

**Town of Livonia
Village of Livonia
Livingston County, New York**

*This report was prepared with funding provided by the New York State
Department of State under Title 11 of the Environmental Protection
Fund.*

FINAL
**Wilkins Creek Subwatershed
Stormwater Study Report**

December 2018



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Executive Summary

The Town of Livonia (Town) has received funding through the New York State (NYS) Department of State's Local Waterfront Revitalization Program to develop a Wilkins Creek Subwatershed Stormwater Study. The purpose of the Study is to evaluate existing conditions and to identify recommended improvements to address impacts associated with increased stormwater flow (*i.e.*, localized flooding) and to improve the quality of stormwater that discharges to Conesus Lake. In addition to the Town, the project advisory team includes the Village of Livonia (Village), Livingston County Planning Department, Conesus Lake Watershed Council, Livingston County Department of Health, Livingston County Soil and Water Conservation District, and the Conesus Lake Association.

During high flow events, stormwater in the upper reaches of the Wilkins Creek watershed causes flooding, property damage, and infrastructure damage further downstream. Stormwater runoff events within the watershed contribute sediment and excessive nutrients (*e.g.*, nitrogen and phosphorus) to the Lake that degrades water quality and contributes to undesirable conditions such as weed growth and algal blooms. All concerned have the desire to mitigate the potential impacts of future storm events, minimize localized flooding, and provide water quality improvement to the Lake.

This Subwatershed Stormwater Study Report provides an overview of the site investigation and alternatives analysis process conducted by Barton & Loguidice, D.P.C. (B&L). The goal of this Study is to provide recommended project improvement alternatives that have a positive impact on the environmental health of Conesus Lake and address flood mitigation for the Town and Village. The following elements are included in this report:

- Existing conditions assessment,
- Previous reports utilized summary,
- Data collection activities summary,
- Stormwater system capacity evaluation (hydrologic and hydraulic modeling), and
- Nutrient/pollutant loading evaluation.

A retrofit opportunity matrix was developed to evaluate potential stormwater mitigation alternatives. The alternatives were based on information obtained from prior studies and field data collection activities. The potential alternatives comprise a wide range of practices for flood mitigation and water quality improvement including streambank restoration, pond retrofits, green infrastructure opportunities, reduction in impervious areas, riparian buffers and wetland creation/expansion. The projects were ranked based on criteria associated with stormwater benefits (quantity and quality), constructability, cost and co-benefits. The goal for selection of

the projects was to include a diverse collection of projects. The purpose was to utilize this matrix as a template that can be repeated by the County, Town and Village, along with additional communities within the Conesus Lake watershed, to progress additional projects as future funding becomes available.

The improvement projects identified included:

1. Livonia High School Green Infrastructure (GI)
2. Livonia High School Pond Retrofit
3. Streambank Stabilization within 6143 Wilkins Tract, 6073 Wilkins Tract, 3890 East Lake Road, and 3900 East Lake Road
4. Pond Retrofit within 6241 Big Tree Road and adjacent lot with Tax Map ID 74.8-1-1 on Big Tree Road
5. Reduction in Impervious Area in the Village
6. Streambank Stabilization behind Livonia Fire Department on South Livonia Road with Tax Map IDs 75.13-1-19.1 and 75.-1-45.11
7. Stormwater Management Area within 3895 East Lake Road and adjacent lot with Tax Map ID 74.-1-13.132 between East Lake Road and Pennemite Road
8. Village GI
9. Stormwater Management Area within 6138 Big Tree Road
10. Streambank Stabilization within 4212 South Livonia Road
11. Wetland Expansion within lot with Tax Map ID 84.-1-4.922 south of Livonia High School off Shelly Road
12. Underground Storage under the Brooks Parking Lot
13. Riparian Buffer within 4589 Shelly Road.
14. Culvert Modification within Livonia Community Park
15. Salt Storage Modification within 50 Commercial Street.
16. Wing Wall Restoration adjacent to 6144 Wilkins Tract

This document provides a preliminary evaluation of the aforementioned projects. Design summaries and cost estimates, and a benefit analysis for each project are also included for implementation as future funding becomes available. Additional design, permitting and analysis would be required to progress the recommended projects.

1.0 Project Background & History

1.1 Site Information

Several prior studies have been conducted associated with the Wilkins Creek watershed. Relevant studies were used to analyze existing conditions and alternatives. The following key documents were reviewed and information compiled as part of this Engineering Study (refer to Section 4.0 for full references):

- “Wilkins Creek Reconnaissance Memo” dated June 2015,
- “Conesus Lake Watershed Characterization Report Update” dated May 2013,
- “Conesus Lake and Watershed Report Cards” dated May 2003 to 2017,
- “Streambank Remediation Study Final Report” dated April 2007,
- “State of Conesus Lake: Watershed Characterization Report” dated May 2002, and
- “Stormwater Toolkit – Reference Document” dated October 2017.

