HYDRO ENGINEERING SOLUTIONS

A DIVISION OF HYDRO, LLC

TATUMVILLE GULLY
HYDRAULIC ANALYSIS
FAIRHOPE, AL

Tatumville Gully is located in Fairhope, Alabama and drains area from Fairhope Avenue to Mobile Bay (Figure 1). A hydraulic model was created for a portion of the upper part of the gully. The study reach extends from Nichols Avenue to Fairland Avenue; and to the east just past Mershon Avenue (Figure 2). A detention pond at the corner of Middle Street and Mershon Avenue is proposed to determine if peak discharges and velocities can be reduced in the downstream reaches.

SURVEY AND DATUM

Survey information used for developing the hydraulic model was taken from a cad file provided by Mott MacDonald. Information taken from the topographic survey includes cross-sections, existing road grade elevations, and all drainage structure information within the study reach. The coordinate system provided is in State Plane AL-W and the datum is to NAVD 88 (feet).

THE STREAM

The drainage area of the stream to Nichols Avenue is approximately 0.12 square miles and is approximately 0.27 square miles at Fairland Avenue. The stream drains an area that is comprised mostly of business and residential areas. The USGS program StreamStats indicates that the basin is 82% developed. The main channel of the stream throughout the reach varies from 20’ wide and 4’ deep upstream to 35’ wide and 10’ deep downstream. The stream slope varies between 0.01 ft/ft upstream to 0.04 ft/ft downstream.

Auburn Location
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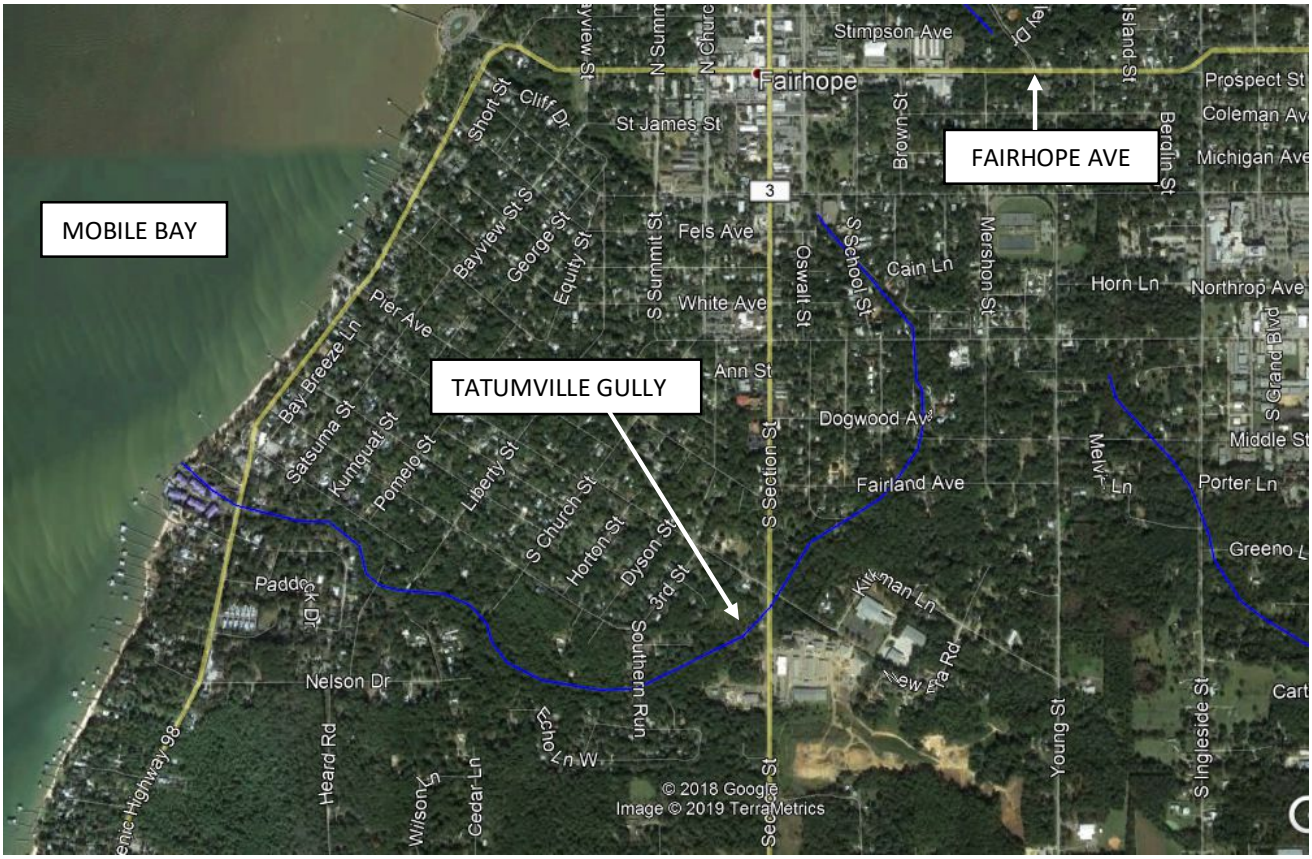

