

ENGINEERING REPORT

Oak Hill Drive / Bartonwood Drive Area Drainage Improvements



PREPARED FOR:

City of Lebanon Engineering Department

PREPARED BY:

Neel-Schaffer, Inc.



March 31, 2011

Introduction

It has been reported that several properties located on Bartonwood Drive north of Winston Avenue suffered flood damages during the May 2010 flood. Storm water runoff from the area generally bounded by Gordon Drive to the north, North Castle Heights Avenue to the east, Winston Avenue to the south, and Bartons Creek to the west, discharges into a drainage ditch and cross drain at Bartonwood Drive. The drainage ditch shows significant active erosion at the upstream side of the existing culvert under Bartonwood Drive, and significant deposition on the downstream side of the culvert. This indicates that the existing pipe configuration is not properly sized and aligned for the volume of water draining to it.

The City of Lebanon commissioned Neel-Schaffer, Inc. to perform a comprehensive drainage analysis of this area in order to identify conceptual drainage improvements that will help reduce flooding. The following report describes methodology utilized and results obtained in the drainage analysis. In addition, both structural improvements and routine maintenance items were identified, and preliminary estimated project costs are included.

Field Review

The field review began near the corner of Oak Hill Drive and Winston Avenue. Water is collected into a 44-inch by 25-inch elliptical concrete pipe (ERCP) cross drain from 12-inch driveway drains on either side of the road. The elliptical pipe empties into a creek running behind the lots along Winston Avenue. At the end of Winston Avenue, the creek turns and continues to run behind the lots on Bartonwood Drive, and then intersects with Bartons Creek. Water drains into the creek from Winston Avenue through 12-inch driveway drains and 12-inch corrugated metal pipe (CMP) cross drains on either side of the street. Water is also collected into the creek beginning at the middle of Oak Hill Drive. Drainage flows into a 20-inch CMP cross drain that empties into a series of ditches along the property line behind Gordon Drive. The ditch, along with drainage from 12-inch driveway pipe, flows into a 24-inch CMP cross drain that empties into another series of ditches that drain into a 30-inch CMP. The pipe then empties into another ditch running along the property line behind Bartonwood Drive and flows through a 42-inch CMP. The pipe drains into another ditch running along the property line at 204 Bartonwood Drive, and empties into Bartons Creek behind the lots. Further north, the creek collects water from a small drainage ditch flowing through a 3-foot by 3-foot catch basin and again through a 2-foot by 2-foot catch basin. The water then flows through a 2-foot by 4-foot manmade box culvert and into a natural detention pond full of debris, which empties into Bartons Creek. The creek then flows under a bridge at the railroad running parallel with U.S. 70 North bypass, and again under U.S. 70 North bypass. During an interview with the property owner at 106 Bartonwood Drive, the resident stated that during the May 2010 flood, the water from the creek was back flowing from the US 70 North bypass bridge into the properties' backyards.

Watershed Description

The watershed covers an area of approximately 79 acres (0.12 square miles), and is generally bounded by Gordon Drive on the north, North Castle Heights Avenue to the west, West Main Street on the south and Bartons Creek on the west. The northern half of the watershed drains to a series of manmade drainage ditches and cross drains. The final cross drain in the series is the cross drain at Bartonwood Drive. The southern half of the watershed drains to a manmade drainage ditch south of Winston Avenue, which ultimately outfalls directly into Bartons Creek. Three primary areas of interest were identified:

- The outfall of the northern half of the watershed at Barons Creek;
- The Bartonwood Drive cross drain; and
- The outfall of the southern drainage ditch at Bartons Creek.

Sub-basins for the watershed were delineated to provide an estimation of the storm water runoff at each of the areas of interest. 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 is 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. Land use is primarily residential, with commercial developments adjacent to West Main Street and North Castle Heights. Hydrologic Soil Group data was obtained from the NRCS. Runoff Curve Numbers within the watershed range from 80 to 89, which reflects the varying degree of urbanization within the watershed. A summary of the hydrologic parameters is presented on Figure 1.