Conesus Lake, the western-most Finger Lake and largest inland lake in Livingston County with a lake surface area of 5.2 square miles, serves as a prominent feature politically, economically, and socially for residents of Livingston County. The Lake serves as a major destination for tourism and recreation for boaters, beachgoers, and fishers (EcoLogic LLC and Livingston County Planning Department, 2002). However, excessive nutrient runoff and sedimentation caused problematic aquatic vegetation growth and algal growth. These conditions can cause a threat to the Lake’s water quality. The Lake is now classified as an impaired waterbody. Excessive nutrient runoff and sedimentation causes problematic aquatic vegetation growth and the outbreak of algal blooms threatening the Lake’s water quality, recreation value, and sustainability, and in turn, the local economy and biodiversity. Additionally, the lake serves as a source of drinking water for

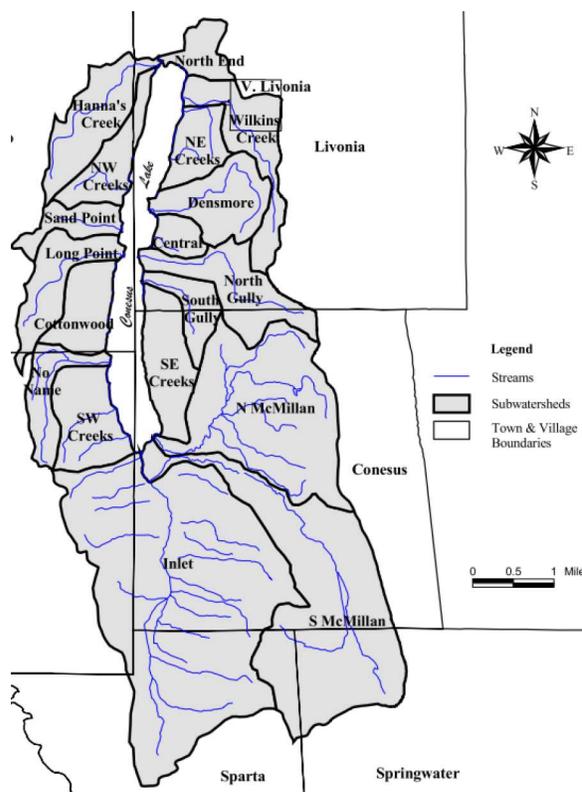


Figure 1-1: Subwatersheds of the Conesus Lake watershed (modified from original source: EcoLogic LLC and Livingston County Planning Department, 2002).

20,000 Livingston County residents (EcoLogic LLC and Livingston County Planning Department, 2013). If ignored, ongoing runoff of nutrients (*i.e.*, phosphorus and nitrogen) and sediment from human activities in the watershed risks exceeding the lake's natural capacity to dilute and purify.

The Lake is considered mesotrophic, where the Lake is enriched in dissolved nutrients that can stimulate excessive algal blooms and dissolved oxygen depletion. The quality of water within the tributary system that flows to the Lake directly affect the Lake's water quality. The watershed encompasses 75 square miles. Overall, the streams within the Lake's watershed exhibit moderate water quality. Over time, the continued inflow of moderate quality water will degrade the water quality within the Lake. Therefore, a Watershed Management Plan was deemed necessary to improve the water quality of the Lake.

The Wilkins Creek Subwatershed Study Area (topic of this Study) encompassing the Town and Village is located along the northeastern end of the Conesus Lake watershed. The Subwatershed Study Area comprises approximately 1,424 acres, or approximately 3% of the total drainage within the Conesus Lake watershed. The Conesus Lake watershed's population was last estimated in 2010 Census to be approximately 9,600, whereas the Town and Village's population was estimated to be 7,800 people, or 81.3% of the total population within the Conesus Lake watershed (EcoLogic LLC and Livingston County Planning Department, 2013). As a more populated area within the Conesus Lake watershed, the Town and Village (within the Wilkins Creek Subwatershed) are considered major stakeholders for the health of the Lake.