Figure 1. Aerial image indicating location of Tatumville Gully

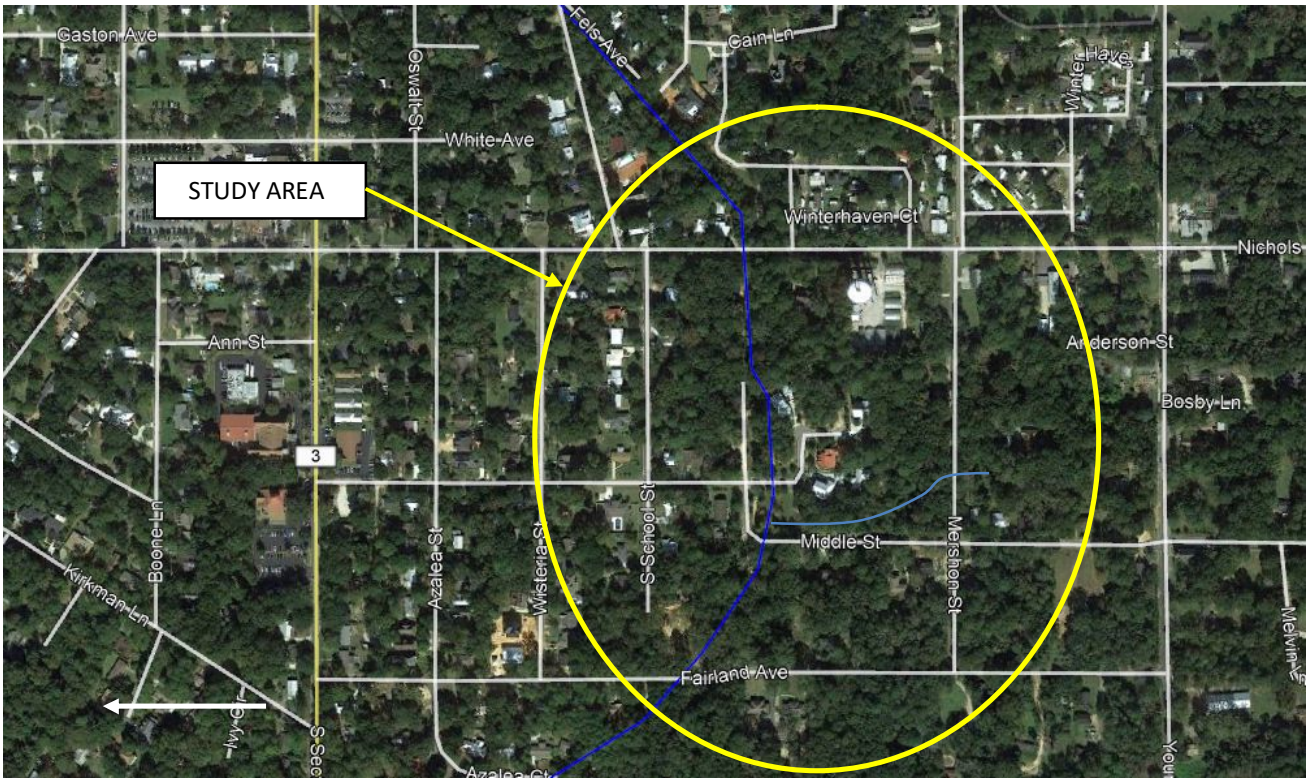

Figure 2. Aerial image indicating location of study area along Tatumville Gully

HYDROLOGIC MODEL

An estimate of peak discharges along the study reach for selected recurrence intervals was determined using the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model (Figure 3). GSSHA is developed and maintained by the US Army Engineer Research and Development Center (ERDC) Hydrologic Modeling Branch. GSSHA is a physically-based, distributed parameter hydrologic model with 2D overland flow, 1D stream flow, and 1D infiltration. Parameters used to generate a GSSHA simulation include precipitation data, digital terrain data, land use data, and soils data.

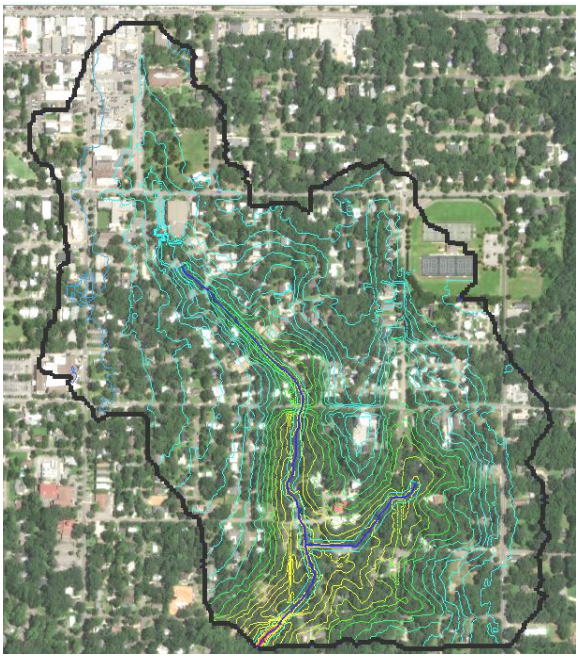

Figure 3. Aerial image indicating drainage area

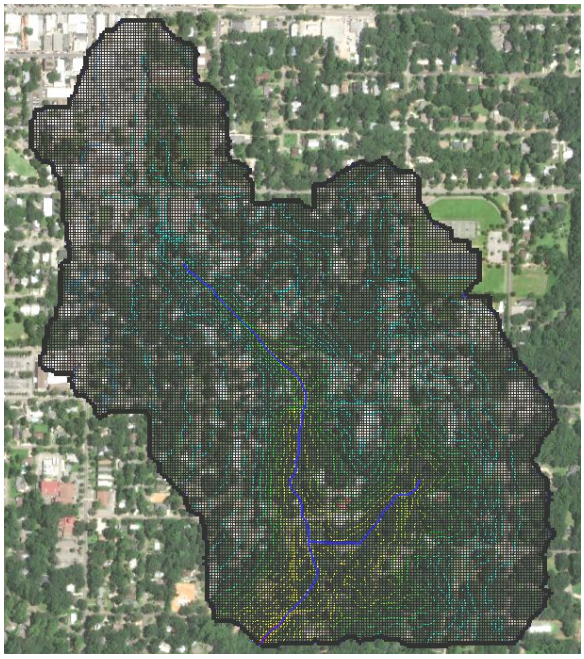

Figure 4. Aerial image indicating drainage area with grid cells

Once the data has been incorporated into the model, the model is divided into individual grid cells. The downstream most point of the model was taken approximately 170' downstream of Fairland Avenue. For this model, the basin utilized a 5 meter by 5 meter grid cell size. Over the entire watershed this generates approximately 29,480 grid cells.

Once the model is built and run, discharges can be determined at any point along the stream arc. For use in the hydraulic model, discharge locations were located at the following locations: Nichols Avenue, Dogwood Avenue, Middle Street, Fairview Avenue, Mershon Street, and at a driveway culvert (Figure 5). Peak discharges for selected recurrence intervals (2-, 10-, 25-, and 100-year floods) are provided in Table 1.

