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ENGINEERING REPORT

Johnson Heights Subdivision
Drainage Improvements

PREPARED FOR:

City of Lebanon Engineering Department

PREPARED BY:

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March 31, 2011

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Introduction

It has been reported that several homes on Christy Drive suffered flood damages during the May 2010 flood. Storm water rose to a level that caused nuisance flooding in the area, but it is not believed that water inundated first floor living spaces. Damages were primarily incurred in garages, crawl spaces, and HVAC units.

Field Review

The field review began at the cul-de-sac on Jacquelin Drive. Water collected from behind the lots flows through a 30-inch corrugated metal pipe (CMP) cross drain. The pipe then empties into a ditch running west along the property lines into another 30-inch CMP at Shirley Drive along with runoff from a 12-inch CMP cross drain located north at the intersection of Christy Drive and Jacquelin Drive. The pipe empties into a ditch that intersects with another ditch with runoff from a 16-inch CMP cross drain located north at the corner of Christy and Melanie Drive. The ditch runs west behind the lots and intersects with another ditch running along the property line at the cul-de-sac on Christy Drive. The ditch collects water from two nearby 16-inch CMPs located in the Church of God parking lot, flows through three 60-inch by 38-inch elliptical reinforced concrete pipe (ERCP) cross drains located on Hartsville Pike, and empties into a small creek. The creek flows north through a 32-inch CMP located at the corner of Mark's Circle and Hartsville Pike and turns west, running along the property lines behind the lots. Further north, at Oakdale Drive, the creek flows through a box culvert that also collects water from 12-inch driveway drains at private driveways. The creek continues north, flowing along the property lines behind lots and turns west again and flows through another box culvert located on Mark's Circle. This culvert also collects water from a 12-inch CMP cross drain located south on Oakdale Drive. The creek continues west, then turns north and flows through a box culvert located on Sam Houston Drive. The culvert also collects water on the south side of the street of Sam Houston from two 12-inch CMPs flowing west. The creek continues north, collecting water from a 15-inch CMP and 12-inch plastic pipe on either side, turns west, and turns north once more before flowing through another box culvert located on Lealand Lane. The culvert collects water along the south side of Lealand Lane from 12-inch driveway drains along the street. On the north end of the street, the creek collects water from runoff through 12-inch driveway drains on either side of Knoll Lane, which flows into a 12-inch CMP cross drain. Water then flows from the pipe west into two (2) 24-inch CMPs along Lealand Lane and empties into the main creek.

Watershed Description

The watershed covers an area of approximately 423 acres (0.66 square miles), and extends from Lealand Avenue southeast to Carthage Highway. Three primary areas of interest were identified:

- The watershed outfall at Lealand Drive;
- The cross drain at Hartsville Pike; and
- The drainage channel extending from Hartsville Pile east along the southern property lines of Johnson Heights subdivision.

Sub-basins for the watershed were delineated to provide an estimation of the storm water runoff. The sub-basin boundaries were estimated based on the 5-foot interval topographic mapping provided by the City, and from information obtained during the field review.

The hydrologic model used in this analysis in HEC-HMS, developed by the U.S. Army Corps of Engineers. The Soil Conservation Service (SCS) method was used to compute storm water runoff for various frequency recurrence intervals. The SCS procedure is based on land use, soil data, and other topographic features which together are used to estimate the runoff potential (known as the Runoff Curve Number) at each area of interest.

Land use within the watershed was determined from aerial photography and information gathered during the field review. Residential development is the primary land use in the areas east of Hartville Pike and Johnson Heights subdivision. Large tracts of undeveloped open space with scattered residential development are present southeast of Hartsville Pike. Hydrologic Soil Group data was obtained from the NRCS. Runoff Curve Numbers within the watershed range from 79 to 83, which reflects the varying degree of urbanization within the watershed. A summary of the hydrologic parameters is presented on Figure 1.