The lake has been, and is currently, exposed to excessive nutrients and sediment threatening its overall health. Known pollutants and conditions include low dissolved oxygen, nutrients (phosphorus and nitrogen), and silt/sediment. Phosphorus, a nutrient of primary concern, is considered a pollutant within the lake due to the excessively high concentrations. All living organisms require this nutrient for growth, however, problems arise when nutrient levels become excessive causing some organisms to proliferate at the expense of others. Excessive nutrient runoff can contribute to large algae blooms, which in turn become oxygen-demanding material as they die and settle to the bottom, further decreasing dissolved oxygen as they decay. The input of this pollutant has resulted in the lake's classification as an impaired waterbody, leading the New York State Department of Environmental Conservation (NYSDEC) to designate the lake as a waterbody requiring a Total Maximum Daily Load for phosphorus. In addition to excessive nutrients, excessive sediment runoff (*i.e.*, organic and inorganic particles) causes turbidity, which in turn decreases light penetration, increasing bacterial populations that threaten the drinking water supply and water-based recreational opportunities the lake offers. Suspended sediments eventually fall to the bottom of the lake destroying the habitat for many benthic organisms a healthy fish ecosystem relies on (Davis, M.L. and Masten, S.J., 2002).

The project advisory team would like to reduce property loss due to excessive flooding and/or erosion during larger storm events while restoring the health of the watershed and its lake to prevent further threats to water quality and sustainability within the lake and on the local economy and recreational value the lake provides.

1.2 Drainage Area Characteristics

The watershed study area comprises nine separate drainage areas (Drainage Areas 1-9) encompassing nearly 1,424 acres. The drainage areas ultimately direct stormwater runoff downgradient to the northeast shore of Conesus Lake. Drainage areas vary in geologic conditions (*e.g.*, soil type, groundwater level, floodplains, and land cover).

Soils are classified into hydrologic soil groups (HSGs) to indicate the minimum rate of infiltration, or rate at which water enters the soil at soil surface, for bare soil after prolonged wetting. HSGs consist of Groups A, B, C, and D soils. Group A soils have the lowest runoff potential and highest infiltration rates, whereas Group D soils have the highest runoff potential and lowest infiltration rates. Soils assigned to dual hydrologic groups (*i.e.*, A/D, B/D, or C/D) represent varying levels of infiltration depending on saturation levels. For drained areas, the soil is assigned to the first letter. For undrained areas, the soil is assigned to the second letter (USDA, 2017). Areas containing soils with higher infiltration rates (*e.g.*, HSG A) may be best suited for conservation; whereas, areas containing soils with lower infiltration rates (*e.g.*, HSG D) may be best suited for future development. Soil types were obtained from the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) SSURGO dataset (Soil Survey Staff, 2017). Soil properties and qualities are summarized for each drainage area in **Table 1 (Soil Properties and Qualities Summary)**. A soils map is included in **Figure 1 (Hydrologic Soil Group)** illustrating the variance between drainage areas. Generally, Drainage