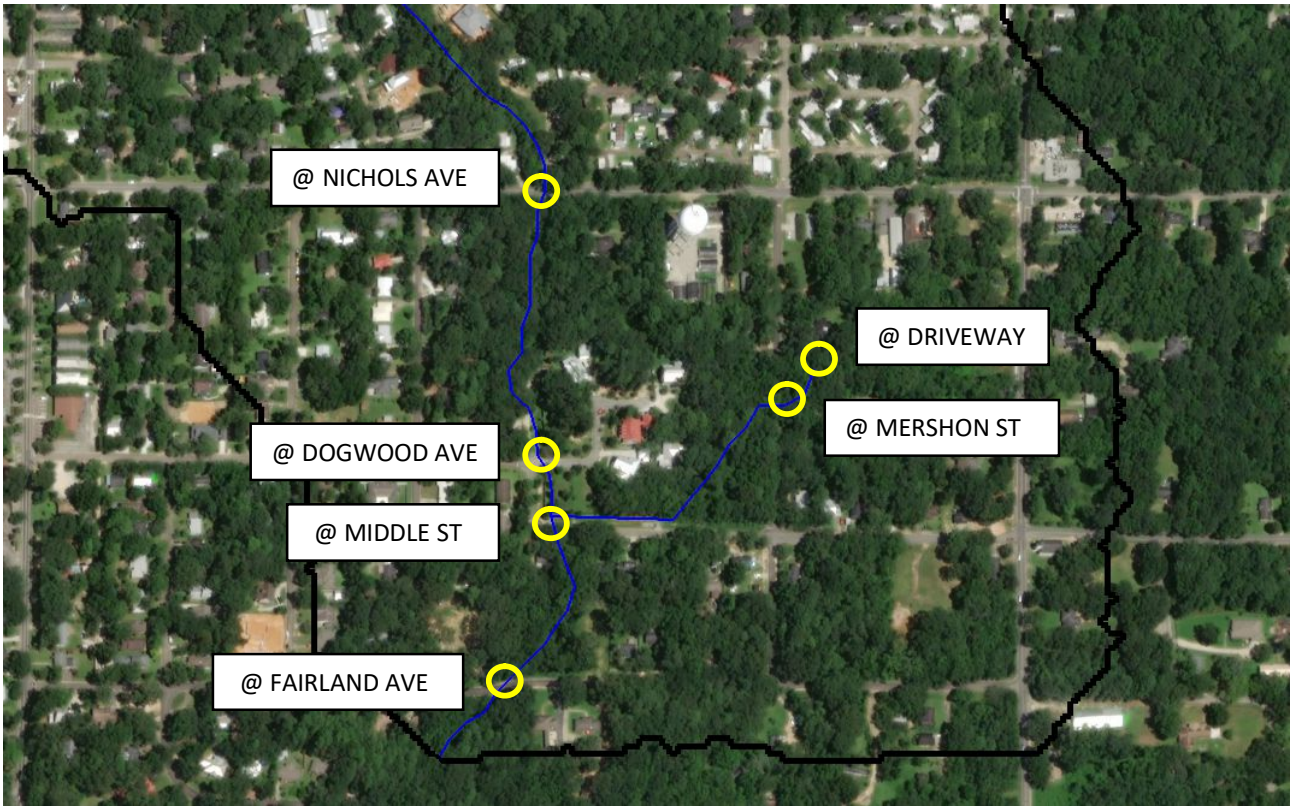

Figure 5. Schematic indicating the discharge locations in GSSHA model for use in the hydraulic model

HYDRAULIC MODEL

The Hydrologic Engineering Center – River Analysis System (HEC-RAS) software developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center was used to create the hydraulic model. HEC-RAS is a water surface profile computation model used to analyze one-dimensional steady flow in open channels. The HEC-RAS model utilizes stream discharge, floodplain cross-section conveyance and slope and an integral part of its modeling routine. Information used to develop the model includes floodplain cross-sections, Manning's n values, structure information, and discharges. The limits of the hydraulic model extend from Nichols Avenue to Fairland Avenue; and to the east just past Mershon Avenue (Figure 6).

It was determined during the development of the HEC-RAS model there appeared to be enough storage volume behind some of the culverts to attenuate flow. In order to detail the routing component, the computer program HydroCAD was used. HydroCAD is a Computer Aided Design system for modeling the hydrology and hydraulics of stormwater runoff. For the analysis, each structure (Nichols Avenue, Dogwood Avenue, Middle Street, Fairview Avenue, Mershon Street, and at a driveway culvert) was coded into the model as a detention pond (Figure 7). The model was set up to act as ponds in series where the backwater from each structure has the ability to affect the upstream structures. Figure 8 indicates the areas that have enough storage volume to impact discharges.