Analysis and Recommendations

Storm water runoff from approximately 86 acres of residential and undeveloped area is collected in a drainage ditch on the south side of Christy Drive. The ditch runs west, generally along the property boundaries between residential properties on Christy Drive (to the north) and the Church of God (to the south) for approximately 700 linear feet. The runoff collected by the ditch discharges to a cross drain under Hartsville Pike, which also collects runoff from an additional 218 acres of largely undeveloped land.

During the technical analysis, it was determined that the drainage ditch south of Christy Drive is undersized in relation to the amount of storm water runoff collected. The swale has a bank-full capacity of 50 cubic feet per second (cfs), which is well below the 2-year runoff of 99 cfs. Measurements taken during the field review also show that the swale was not constructed to the original design specifications shown in the "Church of God" Grading and Drainage Plan (dated July 6, 1999) by Dewaal & Associates. The approved design plan calls for a drainage ditch measuring 14 feet at the bottom and approximately 22 feet at the top. The existing swale measures approximately 2 feet at the bottom and approximately 14 feet at the top. The depth was measured in the field to be 1.8 feet, which slightly exceeds the design depth of 1.55'.

Structural Drainage Improvements

Two alternatives were evaluated to improve the drainage ditch, which should help mitigate the flooding issues on Christy Drive. The first alternative is to grade the drainage swale to the original design specification as shown on the previously referenced drainage plan. This would increase the capacity of the ditch from 50 to 171 cfs, which is slightly higher than the existing 5-year discharge.

The second alternative also requires the ditch to be improved to original design specifications, but adds the construction of a detention basin east of Jacquelin Drive. The detention basin would provide storm water storage for the undeveloped drainage areas to the east and southeast. Construction of the detention basin could result in a reduction of 15.4% to 16.3% in the amount of storm water runoff received by the subject drainage swale. The improved ditch capacity (171 cfs) would be slightly higher than the 10-year discharge resulting from the construction of the proposed detention basin.

Better reduction in flood levels are achieved with construction of the proposed detention basin, but this alternative causes significant additional expense. A description of the proposed alternatives and preliminary estimated construction costs are shown below:

In addition to implementing either of the two above alternatives, it is recommended to expand the small swale located between the end of Christy Drive and the aforementioned drainage ditch. This should help improve local flooding problems during intense storms that cause the swale to overtop and flow toward/into the garage at 502 Christy Drive.

A description of the proposed alternatives and preliminary estimated project costs are shown below. The following costs include engineering/design fees and provision for 20% contingency:

Structural Alternatives (See Figure 2)	**Preliminary Estimated Project Cost**
Alternative 1: Grade main drainage ditch to original design specifications and grade small swale between Christy Drive and drainage ditch	$ 13,500.00
Alternative 2: Alternative 1 plus construct 150 ft. by 375 ft. detention basin.	$ 145,000.00

Routine Maintenance

In addition to implementing structural improvements described above, numerous routine maintenance issues were found throughout the study area during the field reconnaissance. Examples of required maintenance items include removing sediment buildup from culvert inlets, removing excess vegetation and debris from culvert inlets, and repairing damaged culvert end sections. While correcting these deficiencies will not solve flooding problems, it is critical to correct them sooner, rather than later, so that the drainage system can function as designed and conditions do not worsen, leading to possible flooding problems in the future. In addition, it is important to note that areas identified as requiring remediation should be regularly scheduled for maintenance by City crews to prevent future buildup of debris and sediment. A map showing locations identified as requiring maintenance is included as Figure 3. In addition, a document containing captioned photographs of each maintenance location is included as Appendix A, with locations and orientations of each photograph indicated with red arrows on Figure 3. A preliminary cost estimate for the proposed maintenance items are shown below:

Infrastructure Maintenance Items (See Figure 3)	Preliminary Estimated Project Cost
1. Debris/sediment removal from culvert ends at five locations (Items 1, 2, 4, 6, 7)	$ 2,500.00
2. Culvert end repair at two locations (Items 3 and 5)	$ 2,000.00
3. Install erosion control measures at one locations (Item 5)	$ 400.00
4. Debris/sediment removal from channel at one locations (Item 8) – 2,120 L.F.	$ 10,600.00
Total Maintenance Cost	**$ 7,500.00**

It should be noted that no field survey data was available for this study. Elevations were estimated based on the 5-foot interval topographic mapping provided by the City, and from information obtained during the field reconnaissance. Therefore, evaluation of the proposed improvements included in this study should be regarded as conceptual.

