Todd Creek Drainage Master Plan

Final Report Volume 1 - Executive Summary

TETRA TECH

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1.0 INTRODUCTION

In 2014 the City of Memphis (City) selected Tetra Tech to perform a Drainage Master Plan for Todd Creek Study Area, as part of the citywide Stormwater Master Planning Program. The three main goals of the project are to:

- Collect data on the existing stormwater drainage systems and develop a comprehensive geographic information system (GIS) dataset for future City planning and maintenance efforts.
- Evaluate the existing stormwater drainage system and identify areas that lack hydraulic conveyance capacity and the corresponding extents of flooding.
- Evaluate and recommend improvements to alleviate flooding in the stormwater drainage system.

The Todd Creek Study Area (Study Area) is located in the northwest portion of the City within Stormwater District 7, which roughly corresponds to City Council District 7. The Study Area comprises approximately 5,136 acres total and is predominantly residential with 12 percent commercial land use and 11 percent open space.

The Todd Creek Study Area consists of five distinct watersheds or drainage basins, as shown in Figure 1.1:

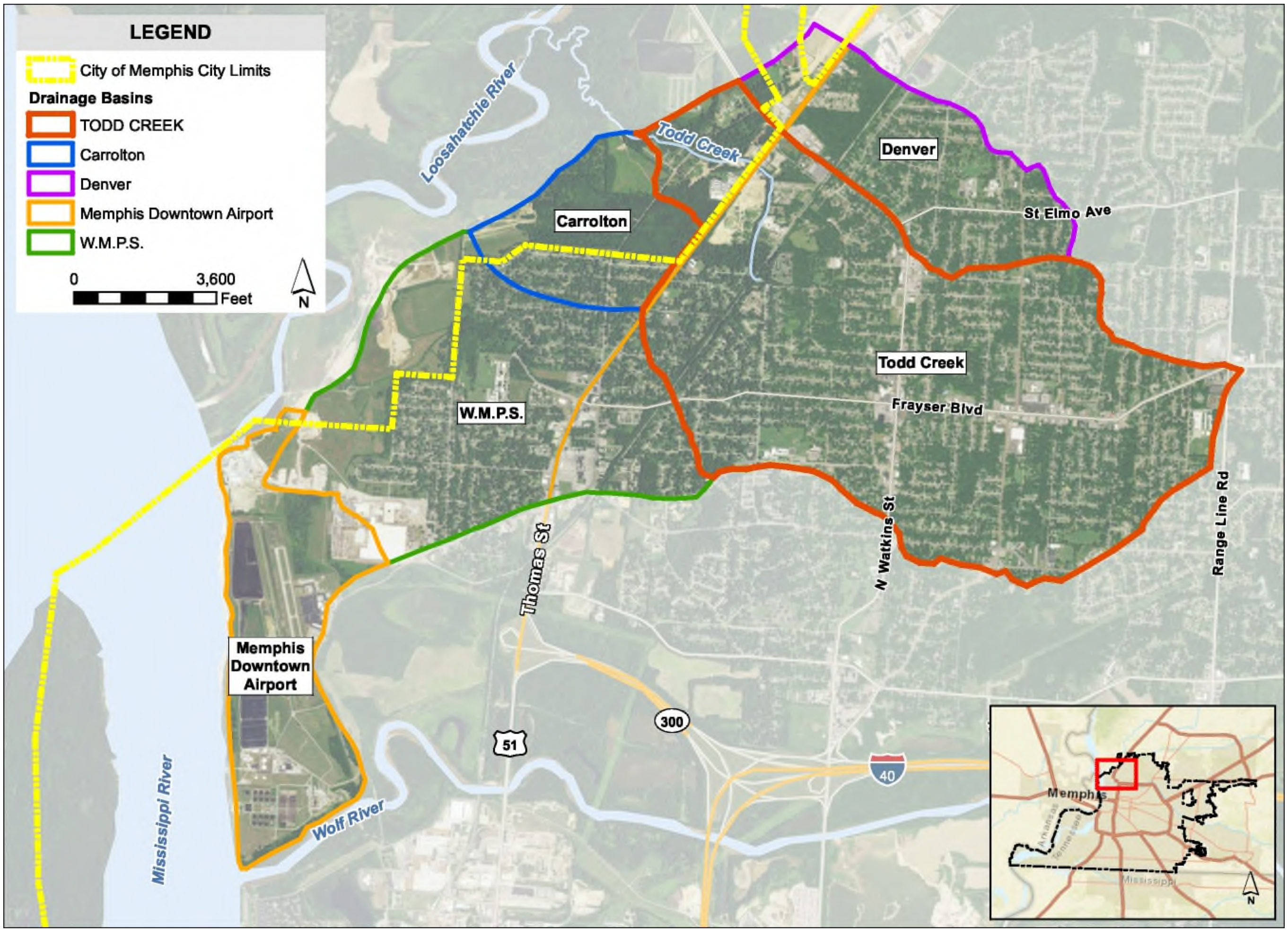
- Todd Creek: This 2,408-acre basin is drained by Todd Creek, which flows to the Loosahatchie River.
- Denver Branch: This 609-acre basin is drained by Denver Branch, which flows to Todd Creek.
- WMPS: This 1,149-acre basin drains to the Loosahatchie River.
- Carrolton: This 404-acre basin drains to the Loosahatchie River.
- Memphis Downtown Airport: This 566-acre basin drains to the Mississippi River. There are no residential structures within this watershed.