Analysis and Recommendations

During the technical analysis, it was determined that the Bartonwood Drive cross drain, which is a 42-inch by 24-inch elliptical corrugated metal pipe (ECMP), does not have enough capacity to prevent flooding during frequent storm events. Not only is the cross drain itself undersized, but the alignment of the pipe, in relation to the flow line of the ditch, significantly decreases the efficiency of the cross drain. Storm discharge leaving the cross drain flows directly into a masonry retaining wall on the north side of the drainage ditch. Significant sediment deposits are present at the outlet of the cross drain, which indicates that excessive turbulence is created when the water hits the retaining wall. The excessive head loss at this transition causes sediment deposits to settle out. Further, the combination of an undersized pipe and poor alignment causes the storm water runoff from frequent rainfall events to back up into the adjacent properties and flow over Bartonwood Drive.



Structural Drainage Improvements

The hydraulic operation of the cross drain was evaluated using data obtained from the City’s GIS mapping and during the field review. Based on this data, it is recommended to replace the existing culvert with a 60-inch by 38-inch elliptical reinforced concrete pipe (ERCP). It is also recommended that the cross drain alignment be shifted to more closely match the alignment of the drainage ditch. This will improve the hydraulic efficiency of the cross drain and help prevent erosion on the downstream side of Bartonwood Drive. The replacement pipe, with the new alignment, will provide a 10-year level of service for the cross drain.

In addition, the channel downstream of the Bartonwood cross drain is recommended to be improved to add capacity, which will restore the existing channel to a 10-year level of service.

It should be noted that a fire hydrant is located on the west side of the road near the existing cross drain. The fire hydrant will need to be relocated during the construction of the new culvert crossing. It will also be necessary to remove one or more medium size trees.

The retaining wall located on the south bank of the drainage ditch immediately upstream of the cross drain inlet has collapsed, allowing the ground to slough down into the channel. There are several erosion control methods that may be feasible at this location, including repairing the retaining wall. It will be necessary to evaluate all options during the design phase of the cross drain replacement to select the most cost effective erosion control measures. If the property owners have caused damage to the wall, it should be their responsibility to repair it.

A description of the proposed structural 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
Replace existing Bartonwood Drive cross drain with 90 L.F. 60-inch by 38-inch elliptical RCP. Install riprap apron at outlet of cross drain. Install erosion control measures upstream of the cross drain. Repair failing retaining wall and channel banks upstream of Bartonwood Drive. Improve channel downstream of Bartonwood Drive (205 LF) and install erosion control measures.	\$ 79,700.00

Routine Maintenance

In addition to removing debris and obstructions 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:

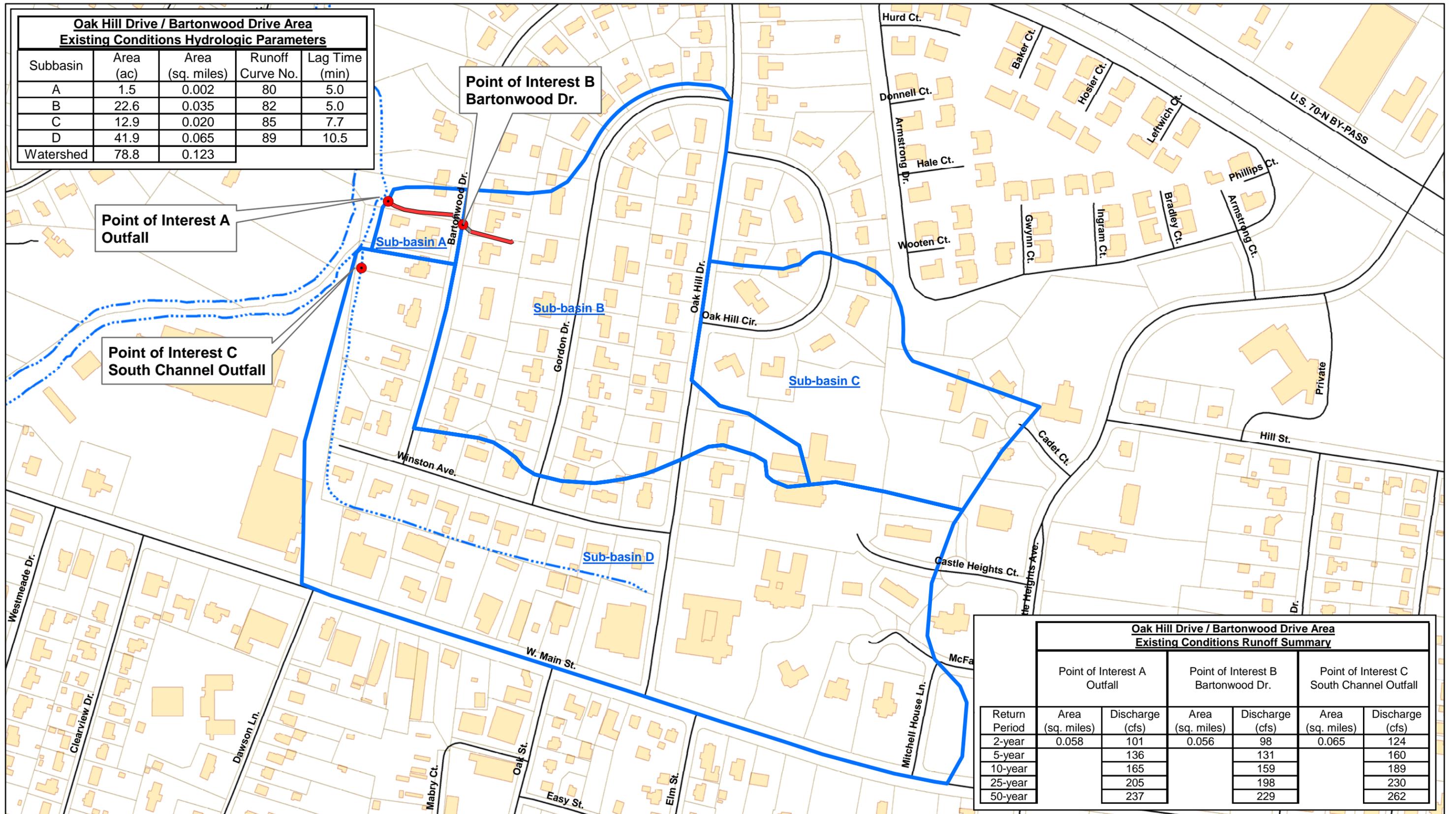
Infrastructure Maintenance Items (See Figure 3)	Preliminary Estimated Project Cost
1. Debris/sediment removal from culvert ends at five locations (Items 1, 5, 7, 8, 12)	\$ 2,500.00
2. Debris/sediment removal from channel at three locations – 3,300 L.F. (Items 2, 4, 13)	\$ 16,500.00
3. Culvert end repair at three locations (Item 3, 10, 11)	\$3,000.00
4. Remove trash/debris from natural detention/low area (Item 9)	\$ 4,500.00
Total Maintenance Cost	\$ 23,000.00

It should be noted that no field survey data was available for this study. Elevations of the cross drain, roadway and adjacent properties were estimated based on the 5-foot interval GIS topographic mapping provided by the City, and from information obtained during the field reconnaissance. Therefore the evaluation of the proposed drainage improvements included as a part of this study should be regarded as conceptual until survey data can be obtained and used for final design.

Although many steps will have to be taken prior to replacing the cross drain at Bartonwood Drive, including survey and design; the infrastructure maintenance items discussed above and shown in Figure 3 can be performed by City crews immediately.



Oak Hill Drive / Bartonwood Drive Area Existing Conditions Hydrologic Parameters				
Subbasin	Area (ac)	Area (sq. miles)	Runoff Curve No.	Lag Time (min)
A	1.5	0.002	80	5.0
B	22.6	0.035	82	5.0
C	12.9	0.020	85	7.7
D	41.9	0.065	89	10.5
Watershed	78.8	0.123		



Oak Hill Drive / Bartonwood Drive Area Existing Conditions Runoff Summary						
Return Period	Point of Interest A Outfall		Point of Interest B Bartonwood Dr.		Point of Interest C South Channel Outfall	
	Area (sq. miles)	Discharge (cfs)	Area (sq. miles)	Discharge (cfs)	Area (sq. miles)	Discharge (cfs)
2-year	0.058	101	0.056	98	0.065	124
5-year		136		131		160
10-year		165		159		189
25-year		205		198		230
50-year		237		229		262