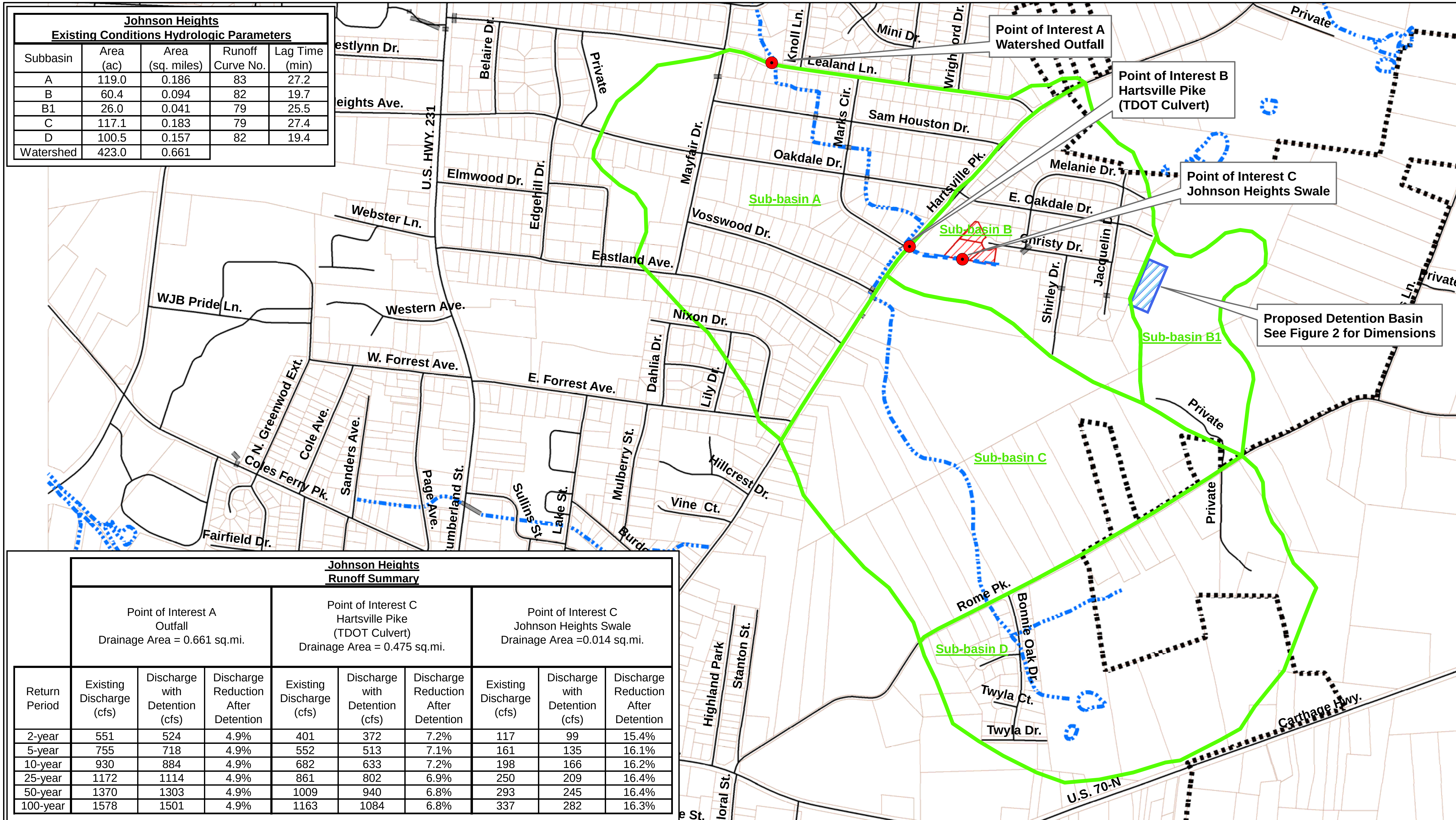
The above costs do not include property acquisition, which will be necessary for Alternative 2 (detention pond). It is estimated that the detention pond would require a drainage easement of approximately 2.4 acres. The proposed pond is situated on a single, undeveloped 28-acre tract of land owned by John M. Sloan, Ken M. Colbert, and others.