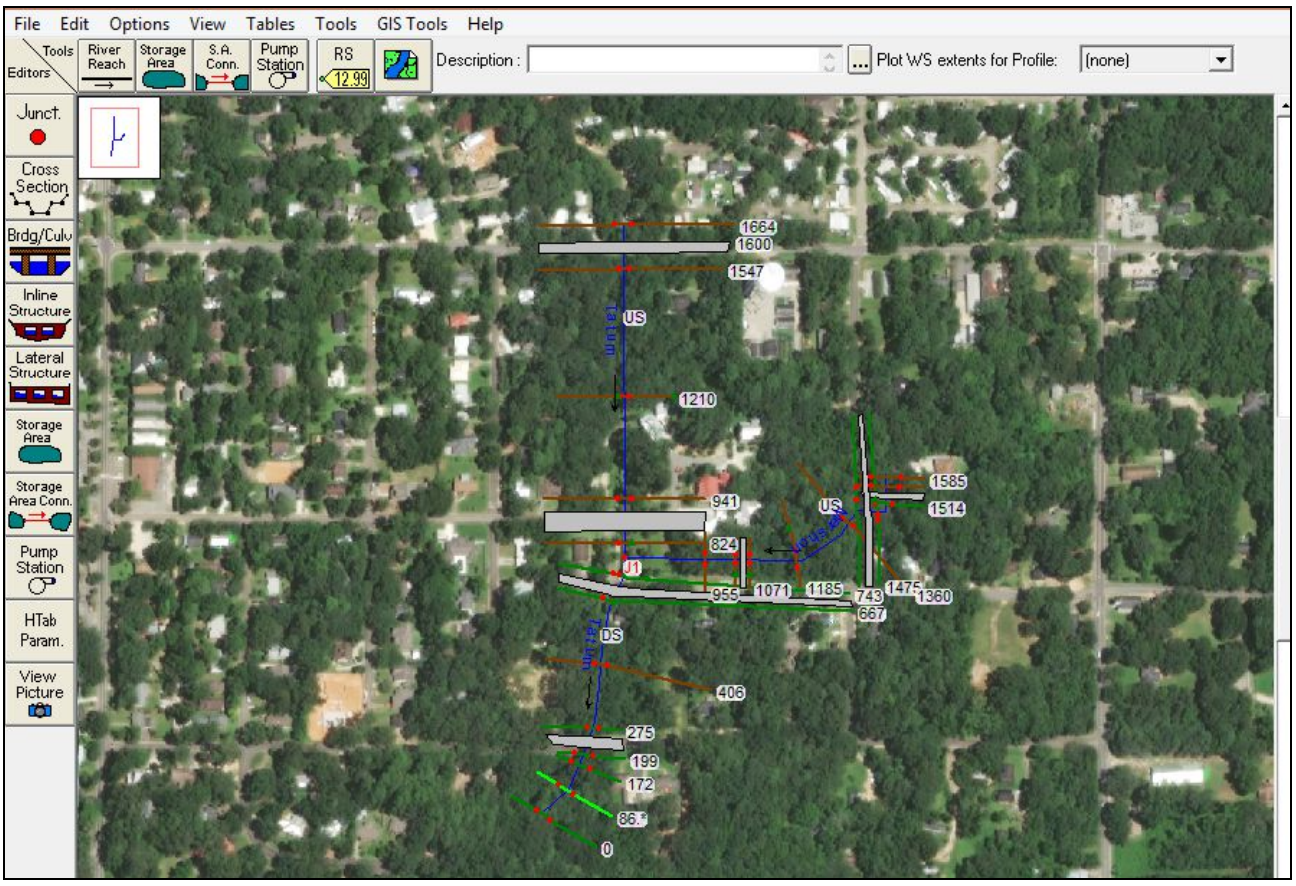

Figure 6. Schematic indicating HEC-RAS model layout

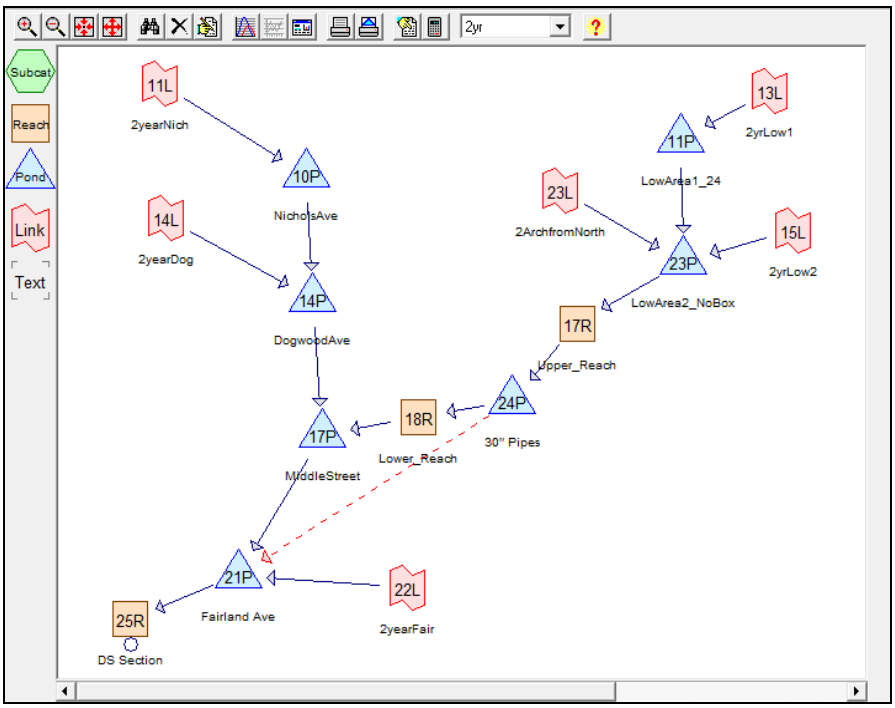

Figure 7. Schematic indicating HydroCAD model layout

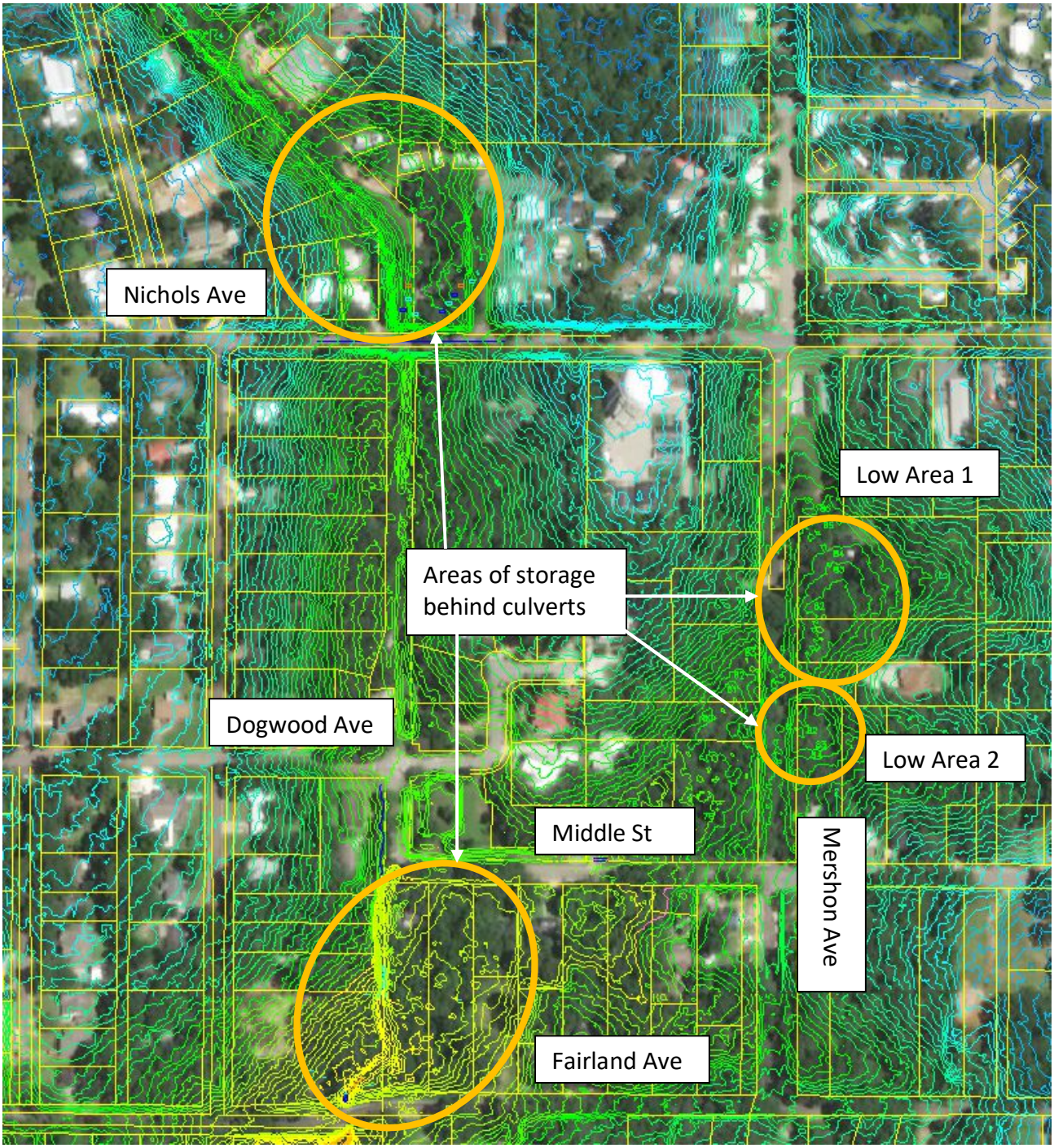

Figure 8. Schematic indicating areas of storage

Once the drainage structures and input hydrographs were entered into the HydroCAD model, the routed discharges could then be taken and input into the HEC-RAS model. The HEC-RAS model could then be used to determine velocities and stages in the downstream reaches. Table 1 is a summary of the routed flows at each drainage structure for the 2-, 10-, 25-, and 100-year flood events. Figures 9 and 10 indicate the water surface elevation profiles for the different flood events.