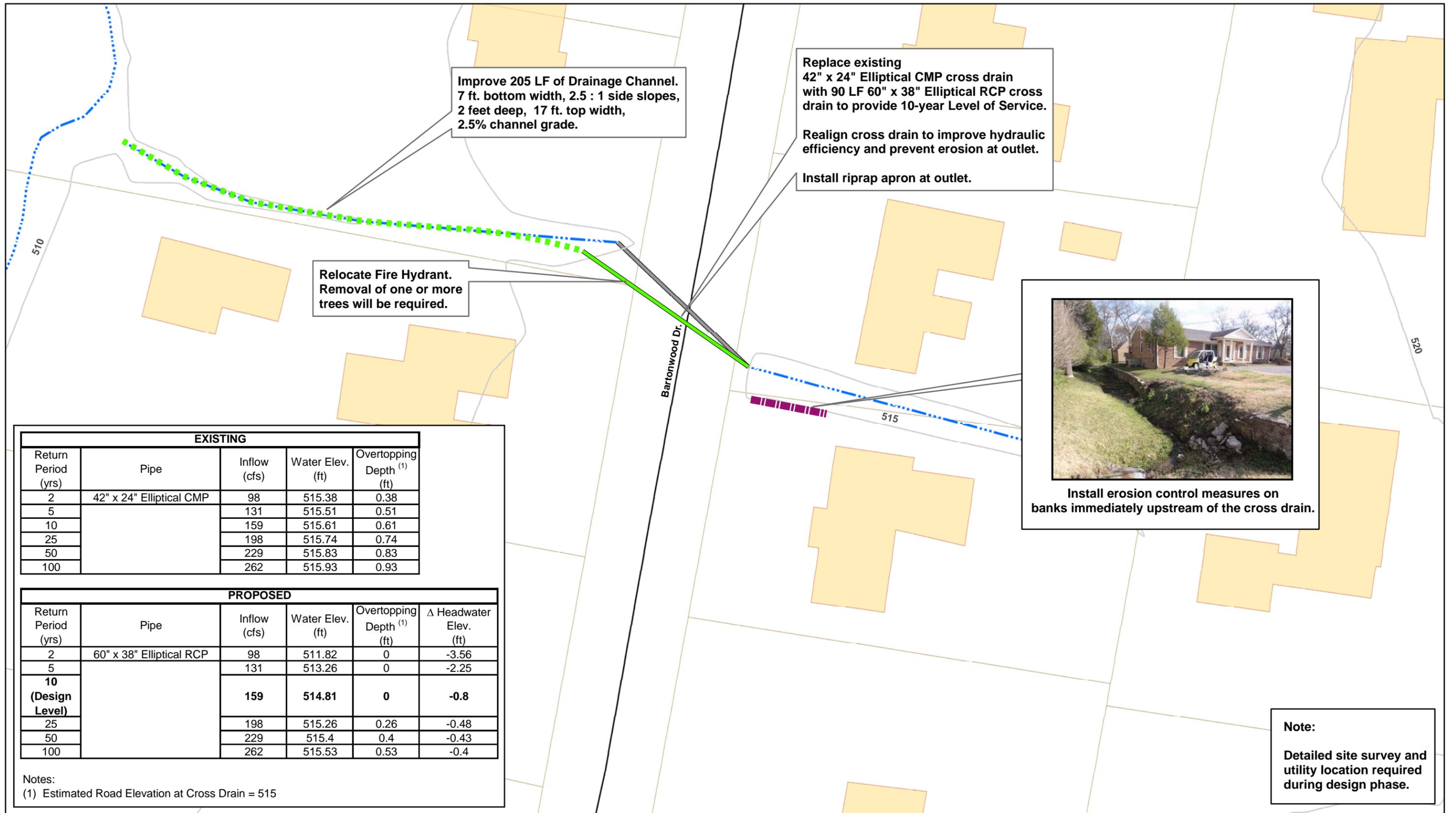
Legend	
Sub-basin Boundaries	Culverts
Point of Interest - Eroded Channel	Railroad
Streams	Streets/Roads
Parcels	