Alternative 1 should not require the purchase of a drainage easement since the original design specifications for the drainage ditch shown on the Grading and Drainage Plan for the Church of God were not met. The cost incurred for the ditch restoration should be the responsibility of the Church.

Although many steps will have to be taken prior to implementing structural drainage improvements in the study area, including survey and design; the infrastructure maintenance items discussed above and shown in Figure 3 can be performed by City crews immediately.

Johnson Heights
Existing Conditions Hydrologic Parameters

Subbasin	Area (ac)	Area (sq. miles)	Runoff Curve No.	Lag Time (min)
A	119.0	0.186	83	27.2
B	60.4	0.094	82	19.7
B1	26.0	0.041	79	25.5
C	117.1	0.183	79	27.4
D	100.5	0.157	82	19.4
Watershed	423.0	0.661		



Johnson Heights
Runoff Summary

Return Period	Point of Interest A Outfall Drainage Area = 0.661 sq.mi.			Point of Interest C Hartsville Pike (TDOT Culvert) Drainage Area = 0.475 sq.mi.			Point of Interest C Johnson Heights Swale Drainage Area =0.014 sq.mi.		
	Existing Discharge (cfs)	Discharge with Detention (cfs)	Discharge Reduction After Detention	Existing Discharge (cfs)	Discharge with Detention (cfs)	Discharge Reduction After Detention	Existing Discharge (cfs)	Discharge with Detention (cfs)	Discharge Reduction After Detention
2-year	551	524	4.9%	401	372	7.2%	117	99	15.4%
5-year	755	718	4.9%	552	513	7.1%	161	135	16.1%
10-year	930	884	4.9%	682	633	7.2%	198	166	16.2%
25-year	1172	1114	4.9%	861	802	6.9%	250	209	16.4%
50-year	1370	1303	4.9%	1009	940	6.8%	293	245	16.4%
100-year	1578	1501	4.9%	1163	1084	6.8%	337	282	16.3%

Legend

- Streams
- Streets/Roads
- Parcels
- Culverts
- City Limits
- Area of Flooding Issues
- Proposed Detention Pond
- Sub-basin Boundaries

City of Lebanon Drainage Analysis
Johnson Heights Subdivision
Drainage Improvements