Table 1. Recurrence Intervals, peak discharges, and routed discharges

Location	Q2 (cfs)		Q10 (cfs)		Q25 (cfs)		Q100 (cfs)	
	Inflow	Routed	Inflow	Routed	Inflow	Routed	Inflow	Routed
Low Area 1	39	14	78	25	110	52	153	121
Low Area 2	79	73	147	106	200	191	334	333
Nichols Ave	149	146	230	218	357	301	593	403
Dogwood Ave	160	158	243	243	388	388	569	569
Middle St	217	213	327	325	506	503	727	719
Fairland Ave	238	224	335	304	547	432	840	715

*Locations can be found on Figure 8

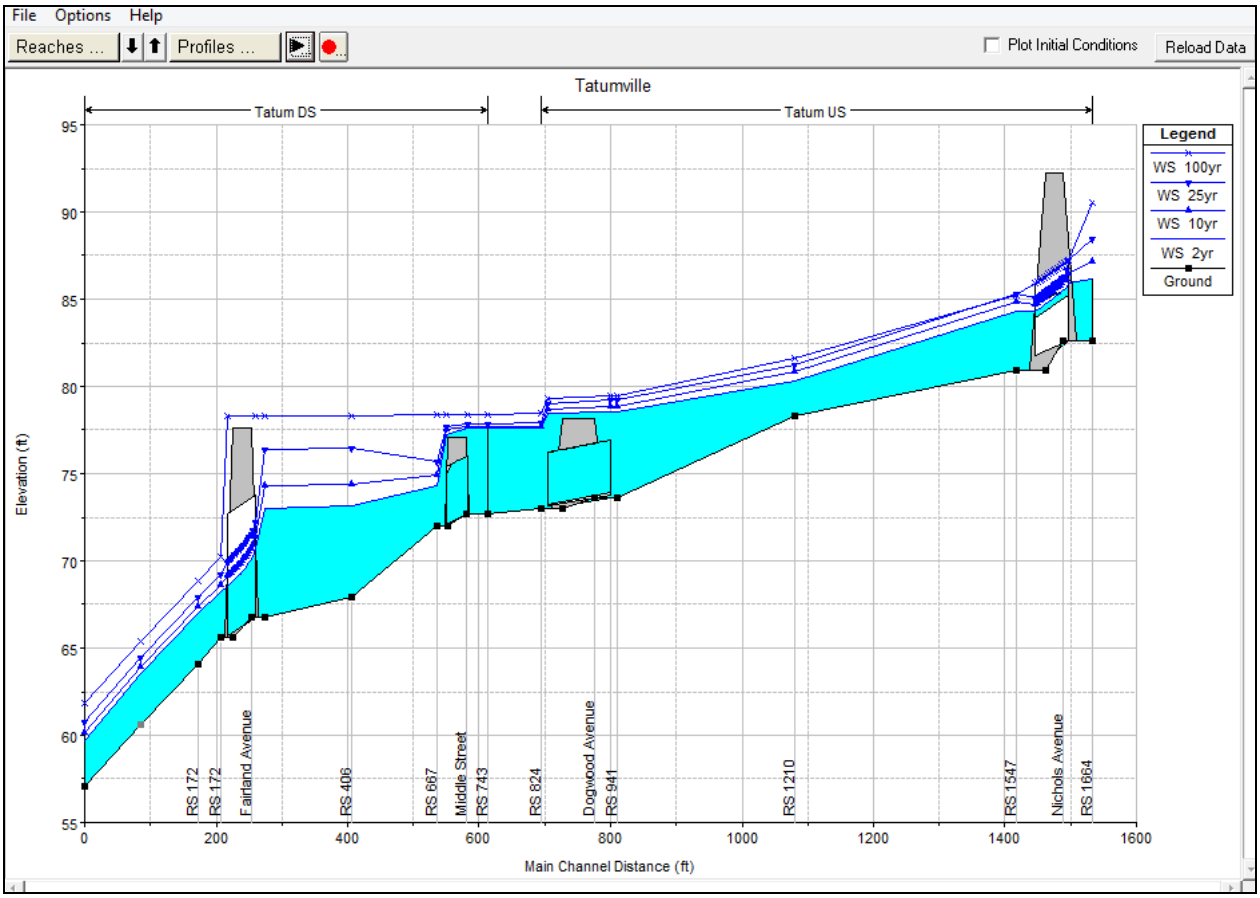

Figure 9. Schematic indicating water surface profiles from Fairland Ave to Nichols Ave

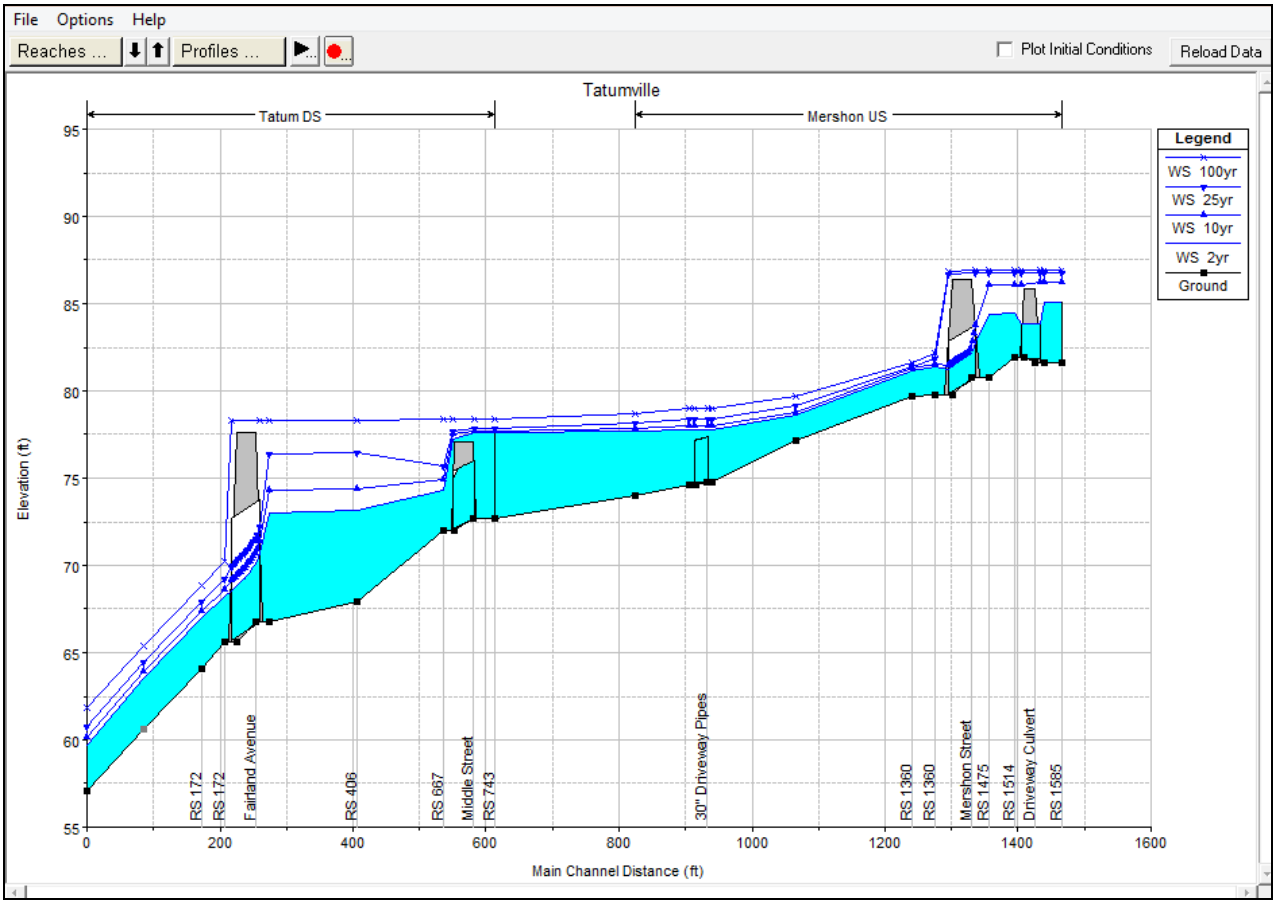

Figure 10. Schematic indicating water surface profiles from Fairland Ave to Mershon St

