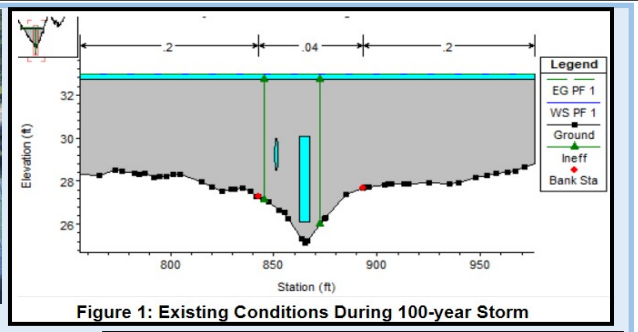

Figure 1: Existing Conditions During 100-year Storm

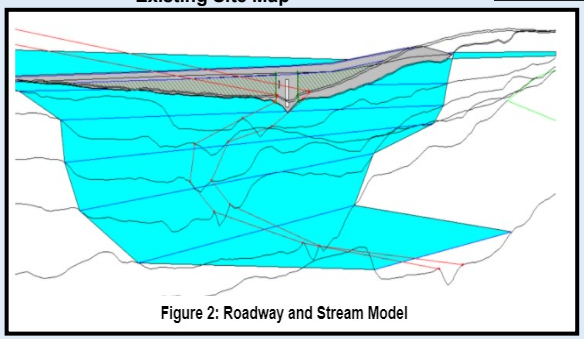

Figure 2: Roadway and Stream Model

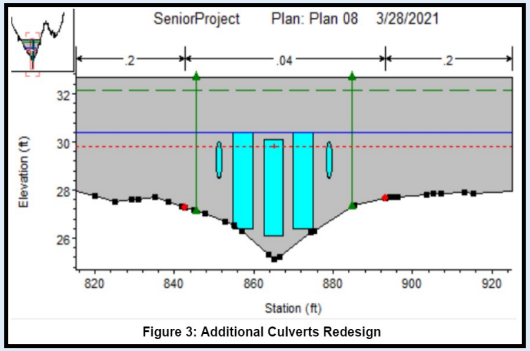

Figure 3: Additional Culverts Redesign

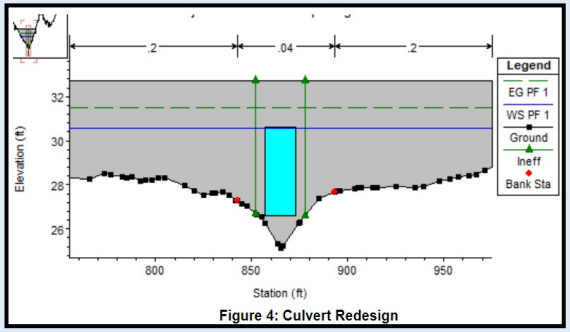

Figure 4: Culvert Redesign

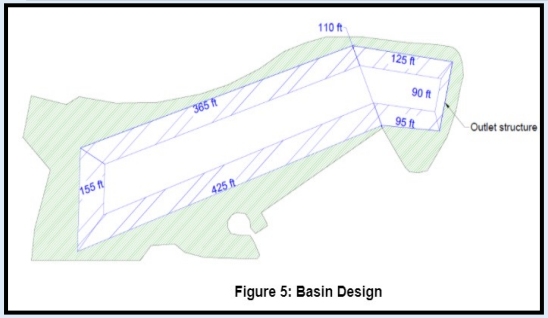

Figure 5: Basin Design

Conclusion

Both of the new culvert designs showed to adequately prevent the overtopping of the road, and in turn prevent flooding. The design of the stormwater retention basin is shown to successfully retain the stormwater volumes cause by high intensity storms and can also move water down stream at a pace 20% less than the initial discharge. The combination of one of the culvert designs and the stormwater basin should solve the flooding issues that the High School may face.

Acknowledgements

The team would like to thank the Civil Engineering Department at TCNJ especially our advisory Dr. Horst.

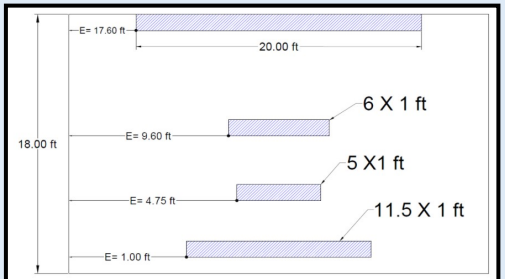

Figure 6: Outlet Structure Design

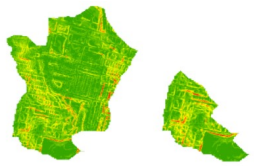

Figure 7: Watershed Shapefiles

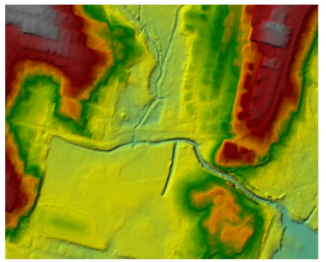

Figure 8: Topographic Map

Storm Frequency (2yr)	
Duration	Depth (in)
1 hour	1.35
2 hours	1.65
3 hours	1.85
6 hours	2.39
12 hours	2.96
1 day	3.30
Storm Frequency (10yr)	
Duration	Depth (in)
1 hour	1.94
2 hours	2.43
3 hours	2.72
6 hours	3.50
12 hours	4.38
1 day	4.99
Storm Frequency (100yr)	
Duration	Depth (in)
1 hour	2.83
2 hours	3.67
3 hours	4.14
6 hours	5.38
12 hours	6.91
1 day	8.24

Table 1: Rainfall

Storm Discharge and Volume		
Storm	Peak Flow cfs	Volume acre-ft
2-year	124.2	34.4
10-year	254.7	70.7
100-year	489.7	149.7

Table 2: Existing Stormwater Data

Additional Culvert Openings Redesign		
River Station	E.G Elevation (ft)	Top of Roadway
1738	32.59	32.70
1700 Culvert U	32.12	32.70
1700 Culvert D	31.64	32.70
1673	30.83	32.70

Culvert Redesign		
River Station	E.G Elevation (ft)	Top of Roadway
1738	31.95	32.70
1700 Culvert U	31.49	32.70
1700 Culvert D	31.34	32.70
1673	30.64	32.70

Table 3: Culvert Design Results

Depth	Volume
Feet	Acre-ft
1	1.06
2	2.14
3	3.24
4	4.37
5	5.52
6	6.69
7	7.88
8	9.10
9	10.34
10	11.60
11	12.89
12	14.19
13	15.52
14	16.87
15	18.25
16	19.65
17	21.07
18	22.51

Retention Basin Results		
Storm	Peak Flow cfs	New Flow cfs
2	124.2	99.9
10	254.7	206.1
100	489.7	391.2

Table 4: Basin Results