For the initial public outreach effort, Tetra Tech and All World Project Management coordinated with key stakeholders such as the Frayser Neighborhood Council, school and church leaders, and other community groups. The Tetra Tech team conducted two public meetings within the Todd Creek Study Area: on July 22, 2014 at Innovation Church; and July 24, 2014 at Martin Luther King Preparatory Academy. Feedback from local citizens improved the evaluation, identification, and prioritization of project opportunities during the study. The City also provided a GIS database for flooding-related service requests received from November 2003 through December 2014, including location and type of flooding (e.g. home, street, yard or general flooding).

Prior to the model development stage, the Tetra Tech team performed an extensive data collection effort in order to develop an accurate GIS database of the existing storm drainage system. The field surveying inventory included 600 drainage structures (typically for 24-inch diameter or larger pipe), 35 road crossings (bridges or culverts), 284 cross-sections along 12 miles of open channel, 95 finished floor elevations, and geo-referenced photos at open-to-closed flow transitions.

The City also engaged the University of Memphis Ground Water Institute (GWI) to install and maintain two stream level (flow depth) meters and two rain gauges within the Todd Creek Study Area, in order to support the model validation and calibration process. The level meters were located at Todd Creek at Frayser School Drive; and at Denver Branch at Steele Street. The rain gauges were located at MC Stiles Wastewater Treatment Plant and at the Memphis Police Training Academy. The GWI collected stream level and precipitation data from June 2014 through mid-October, 2014.

Figure 1.1: Todd Creek Study Area Drainage Basins



2.0 EXISTING CONDITIONS MODELING SUMMARY

The existing drainage system in the Study Area consists of a variety of natural channels, concrete-lined channels, bridges, box culverts, pipe culverts; and storm sewer systems with inlets, manholes, junctions and connecting pipes or other closed conduits. Detailed descriptions of the existing drainage systems and modeling process can be found in Volume 2 of the Final Report.

The City determined that InfoSWMM® would be the modeling platform used to provide a basis for analyzing the existing storm drainage system, identify hydraulic contraction locations and capacity limitations, and ultimately identify improvement opportunities to reduce flooding at or near homes and businesses in the Todd Creek Study Area.

The survey-based GIS database was used as the starting point for the hydraulic model network. The Todd Creek Study Area hydraulic model includes a total of 52,174 lineal feet of open channel, 108,170 lineal feet of storm sewer drainage components, and 31 road crossings (culverts or bridges). The model includes 80,056 lineal feet of overland flow paths to convey flooded water from under-capacity sections to downstream locations where adequate capacity exists. The model also includes 11 outfalls representing the downstream boundary or terminal node of each drainage system.

The Todd Creek watershed is the largest portion of the overall study area with over 59 percent of the stormwater conveyance network. The WMPS is the second largest system with over 23 percent of the modeled drainage system. The Denver Branch, Memphis Downtown Airport and Carrolton areas comprise approximately 11 percent, five percent and one percent of the total modeled drainage system, respectively.

For open channels, the field survey effort focused on collecting data within the channel banks. The field surveyed cross-sections were merged with Shelby County LIDAR data to produce a single three-dimensional (3D) surface model of the entire study area including channels and floodplain areas. Cross-sections for modeling were cut from the 3D surface at each open channel section. This 3D surface was also used to delineate floodplain limits for design storm simulations of existing and proposed conditions.

The Todd Creek Study Area model was calibrated and validated using data collected from the two level metering locations. The time-series level data was converted to flow rate with a depth vs flow rating curve. The model developed for the Todd Creek Study Area meets current industry criteria, and based on meetings and discussions with the City and program management team, is considered well-calibrated based on available data.

After the modeling validation and calibration was accepted by the City, the 2-, 5-, 10-, 25-, 50-, and 100-year, 24-hour design storms were used to evaluate the system's hydraulic capacity and potential for flooding. Floodplain inundation maps to illustrate the extent of flooding from the 10-year and 100-year, 24-hour design storm events. The inundation maps are color coded based on depth of flooding. A series of hydraulic grade line profiles were also developed along the main reaches of the drainage systems, for 10-year and 100-year, 24-hour design storm events.