After the routed discharges were entered into the hydraulic model and water surface elevations were generated, a conceptual pond at the corner of Middle St and Mershon Ave was analyzed. Initially the pond was contained within a single lot, however, results indicated that this would not provide enough storage volume to be beneficial. The other conceptual pond utilizes 2 lots and a portion of the city's property (Figure 11). Once the conceptual grading was completed, the pond was entered into the previously built HydroCAD model (Figure 12). Table 2 is a summary of the routed flows at each drainage structure for the 2-, 10-, 25-, and 100-year flood events including the implementation of the conceptual pond. Figure 13 indicates the water surface elevation profile differences downstream of Middle Street based on the existing conditions and with the conceptual pond. Table 3 indicates the velocity changes in the stream sections downstream of Middle Street and Fairland Avenue.

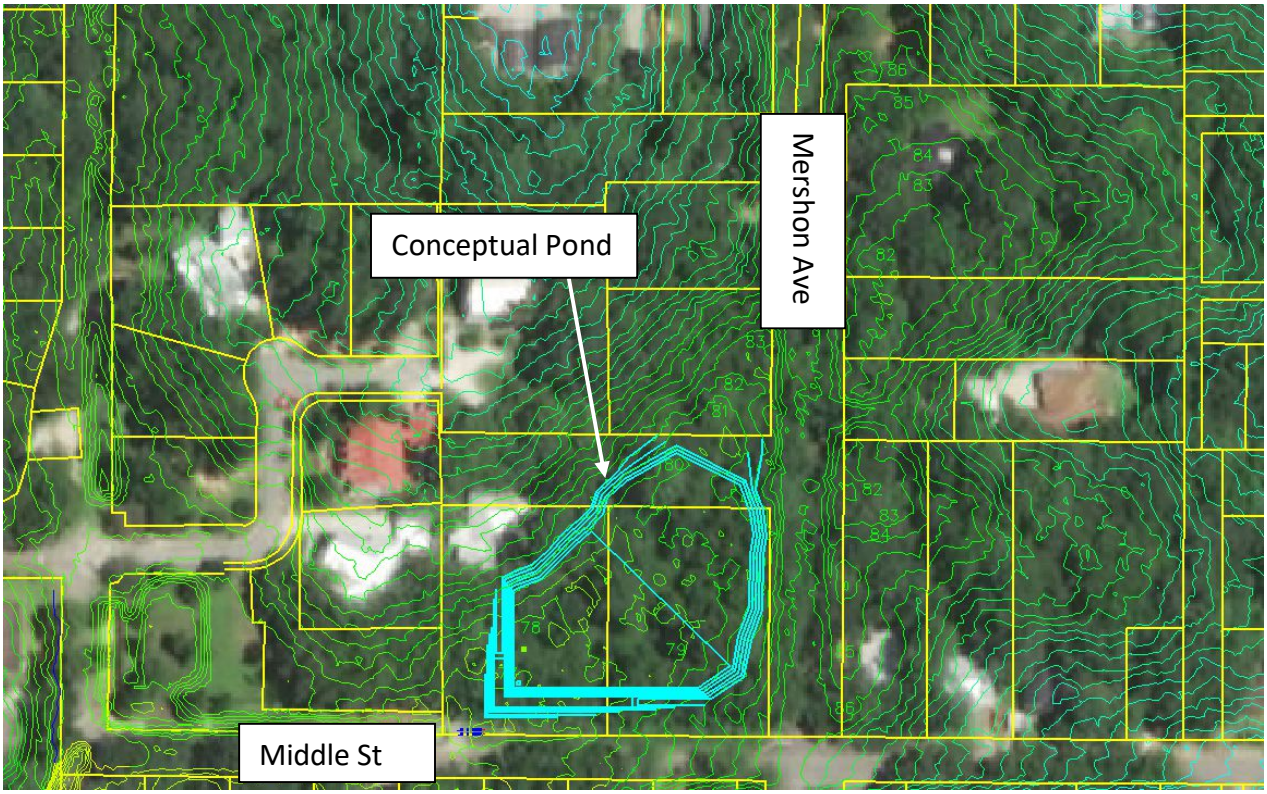

Figure 11. Schematic indicating conceptual pond at Middle St and Mershon Ave

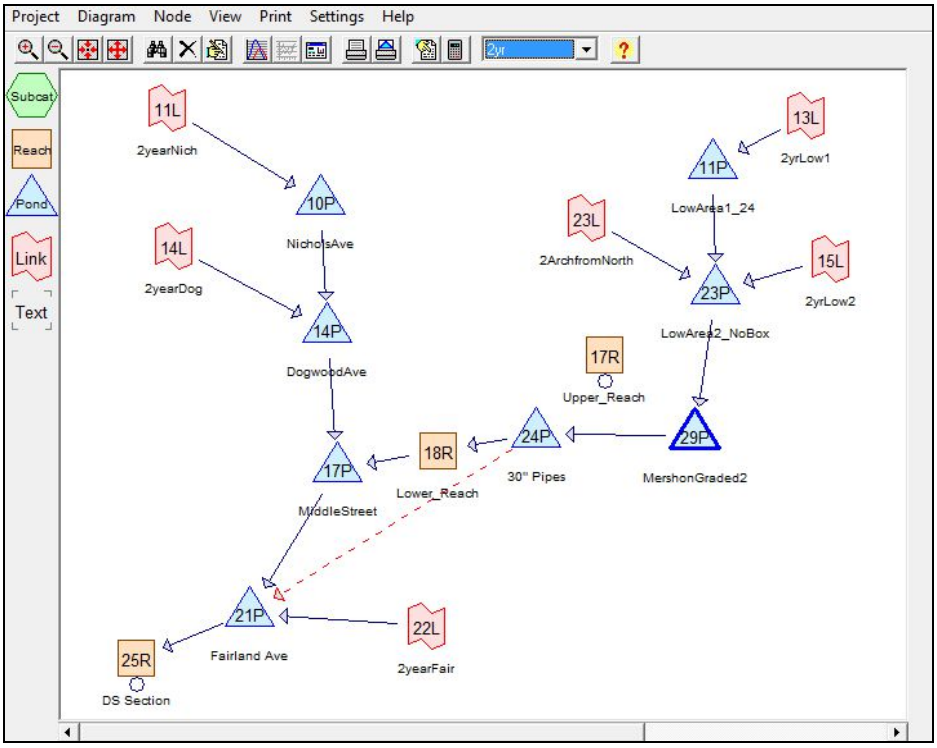

Figure 12. Schematic indicating conceptual pond at Middle St and Mershon Ave

Table 2. Recurrence Intervals, peak discharges, and routed discharges

Location	Q2 (cfs)			Q10 (cfs)			Q25 (cfs)			Q100 (cfs)		
	Inflow	Routed	w Pond	Inflow	Routed	w Pond	Inflow	Routed	w Pond	Inflow	Routed	w Pond
Low Area 1	39	14	14	78	25	25	110	52	52	153	121	121
Low Area 2	79	73	73	147	106	106	200	191	191	334	333	333
Nichols Av	149	146	146	230	218	218	357	301	301	593	403	403
Dogwood Av	160	158	157	243	243	241	388	388	388	569	569	569
Middle St	217	213	177	327	325	313	506	503	503	727	719	719
Fairland Av	238	224	196	335	304	290	547	432	426	840	715	699