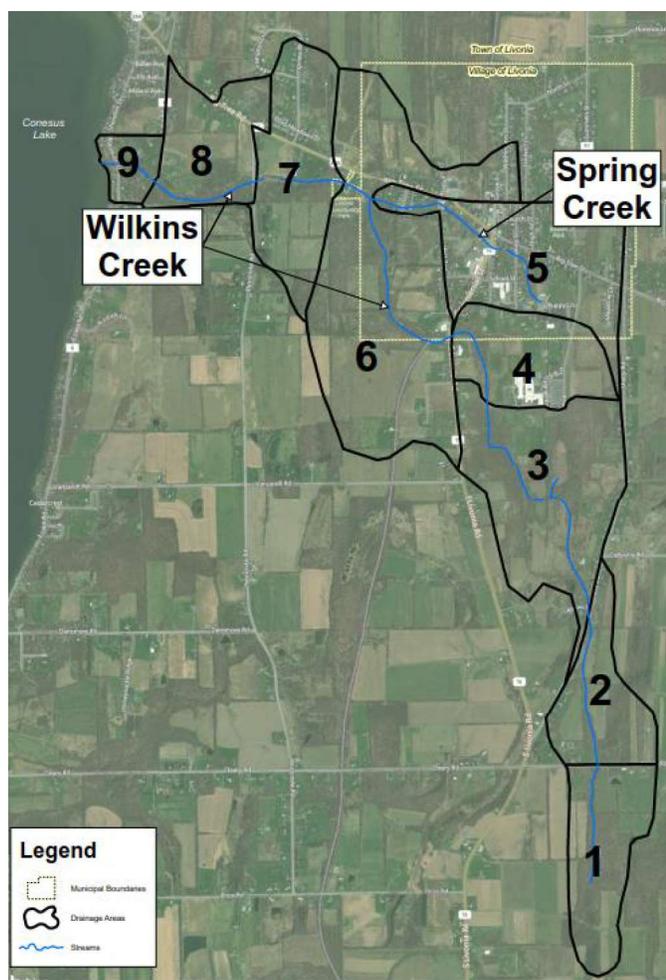


Figure 1-2: Drainage Areas within the Wilkins Creek Watershed

TABLE 1 - SOIL PROPERTIES AND QUALITIES SUMMARY

Basin	HSG	Land Use	Acres
1	A/D	005 Woods	1.10
1	A/D	006 Pasture, grassland, or range	0.18
1	B	003 Brush, brush/weed/grass mix	4.92
1	B	005 Woods	24.05
1	B	006 Pasture, grassland, or range	11.64
1	B	007 Row crops (straight row)	44.87
1	B	008 Open Space (Lawns, Parks, etc.)	0.74
1	B/D	003 Brush, brush/weed/grass mix	0.19
1	B/D	005 Woods	4.28
1	B/D	006 Pasture, grassland, or range	3.30
1	B/D	007 Row crops (straight row)	3.73
1	B/D	008 Open Space (Lawns, Parks, etc.)	0.30
1	C/D	005 Woods	9.65
1	C/D	006 Pasture, grassland, or range	2.36
1	C/D	007 Row crops (straight row)	3.18
1	C/D	008 Open Space (Lawns, Parks, etc.)	0.06
2	A	005 Woods	1.44
2	A	006 Pasture, grassland, or range	25.66
2	A/D	005 Woods	3.24
2	A/D	006 Pasture, grassland, or range	8.99
2	A/D	008 Open Space (Lawns, Parks, etc.)	0.18
2	B	005 Woods	2.86
2	B	006 Pasture, grassland, or range	33.34
2	B	008 Open Space (Lawns, Parks, etc.)	1.69
2	B/D	005 Woods	14.34
2	B/D	006 Pasture, grassland, or range	0.69
2	B/D	008 Open Space (Lawns, Parks, etc.)	0.96
2	C/D	005 Woods	1.95
2	C/D	006 Pasture, grassland, or range	2.06
2	C/D	008 Open Space (Lawns, Parks, etc.)	0.21
3	A/D	006 Pasture, grassland, or range	0.22
3	A/D	007 Row crops (straight row)	0.24
3	B	002 Meadow, cont. grass, non-grazed	4.92
3	B	003 Brush, brush/weed/grass mix	16.12
3	B	005 Woods	29.57
3	B	006 Pasture, grassland, or range	92.56
3	B	007 Row crops (straight row)	4.94
3	B	008 Open Space (Lawns, Parks, etc.)	23.62
3	B	008 Residential District (1/2 acre size lot)	2.56
3	B	008 Residential District (1/8 acre size lot)	0.28
3	B/D	002 Meadow, cont. grass, non-grazed	0.18
3	B/D	003 Brush, brush/weed/grass mix	4.99
3	B/D	005 Woods	26.47
3	B/D	006 Pasture, grassland, or range	5.20
3	B/D	007 Row crops (straight row)	0.17
3	B/D	008 Open Space (Lawns, Parks, etc.)	0.13
3	B/D	008 Residential District (1/2 acre size lot)	0.19
3	B/D	008 Residential District (1/8 acre size lot)	0.00
3	C/D	005 Woods	11.31
3	C/D	006 Pasture, grassland, or range	5.41
4	A/D	003 Brush, brush/weed/grass mix	0.03
4	A/D	005 Woods	2.86
4	A/D	006 Pasture, grassland, or range	3.10
4	A/D	007 Row crops (straight row)	0.95

TABLE 1 - SOIL PROPERTIES AND QUALITIES SUMMARY (*Continued*)