**City of Lebanon Drainage Analysis
Oak Hill Drive / Bartonwood Drive Area
Drainage Improvements**



**Existing Conditions
Hydrology**

Figure 1



EXISTING				
Return Period (yrs)	Pipe	Inflow (cfs)	Water Elev. (ft)	Overtopping Depth ⁽¹⁾ (ft)
2	42" x 24" Elliptical CMP	98	515.38	0.38
5		131	515.51	0.51
10		159	515.61	0.61
25		198	515.74	0.74
50		229	515.83	0.83
100		262	515.93	0.93

PROPOSED					
Return Period (yrs)	Pipe	Inflow (cfs)	Water Elev. (ft)	Overtopping Depth ⁽¹⁾ (ft)	Δ Headwater Elev. (ft)
2	60" x 38" Elliptical RCP	98	511.82	0	-3.56
5		131	513.26	0	-2.25
10 (Design Level)		159	514.81	0	-0.8
25		198	515.26	0.26	-0.48
50		229	515.4	0.4	-0.43
100		262	515.53	0.53	-0.4

Notes:
 (1) Estimated Road Elevation at Cross Drain = 515

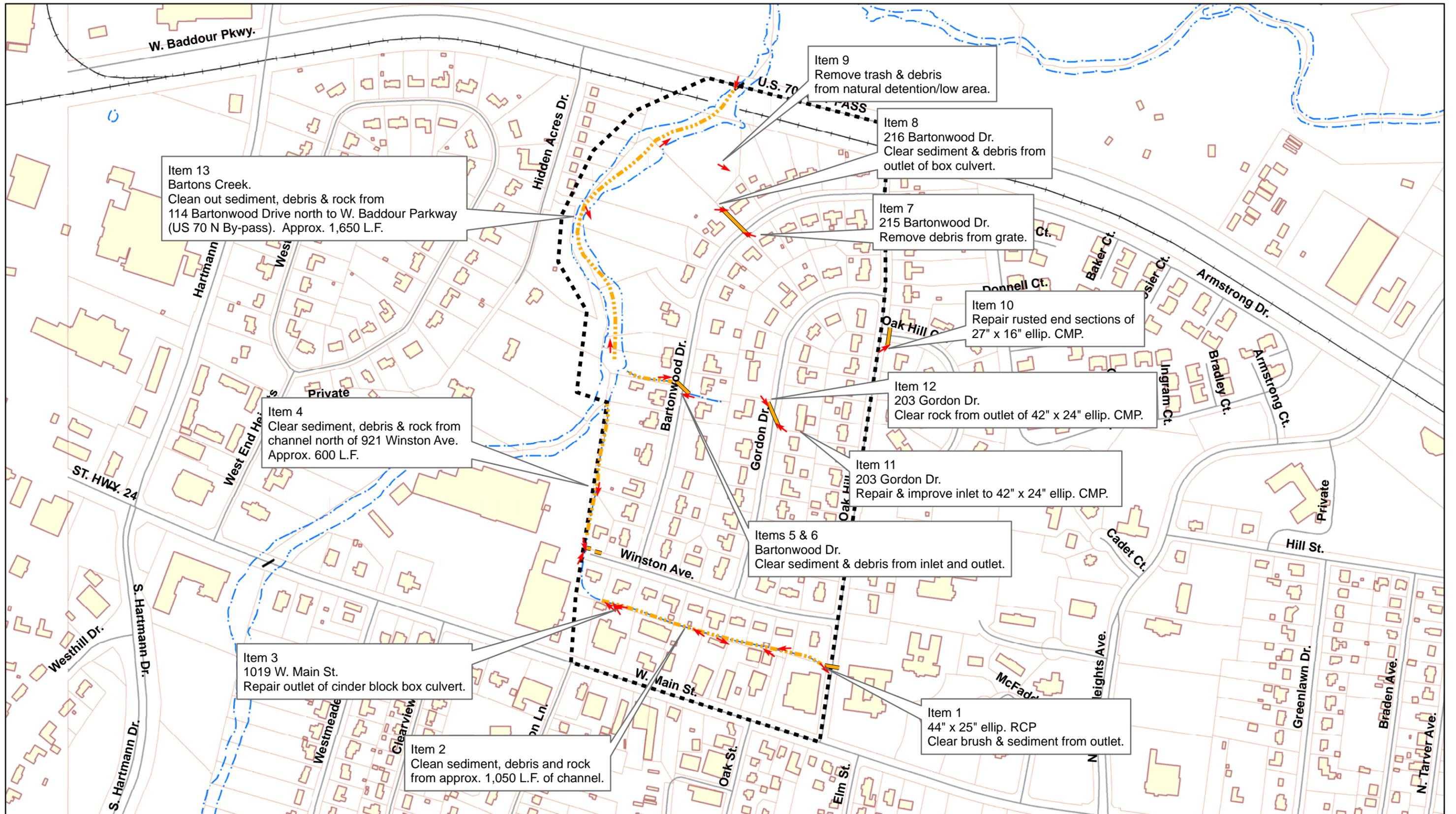
Note:
 Detailed site survey and utility location required during design phase.