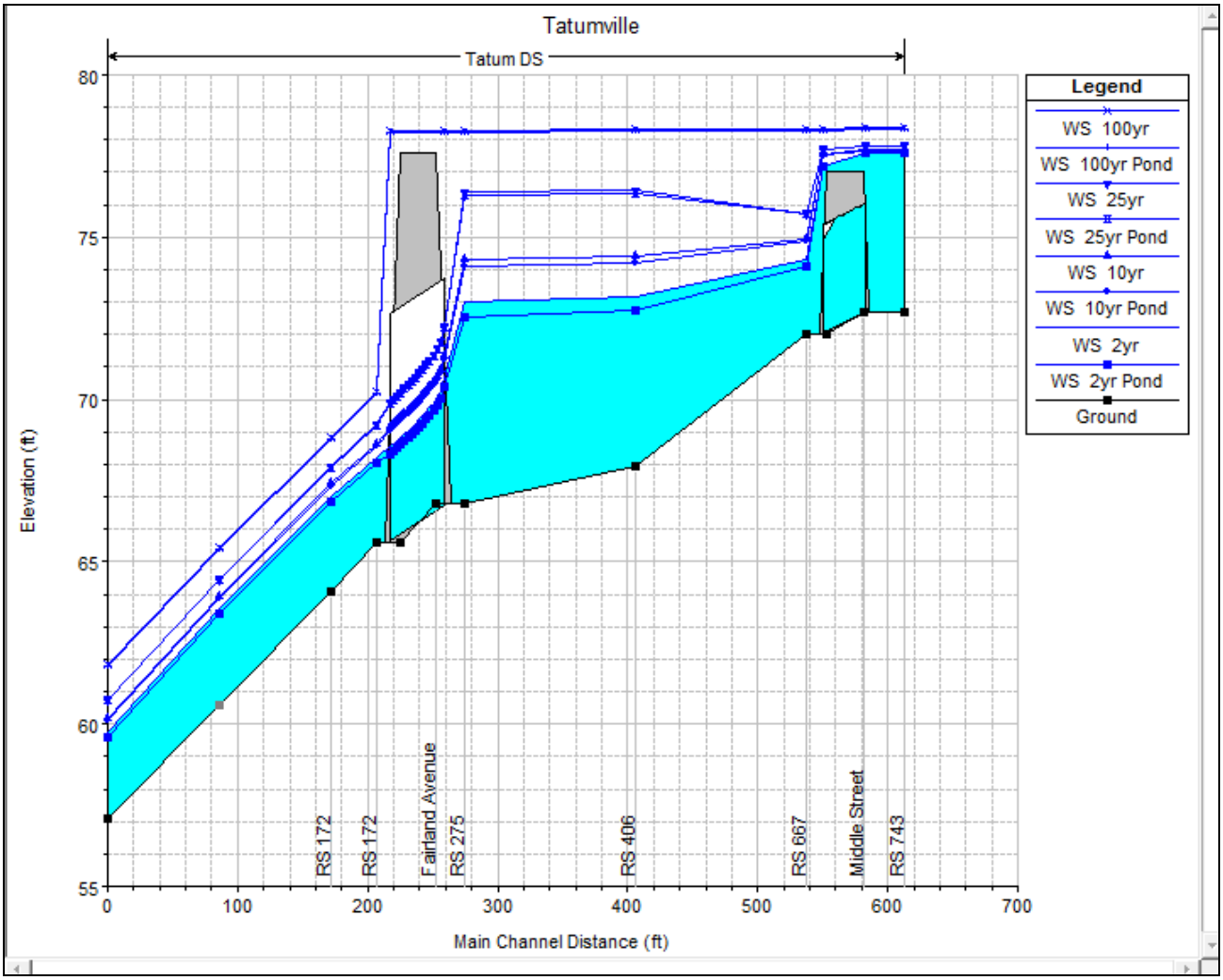

Figure 13. Schematic indicating water surface profile differences downstream of Middle Street

Table 3. Velocity comparisons downstream of Middle St and Fairland Ave

Location	V2 (ft/s)		V10 (ft/s)		V25 (ft/s)		V100 (ft/s)	
	Ex Cond	w Pond	Ex Cond	w Pond	Ex Cond	w Pond	Ex Cond	w Pond
DS of Middle St	7.3	7.0	8.1	8.0	8.9	8.9	1.4*	1.4*
DS of Fairland Ave	6.5	6.2	7.0	6.9	7.7	7.6	8.7	8.7

* Lower due to backwater effects from Fairland Avenue

Finally, a scenario was analyzed to see if the stages could be lowered upstream of Mershon Avenue and not impact any of the downstream reaches. Currently a 58" x 36" concrete arch pipe runs under Mershon Avenue. Adding a conceptual second pipe under the road was analyzed. Adding the second pipe will reduce stages, but will increase discharges at the outlet of the pipes. An analysis was performed to see if the conceptual pond at Middle St and Mershon Av could offset the increases in discharge. Table 4 indicates the routed discharges at each drainage structure for the existing conditions, with the conceptual pond added, and with the conceptual pond and additional pipe added. Figures 14-17 indicate the water surface elevation profile differences upstream of Mershon Ave based on the existing conditions and the addition of the extra pipe under Mershon Ave. Figure 18 indicates the water surface elevation differences plotted on a contour map.