Many hydraulic restrictions ("bottlenecks") and areas of significant flooding were identified as a result of the modeling. Detailed descriptions of the system analysis results, including capacity evaluation and quantification of structural flooding, can be found in Volume 2 of the Final Report.

3.0 ALTERNATIVES DEVELOPMENT SUMMARY

3.1 APPROACH AND PRELIMINARY ALTERNATIVES DEVELOPMENT

An evaluation of alternatives was performed to identify and evaluate opportunities to improve system performance and reduce the frequency or severity of flooding. Ideally, the existing drainage systems would be upgraded to increase hydraulic capacity to handle at least the 10-year, 24-hour design event without surcharging. After completing the assessment of the existing system, it became apparent that such a capacity level would not be feasible throughout the entire Study Area. A more practical objective was to eliminate as many primary residential/commercial structures as possible from the 10-year, 24-hour design event floodplain. Secondary structures such garages, sheds and trailers were not included in the analysis; nor were basements in primary structures considered.

The two types of improvement alternatives considered were (1) increased detention storage to attenuate peak flows, and (2) increased conveyance to remove isolated hydraulic contractions ("bottlenecks") and lower system hydraulic grade line (HGL) profiles.

Potential storage (detention) facilities were first identified and evaluated. However, providing storage sites alone were not sufficient to reduce significant flooding in the model simulation. This is partly due to the significant number of bottlenecks in the system. Therefore, additional conveyance improvements - such as upsizing channels, pipes and box culverts - were identified and analyzed.

A meeting was held on March 2, 2015 with representatives from the City to review the status of model development activities and potential alternatives that could be evaluated to reduce flooding. No system capacity alternatives were eliminated during this meeting. However, out of 18 potential storage sites reviewed, only three were chosen to be viable options based on the location and current property ownership, and were included in the alternatives to be further evaluated:

- **Denver Park** (Storage Site 7): This site is located within Denver Park near the intersection of Pueblo and Denver, in the Todd Creek drainage basin.
- **Trezevant High School** (Storage Site 14): This site is located at Trezevant High School near the intersection of Nunnelee and Trezevant, in the Todd Creek drainage basin.
- **Georgian Hills Park** (Storage Site 17): This site is located at Georgian Hills Park near the intersection of Argonne and Kinglsey, in the Denver drainage basin.

3.2 FINAL RECOMMENDED ALTERNATIVES

This section provides a listing of the evaluated alternatives that are recommended for the Todd Creek Study Area, with the general location of flooding intended to be alleviated (which is not necessarily the same as the location of the actual proposed improvement). All alternatives are system capacity alternatives, unless otherwise indicated.

A total of twenty-three (23) alternatives were evaluated for the Final Report, including twenty (20) system capacity alternatives, one (1) storage alternative and two (2) combined storage and system capacity alternatives. Location maps and detailed descriptions of the recommended alternatives, including planning-level cost opinions for each project, can be found in Volume 2 of the Final Report. Floodplain delineation maps and hydraulic profiles (along main branches) for the proposed alternatives, based on the 10-year and 100-year design storms, can also be found in Volume 2.

Todd Creek Basin

- **T-1 Capacity/Storage Alternative:** Goal is to reduce flooding that begins at the Frayser School Boulevard crossing and continues upstream to Trezevant Street. Severe flooding areas include properties along Haywood Avenue, Gowan Avenue, Riney Street, University Street, Frayser Boulevard, Mountain Terrace Street, Nunnelee Avenue, Brookmeade Street and Trezevant Street. This alternative also includes the recommended **Trezevant High School** storage site.
- **T-10 Alternative:** Goal is to reduce flooding along Frayser School Drive.
- **T-11 Alternative:** Goal is to reduce flooding along Gowan Avenue.
- **T-13 Alternative:** Goal is to reduce flooding along Corner Drive and Riney Street.
- **T-14 Capacity/Storage Alternative:** Goal is to reduce flooding near the intersection of Julia Street and Pamela Drive, and along Hallbrook Street. This alternative also includes **Denver Park** storage site.
- **T-17 Alternative:** Goal is to reduce flooding at the upper reach along Whitney Avenue and the lower reach along Frayser View Drive and Aden Street.
- **T-19 Alternative:** Goal is to reduce flooding along Overton Crossing Street and near the intersection of University Street and Slocum Avenue.
- **T-20 Alternative:** Goal is to reduce flooding at the intersection of Corning Avenue and Gayle Drive, and along University south of Cassie.
- **T-22 Alternative:** Goal is to reduce flooding at the intersection of Jan Drive and Mountain Terrace Street.
- **T-23 Alternative:** Goal is to reduces flooding in the backyards along Brookmeade Street.
- **T-24 Alternative:** Goal is to reduces flooding at the upper reach along Madeline Circle.