Legend

- Streams
- Railroad
- Parcels
- Streets/Roads
- Culverts
- Recommended Cross Drain Improvement
- Buildings
- Stream/Ditch Maintenance Locations

**City of Lebanon Drainage Analysis
 Oak Hill Drive / Bartonwood Drive Area
 Drainage Improvements**





Legend

- Streams
- Parcels
- Existing Culverts
- Ph4_west_end_hghts_field_area
- Infrastructure Maintenance Locations
- Stream/Ditch Maintenance Locations
- ↑ Directional Photo Log

**City of Lebanon Drainage Analysis
Oak Hill Drive / Bartonwood Drive Area
Drainage Improvements**



**Preliminary Infrastructure
Maintenance Locations**

Figure 3

APPENDIX A

Routine Maintenance Location Photographs



Item 1 - Oak Hill Dr. north of W. Main St. Clear brush and sediment from outlet of 44" x 25" Ellip. RCP. Picture 2061.

Item 2 – Clean out sediment, debris and rock from channel running westward Oak Hill Drive to 922 Winston Av. Approx. 1,050 l.f.



Looking west from 908 Winston Ave. Picture 2063



Looking west from 1003 W. Main St. Picture 2065

Item 2 - Continued



Looking west from 1007 W. Main St. Picture 2071



Looking west from 1011 W. Main St. Picture 2075

Item 2 - Continued



Looking west from 1019 W. Main St. Picture 2080



Looking west from 1019 W. Main St. Picture 2082



Item 3 – 1019 W. Main St. Repair outlet of 7'-3" x 32" cinder block box culvert. Picture 2081.



Item 4 – Channel running north from 921 Winston Ave. to 112 Bartonwood Dr. Approx. 600 l.f. Clean out sediment, debris and rock. Picture 2110.



Item 5 –East side of Bartonwood Dr. Inlet of 42” x 24” CMP is clogged with sediment /debris. Also note active erosion above inlet. Picture 1341.



Item 6 – West side of Bartonwood Dr. Clean sediment and debris from outlet of 42” x 24” CMP. Picture 2105.



Item 7 – 215 Bartonwood Dr. Remove debris from grate. Picture 2113.



Item 8 – 216 Bartonwood Dr. Clean debris and sediment from outlet of 4' x 2' box culvert. Picture 2120.



Item 9 – Natural detention/low area adjacent to Bartons Creek south of W. Baddour Pkwy. Clean out trash and debris. Picture 2126.



Item 10 – Oak Hill Dr. and Oak Hill Cir. Repair rusted end sections of 27” x 16” ellip. CMP. Picture 2140.



Item 11 – 203 Gordon Dr. Repair and improve inlet to 42” x 24” ellip. CMP. Picture 2152.



Item 12 – 203 Gordon Dr. Clear rock from outlet of 42” x 24” ellip. CMP. Picture 2155.

Item 13 – Bartons Creek. Clean out sediment, debris and rock from 114 Bartonwood Drive north to W. Baddour Parkway (US 70 N By-pass). Approx. 1,650 l.f.



Looking north from 204 Baronwood Dr. Picture 2109.



Looking south. From approx. midway point of clean out reach. Picture 2131.

Item 13 - Continued



Looking north at railroad bridge. Picture 2128.



Looking north from W. Baddour Parkway bridge. Picture 2128.