N W E S
1 inch equals 700 feet

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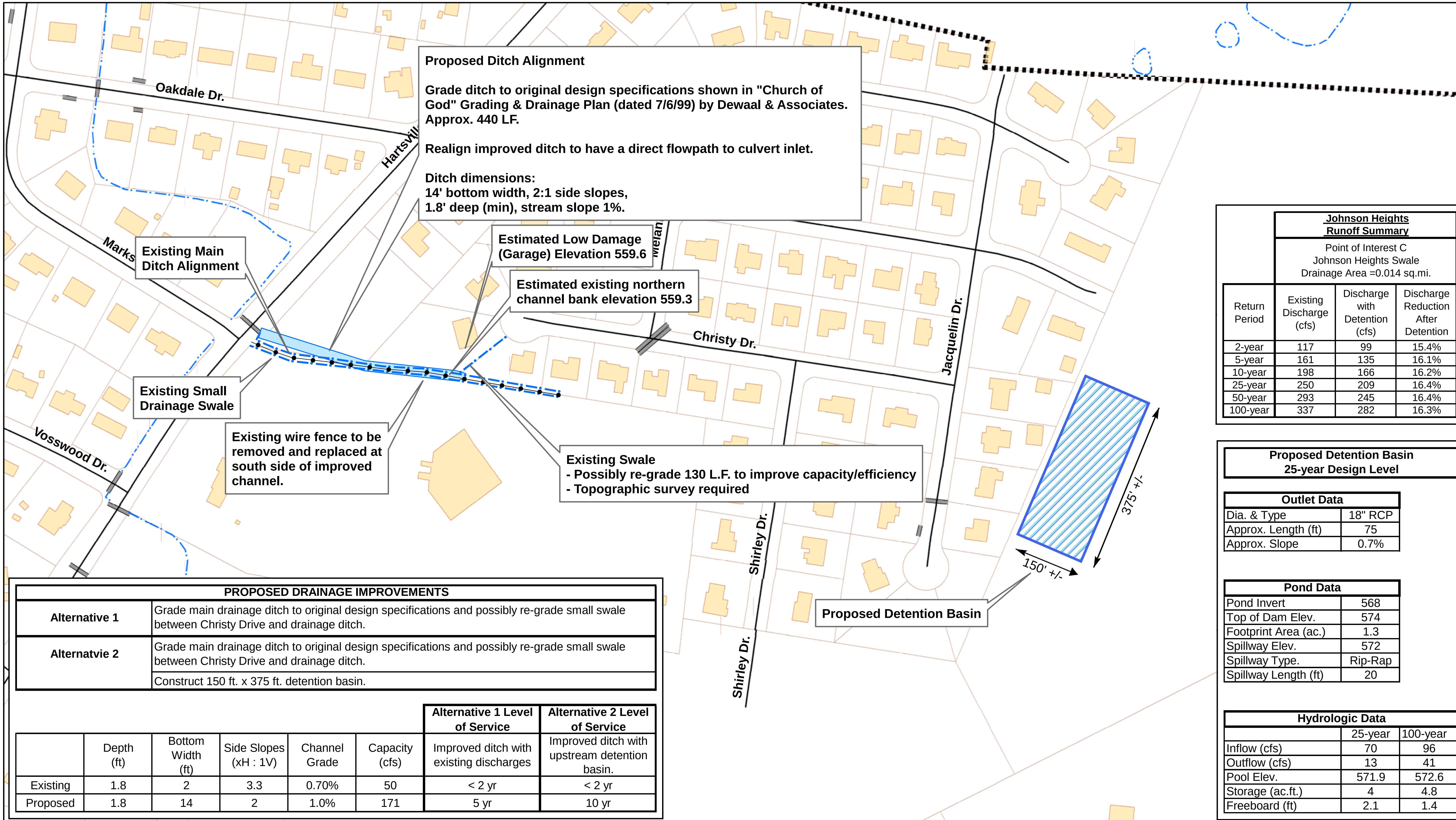
Hydrology Results

Figure 1



Johnson Heights Runoff Summary

Point of Interest C
Johnson Heights Swale
Drainage Area =0.014 sq.mi.

Return Period	Existing Discharge (cfs)	Discharge with Detention (cfs)	Discharge Reduction After Detention
2-year	117	99	15.4%
5-year	161	135	16.1%
10-year	198	166	16.2%
25-year	250	209	16.4%
50-year	293	245	16.4%
100-year	337	282	16.3%

Proposed Detention Basin
25-year Design Level

Outlet Data	
Dia. & Type	18" RCP
Approx. Length (ft)	75
Approx. Slope	0.7%

Pond Data	
Pond Invert	568
Top of Dam Elev.	574
Footprint Area (ac.)	1.3
Spillway Elev.	572
Spillway Type.	Rip-Rap
Spillway Length (ft)	20

Hydrologic Data	25-year	100-year
Inflow (cfs)	70	96
Outflow (cfs)	13	41
Pool Elev.	571.9	572.6
Storage (ac.ft.)	4	4.8
Freeboard (ft)	2.1	1.4

PROPOSED DRAINAGE IMPROVEMENTS

Alternative 1	Grade main drainage ditch to original design specifications and possibly re-grade small swale between Christy Drive and drainage ditch.
Alternatvie 2	Grade main drainage ditch to original design specifications and possibly re-grade small swale between Christy Drive and drainage ditch. Construct 150 ft. x 375 ft. detention basin.