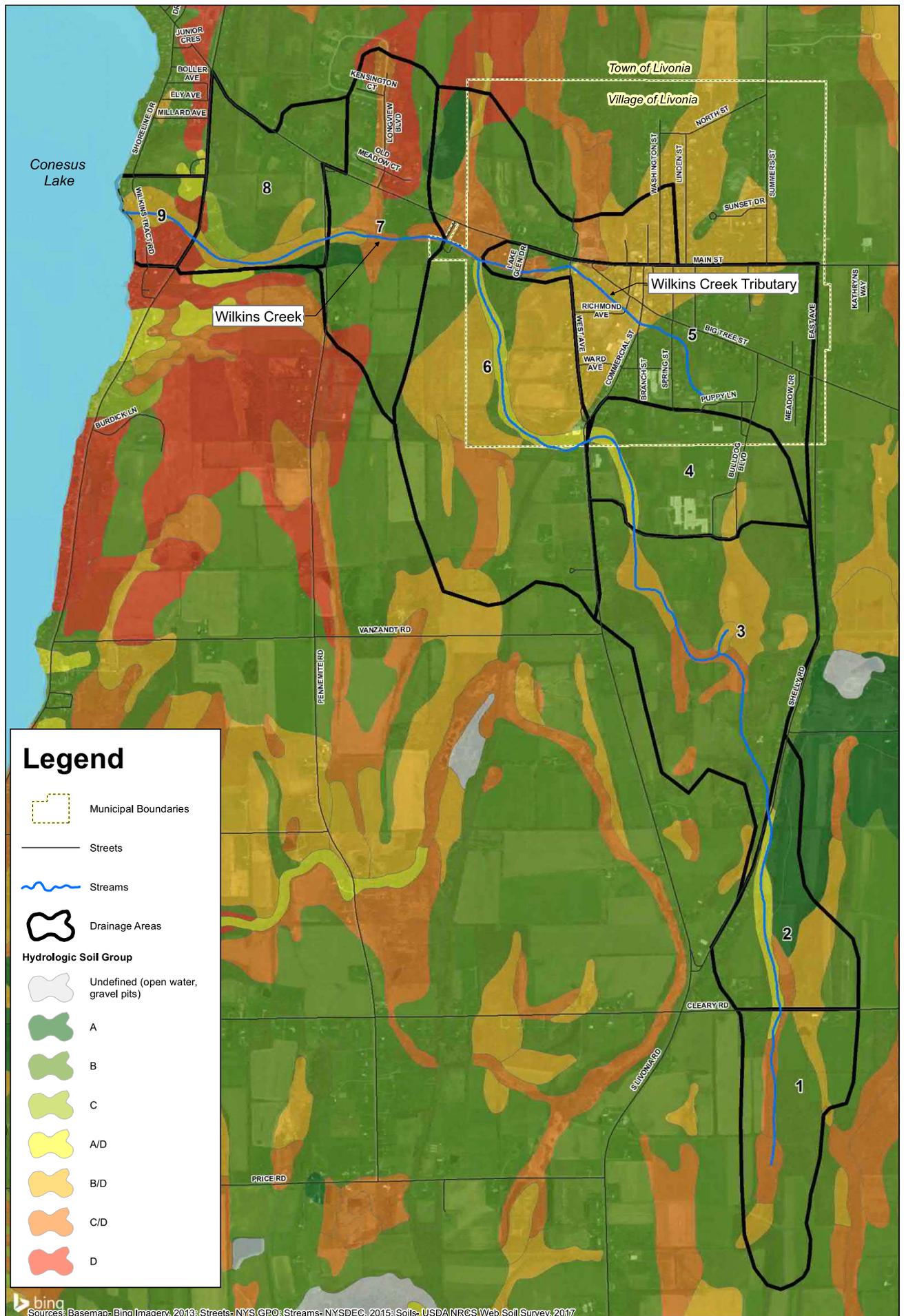
4 A/D	008 Open Space (Lawns, Parks, etc.)	0.23
4 A/D	008 Residential District (1/2 acre size lot)	0.08
4 B	002 Meadow, cont. grass, non-grazed	1.13
4 B	003 Brush, brush/weed/grass mix	3.19
4 B	005 Woods	3.45
4 B	006 Pasture, grassland, or range	42.39
4 B	007 Row crops (straight row)	12.07
4 B	008 Open Space (Lawns, Parks, etc.)	22.80
4 B	008 Residential District (1/2 acre size lot)	9.04
4 B	008 Residential District (1/8 acre size lot)	6.44
4 B	008 Urban District (Commercial & Business)	2.97
4 B/D	005 Woods	0.00
4 B/D	006 Pasture, grassland, or range	0.99
4 B/D	008 Open Space (Lawns, Parks, etc.)	0.18
4 B/D	008 Residential District (1/2 acre size lot)	0.92
4 B/D	008 Residential District (1/8 acre size lot)	1.40
4 B/D	008 Urban District (Commercial & Business)	0.88
5 A/D	008 Residential District (1/2 acre size lot)	0.07
5 B	002 Meadow, cont. grass, non-grazed	9.60
5 B	003 Brush, brush/weed/grass mix	1.51
5 B	005 Woods	6.96
5 B	006 Pasture, grassland, or range	43.50
5 B	007 Row crops (straight row)	0.16
5 B	008 Open Space (Lawns, Parks, etc.)	27.82
5 B	008 Residential District (1/2 acre size lot)	32.98
5 B	008 Residential District (1/8 acre size lot)	7.39
5 B	008 Urban District (Commercial & Business)	1.31
5 B/D	002 Meadow, cont. grass, non-grazed	1.32
5 B/D	005 Woods	5.32
5 B/D	006 Pasture, grassland, or range	0.83
5 B/D	007 Row crops (straight row)	0.43
5 B/D	008 Open Space (Lawns, Parks, etc.)	13.63
5 B/D	008 Residential District (1/2 acre size lot)	17.56
5 B/D	008 Residential District (1/8 acre size lot)	13.46
5 B/D	008 Urban District (Commercial & Business)	5.10
5 C/D	005 Woods	1.22
5 C/D	007 Row crops (straight row)	0.75
5 C/D	008 Open Space (Lawns, Parks, etc.)	2.54
5 C/D	008 Residential District (1/2 acre size lot)	1.57
5 C/D	008 Residential District (1/8 acre size lot)	1.17
6 A	003 Brush, brush/weed/grass mix	0.03
6 A	005 Woods	7.97
6 A	006 Pasture, grassland, or range	4.35
6 A	007 Row crops (straight row)	0.01
6 A/D	005 Woods	13.46
6 A/D	006 Pasture, grassland, or range	0.00
6 A/D	008 Open Space (Lawns, Parks, etc.)	0.92
6 A/D	008 Residential District (1/2 acre size lot)	0.48
6 A/D	008 Residential District (1/8 acre size lot)	0.29
6 B	002 Meadow, cont. grass, non-grazed	3.74
6 B	003 Brush, brush/weed/grass mix	2.61
6 B	005 Woods	37.04
6 B	006 Pasture, grassland, or range	64.14
6 B	007 Row crops (straight row)	40.30
6 B	008 Open Space (Lawns, Parks, etc.)	16.07