Table 4. Recurrence Intervals and routed discharges for existing, w/ pond, and w/ pond and pipe

Location	Q2 (cfs)			Q10 (cfs)			Q25 (cfs)			Q100 (cfs)		
	Ex	w Pond	w Pond w Pipe	Ex	w Pond	w Pond w Pipe	Ex	w Pond	w Pond w Pipe	Ex	w Pond	w Pond w Pipe
Low Area 1	14	14	13	25	25	24	52	52	50	121	121	119
Low Area 2	73	73	82	106	106	129	191	191	184	333	333	329
Nichols Av	146	146	146	218	218	218	301	301	301	403	403	403
Dogwood Av	158	156	157	243	243	243	388	388	388	569	569	569
Middle St	207	175	178	326	319	312	503	503	502	720	720	733
Fairland Av	223	196	198	304	289	292	433	427	424	716	700	725

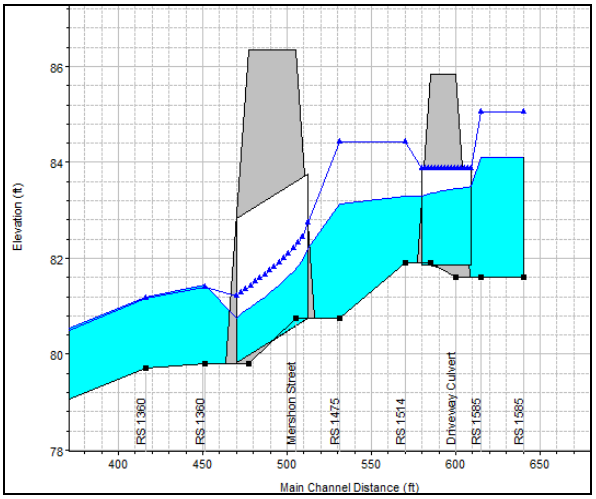

Figure 14. Profile plot of the 2yr water surface elevation difference for existing conditions and addition of new pipe under Mershon Ave

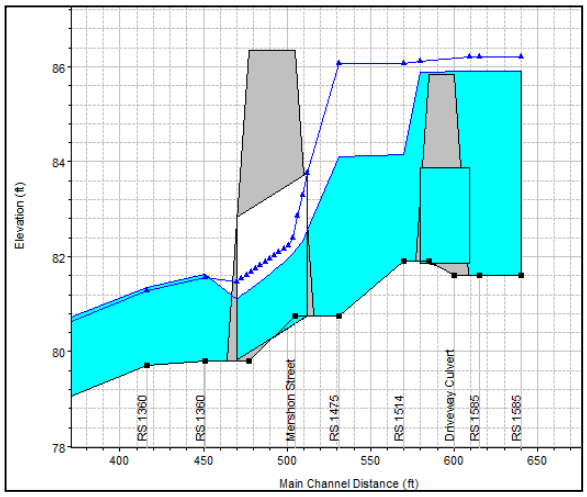

Figure 15. Profile plot of the 10yr water surface elevation difference for existing conditions and addition of new pipe under Mershon Ave

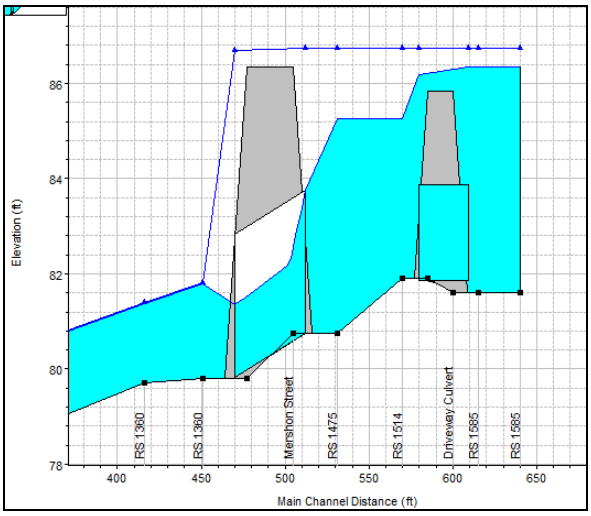

Figure 16. Profile plot of the 25yr water surface elevation difference for existing conditions and addition of new pipe under Mershon Ave

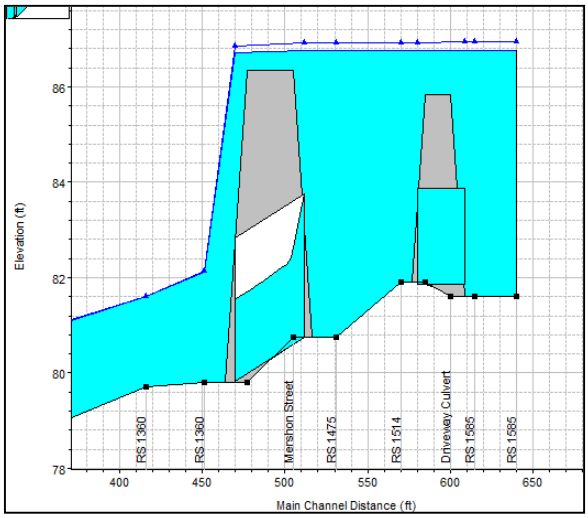

Figure 17. Profile plot of the 100yr water surface elevation difference for existing conditions and addition of new pipe under Mershon Ave

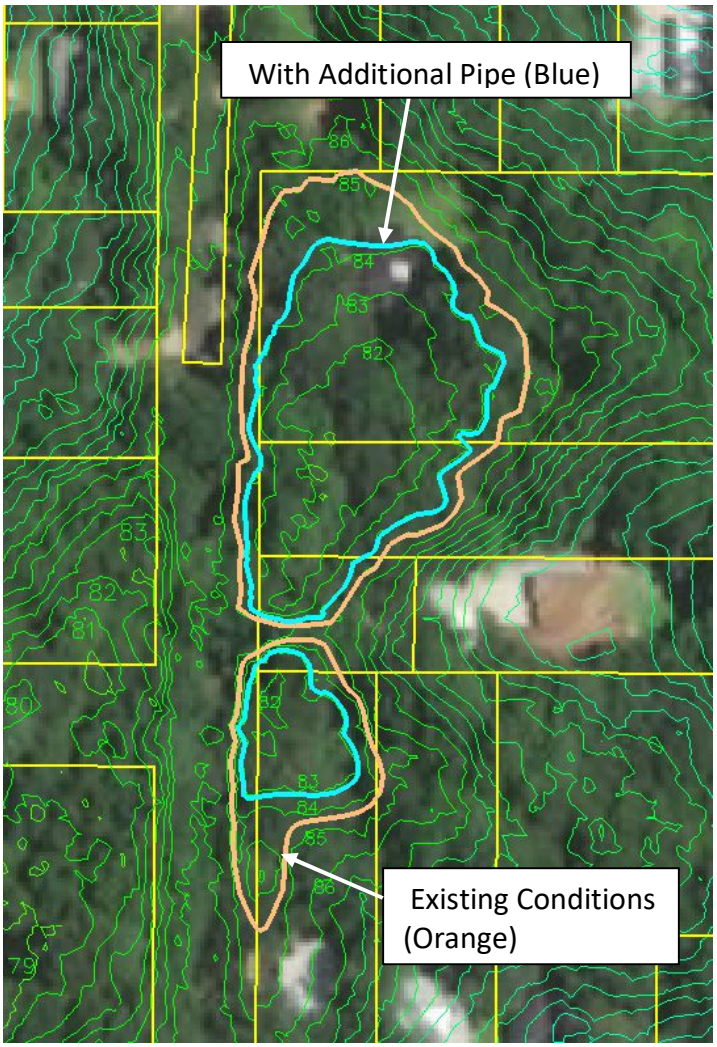

Figure 18. Water surface elevations for existing conditions and with additional pipe added for the 2yr event

07 / 08 / 2019

Date

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