Denver Branch Basin

- **D-1 Alternative:** Goal is to reduce flooding at the upper reach between Overton Crossing Street and Denver Street, and near the intersection of Argonne Street and Leyton Cove.
- **D-2 Alternative:** Goal is to reduce flooding along Carlyle Avenue and Watkins Street.
- **D-3 Storage Alternative:** This alternative consists of the **Georgian Hills Park** storage site. The goal is to reduce flooding downstream of the park.
- **D-4 Alternative:** Goal is to reduce flooding between Argonne Street and Belleau Street, from Townsend Avenue to St. Elmo Avenue.
- **D-5 Alternative:** Goal is to reduce flooding between Leyton Avenue and St. Elmo Avenue.
- **D-6 Alternative:** Goal is to reduce flooding along Coventry Drive.

WMPS Basin

- **W-1 Alternative**: Goal is to reduce flooding located at the Canadian National Railroad, along Frayser Boulevard between Thomas Street (US Highway 51) and Dawn Drive, and at the Benjestown and unnamed road crossings.
- **W-3 Alternative**: Goal is to reduce flooding located along Harvester Lane.
- **W-4 Alternative**: Goal is to reduce flooding located along Sunrise Street.
- **W-6 Alternative**: Goal is to reduce flooding located along Dawn Drive.
- **W-7 Alternative**: Goal is to reduce flooding located along Millington Street and Par Avenue.
- **W-8 Alternative**: Goal is to reduce flooding along Kingston Street, between Klinke Avenue and Morningside Drive, near the intersection of Marsh Avenue and Northgate Street, and along Dawn Drive near Juliet Avenue.
- **W-9 Alternative**: Goal is to reduce flooding along Thomas Street (US Highway 51) from Cindy Lane to Frayser Boulevard.

Carrolton Basin

No storage or capacity alternatives were evaluated for this system since there are no structures within the greater than one foot depth floodplain for the 10-year, 24-hour design storm event.

Memphis Downtown Airport System Basin

No storage or capacity alternatives were evaluated for this system since the modeled system appears to convey the 10-year, 24-hour design storm event flows. Past drainage concerns for this basin are primarily due to Mississippi River flooding, which is beyond the scope of this study.

3.3 CONCLUSION

The sizing and effectiveness of improvements assumes that all of the projects in a particular watershed are implemented. For example, if an upstream capacity upgrade project is completed prior to recommended downstream improvements, the downstream system may not have sufficient capacity which could lead to adverse impacts in those areas. Implementation of individual projects, or subsets of projects would need to be further evaluated on a case-by-case basis.

The recommended improvements were prioritized based on constructability and the effectiveness of reducing residential flooding. Projects were prioritized as follows: storage improvements first, followed by conveyance improvements in a downstream to upstream manner. Projects located upstream of the main branches were prioritized based on the effectiveness of removing homes from the predicted 10-year and 100-year floodplain.

Table 3.1 below summarizes the total approximate costs by priority level, and the anticipated total number of homes removed from the 10-year and 100-year floodplains, if all of the projects in each priority grouping are implemented. Table 6.2 in the Final Report (Volume 2) summarizes the recommended improvements for each project including type of improvement, priority level, approximate project cost, number of homes in the existing 10-year and 100-year floodplain, and anticipated number of homes removed from the 10-year and 100-year floodplains if the project is implemented.

The Priority 1 improvements provide the most benefit and would remove approximately 233 residential structures from the 100-year floodplain at a cost of approximately $28.8M (or $124k per home removed). The Priority 2 and 3 improvements would remove a total of 23 residential structures from the 100-year floodplain at a cost of approximately $17.5M (or $763k per home removed). The Priority 2 and 3 projects have a significantly higher cost benefit ratio and is the main reason for their lower priority ranking.

The cumulative anticipated project cost for Priority 1, 2 and 3 improvements is $43.6M. To optimize the City's capital expenditure for the greatest positive impact, we recommend a phased implementation approach. We recommend implementing the Priority 1 improvements and then evaluating the remaining system to determine if isolated flooding continues to persist. If isolated flooding does continue to occur, the City can implement specific Priority 2 or 3 projects as needed to address specific issues.

	Table 3.1: Summary of Improvement by Priority			
Priority Level	**Project ID's**	**Total Cost Opinion, $**	**Homes Removed from 10-Year Floodplain**	**Homes Removed from 100-Year Floodplain**
1	T-1, T-14, T-24, D-1, D-4, W-1, W-8, W-9	$28,780,113	131	233
2	T-17, T-19, T-22, T-23, D-3, D-5, D-6	$8,194,000	23	14
3	T-10, T-11, T-13, T-20, D-2, W-4, W-6, W-7	$9,359,718	16	9

END OF VOLUME 1

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