TABLE 1 - SOIL PROPERTIES AND QUALITIES SUMMARY (Continued)

6 B	008 Residential District (1/2 acre size lot)	4.38
6 B	008 Residential District (1/8 acre size lot)	0.59
6 B	008 Urban District (Commercial & Business)	0.08
6 B/D	002 Meadow, cont. grass, non-grazed	0.72
6 B/D	003 Brush, brush/weed/grass mix	4.58
6 B/D	005 Woods	56.37
6 B/D	006 Pasture, grassland, or range	32.32
6 B/D	007 Row crops (straight row)	26.48
6 B/D	008 Open Space (Lawns, Parks, etc.)	7.68
6 B/D	008 Residential District (1/2 acre size lot)	7.56
6 B/D	008 Residential District (1/8 acre size lot)	2.85
6 B/D	008 Urban District (Commercial & Business)	0.58
6 C/D	003 Brush, brush/weed/grass mix	1.18
6 C/D	005 Woods	7.30
6 C/D	006 Pasture, grassland, or range	14.22
6 C/D	007 Row crops (straight row)	14.64
6 C/D	008 Open Space (Lawns, Parks, etc.)	4.33
6 C/D	008 Residential District (1/2 acre size lot)	2.62
6 C/D	008 Residential District (1/8 acre size lot)	2.04
6 C/D	008 Urban District (Commercial & Business)	0.82
6 D	005 Woods	0.30
6 D	006 Pasture, grassland, or range	2.16
6 D	007 Row crops (straight row)	0.49
7 A	005 Woods	0.99
7 A	006 Pasture, grassland, or range	3.97
7 A	007 Row crops (straight row)	0.05
7 B	003 Brush, brush/weed/grass mix	4.29
7 B	005 Woods	15.63
7 B	006 Pasture, grassland, or range	35.03
7 B	007 Row crops (straight row)	24.13
7 B	008 Open Space (Lawns, Parks, etc.)	8.61
7 B	008 Residential District (1/2 acre size lot)	2.06
7 B/D	003 Brush, brush/weed/grass mix	0.07
7 B/D	006 Pasture, grassland, or range	2.79
7 C/D	005 Woods	3.88
7 C/D	006 Pasture, grassland, or range	12.33
7 C/D	007 Row crops (straight row)	3.05
7 C/D	008 Open Space (Lawns, Parks, etc.)	2.73
7 C/D	008 Residential District (1/2 acre size lot)	0.23
7 D	003 Brush, brush/weed/grass mix	0.10
7 D	005 Woods	9.17
7 D	006 Pasture, grassland, or range	9.15
7 D	007 Row crops (straight row)	8.24
7 D	008 Open Space (Lawns, Parks, etc.)	1.13
7 D	008 Residential District (1/2 acre size lot)	0.17
8 A	005 Woods	1.45
8 A	006 Pasture, grassland, or range	1.34
8 A	008 Open Space (Lawns, Parks, etc.)	0.05
8 A/D	005 Woods	0.21
8 A/D	006 Pasture, grassland, or range	0.82
8 B	003 Brush, brush/weed/grass mix	3.64
8 B	005 Woods	9.04
8 B	006 Pasture, grassland, or range	33.90
8 B	007 Row crops (straight row)	13.77
8 B	008 Open Space (Lawns, Parks, etc.)	13.23