	Depth (ft)	Bottom Width (ft)	Side Slopes (xH : 1V)	Channel Grade	Capacity (cfs)	Alternative 1 Level of Service Improved ditch with existing discharges	Alternative 2 Level of Service Improved ditch with upstream detention basin.
Existing	1.8	2	3.3	0.70%	50	< 2 yr	< 2 yr
Proposed	1.8	14	2	1.0%	171	5 yr	10 yr

Legend

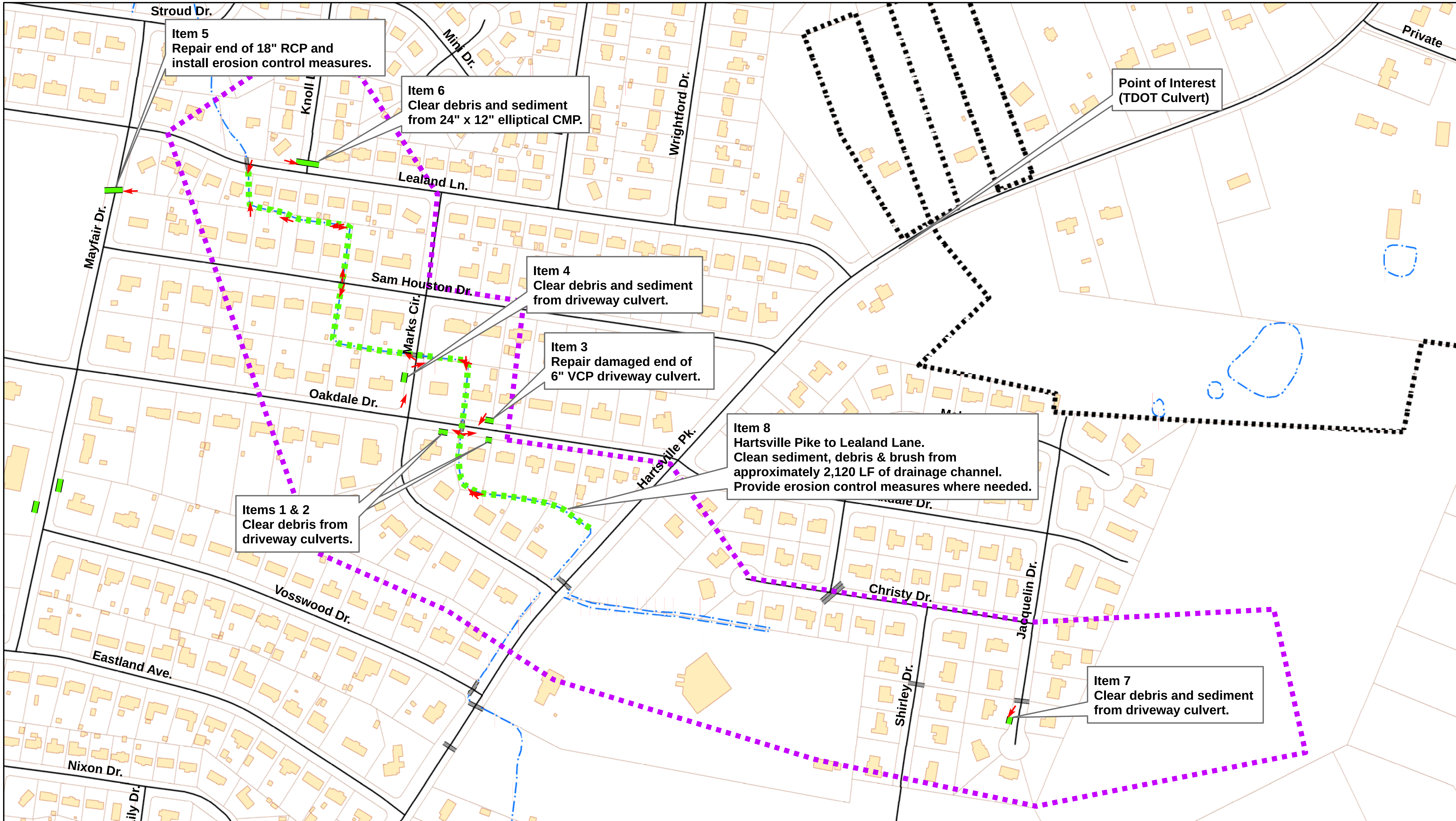
- Streams
- Streets/Roads
- Parcels
- Culverts
- City Limits
- Buildings
- Proposed Detention Pond
- Drainage Channel Improvement
- Existing Wire Fence