TABLE 1 - SOIL PROPERTIES AND QUALITIES SUMMARY (*Continued*)

8 B	008 Residential District (1/2 acre size lot)	3.63
8 B	008 Residential District (1/8 acre size lot)	0.52
8 B/D	005 Woods	9.65
8 B/D	006 Pasture, grassland, or range	4.78
8 B/D	007 Row crops (straight row)	0.79
8 B/D	008 Open Space (Lawns, Parks, etc.)	0.63
8 C/D	006 Pasture, grassland, or range	5.09
8 C/D	007 Row crops (straight row)	1.09
8 D	006 Pasture, grassland, or range	2.96
8 D	008 Open Space (Lawns, Parks, etc.)	0.39
8 D	008 Residential District (1/2 acre size lot)	0.02
9 A/D	006 Pasture, grassland, or range	1.74
9 A/D	008 Open Space (Lawns, Parks, etc.)	0.69
9 A/D	008 Residential District (1/2 acre size lot)	0.12
9 B	001 Pond or Lake Surface	0.83
9 B	006 Pasture, grassland, or range	0.93
9 B	008 Open Space (Lawns, Parks, etc.)	1.90
9 B	008 Residential District (1/2 acre size lot)	0.85
9 B	008 Residential District (1/8 acre size lot)	0.12
9 B/D	001 Pond or Lake Surface	0.40
9 B/D	005 Woods	1.80
9 B/D	006 Pasture, grassland, or range	3.13
9 B/D	008 Open Space (Lawns, Parks, etc.)	1.97
9 B/D	008 Residential District (1/2 acre size lot)	2.82
9 B/D	008 Residential District (1/8 acre size lot)	0.02
9 C	006 Pasture, grassland, or range	0.03
9 D	001 Pond or Lake Surface	0.29
9 D	003 Brush, brush/weed/grass mix	1.74
9 D	005 Woods	1.40
9 D	006 Pasture, grassland, or range	4.00
9 D	008 Open Space (Lawns, Parks, etc.)	3.15
9 D	008 Residential District (1/2 acre size lot)	1.41
9 D	008 Residential District (1/8 acre size lot)	0.44



Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Soils- USDA NRCS Web Soil Survey, 2017