City of Lebanon Drainage Analysis
Johnson Heights Subdivision
Drainage Improvements

N W E S
1 inch equals 200 feet

Conceptual Drainage Improvement Recommendations

Figure 2



Legend

- Streams
- Streets/Roads
- Parcels
- City Limits
- Buildings
- Culverts
- Infrastructure Maintenance Locations
- Stream/Ditch Maintenance Locations
- Area of Field Reconnaissance
- Directional Photo Log

City of Lebanon Drainage Analysis
Johnson Heights Subdivision
Drainage Improvements

N E S W

1 inch equals 300 feet

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Infrastructure Maintenance Locations

Figure 3

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engineers
planners
surveyors
environmental scientists
landscape architects

APPENDIX A

Routine Maintenance Location Photographs

210 25th Avenue North ● Suite 800 ● Nashville, TN 37203 ● 615.383.8420 ● Fax 615.383.9984

Item 1 – 107 Marks Cir. Clear debris from driveway culvert. Culvert is located on Oakdale Dr. Picture 1797.

Item 2 – 418 Oakdale Dr. Clear debris from driveway culvert (shown in background). Picture 1796.

Item 3 – 421 Oakdale Dr. Repair damaged end of 6" VCP driveway culvert. Picture 1808.

Item 4 – 417 Oakdale Dr. Clear debris and sediment from driveway culvert adjacent to Marks Cir. Picture 1809.

Item 5 – Mayfair Dr. between Sam Houston Dr. and Lealand Ave. Repair end of 18" RCP and install erosion control measures. Picture 1827.

Item 6 – Lealand Ln. and Knoll Ln. Clear debris and sediment from 24" x 12" elliptical CMP. Picture 1840.


Item 7 – 1010 Jacquelin Dr. Clear debris and sediment from driveway culvert. Picture 1840.

Item 8 – Hartsville Pike to Lealand Lane. Clean sediment, debris and brush from approximately 2,120 LF of drainage channel. Provide erosion control measures where needed.

Behind 418 Oakdale Dr. Looking east towards Hartsville Pike Picture 1800.

Behind 418 Oakdale Dr. Looking northwest towards Oakdale Dr. Picture 1801.

Item 8 – Continued

Looking west towards Mark Cir. from behind 419 Oakdale Dr. Picture 1804.

Looking south towards Oakdale Dr. Picture 1805.

Item 8 – Continued

Looking west from Marks Cir. Picture 1810.

Looking east from Marks Cir. Picture 1812.

Item 8 – Continued

Looking south from Sam Houston Dr. Picture 1814.

Looking north from Sam Houston Dr. Picture 1815.

Item 8 – Continued

Looking east from behind 413 Sam Houston Dr. Picture 1820.

Looking west from behind 413 Sam Houston Dr. Picture 1821.

Item 8 – Continued

Looking west from behind 409 Sam Houston Dr. Picture 1823.

Looking north towards Lealand Dr. Picture 1824.

Item 8 – Continued

Looking south from Lealand Ln. Picture 1833.