1 inch = 1,250 feet

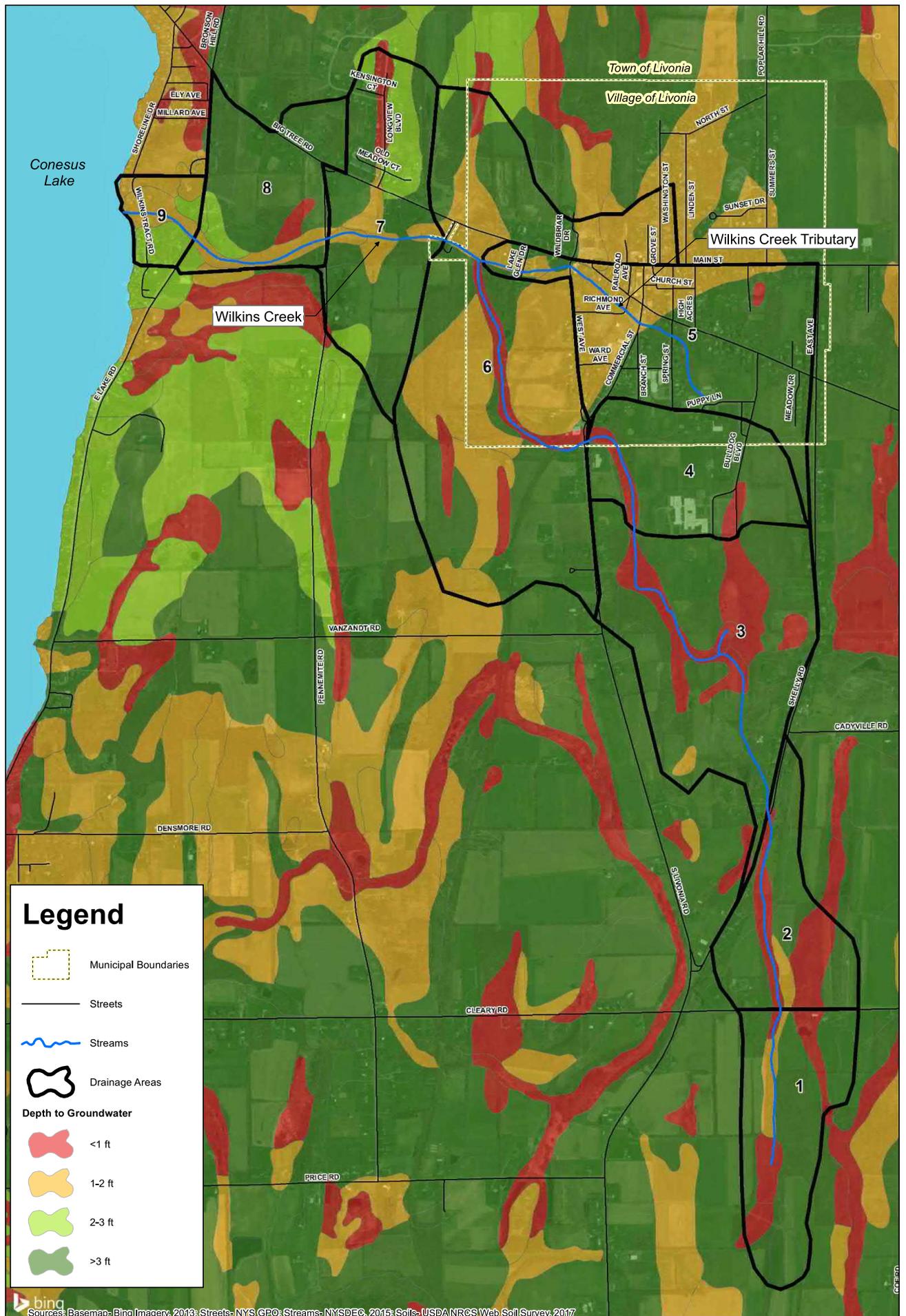
Area 9 comprises the largest percentage of ‘D’ soil group. The other drainage areas generally range between ‘B’ and ‘C’ soil groups.

The groundwater level varies with changes in soil groups. Generally, the higher the infiltration rate a certain soil group has, the lower the groundwater level. Areas with lower groundwater levels and high infiltration rates provide positive impacts to water quality by trapping sediments and capturing pollutants prior to discharging to the Lake. Approximate groundwater levels, as defined by Soil Survey Database (Soil Survey Staff, 2017), are included within **Figure 2 (Depth to Groundwater)**.

Land use is important to the drainage area’s hydrologic cycle as it has one of the greatest impacts on water quality. More urbanized land usage generally relates to more impervious covers, resulting in higher peak flows preventing attenuation (*i.e.*, water retention) and filtration of nutrients and sediments. More ruralized land usage generally relates to more pervious covers, resulting in lower peak flows and increased nutrient and sediment filtration. However, some ruralized land usage such as farming and livestock operations have higher than typical nutrient runoff loads. Within the Wilkins Creek watershed, land use typically varies with population density, where more urbanized parcels are generally located within the center of the Village and ruralized parcels generally located south and west of the Village. Property classes, as defined by parcel data, are presented in **Figure 3 (Land Use)**.

Land cover is also important to the drainage hydrologic cycle, exerting considerable influence on the chemical, physical, and biological characteristics of waterbodies. Land cover classifies the vegetation (or lack thereof) covering the ground. Removing the natural vegetation due to human activities reduces the soil’s ability to filter nutrients and sediments, resulting in increased amounts of runoff and pollution. Within the Wilkins Creek watershed, land cover typically varies with population density, where more impervious cover types are generally located within the center of the Village and more pervious cover types (*e.g.*, crops and forest) are generally located south and west of the Village. Land cover, as defined by the National Land Cover Database, is presented in **Figure 4 (Land Cover)**.

Floodplain and forested areas, when preserved and sustained, help minimize peak flows and sediment loads by dispersing flow and allowing infiltration. A floodplain by definition is a nearly flat plain near a waterbody that is naturally subject to flooding. Floodplains generally contribute to localized flooding, however, offer much needed nutrient filtration. Floodplains exist within the Wilkins Creek watershed, adjacent along the entire Creek. The 100-year and 500-year floodplain, as defined by the Federal Emergency Management Agency (FEMA, 1996), are illustrated in **Figure 5 (Floodplains)**. Forested areas (*i.e.*, woods and woods/grass combination) are included in **Figure 4 (Land Cover)**. During field reconnaissance (see Section 2.1), areas with streambank erosion were found to be disconnected from their original floodplains, which



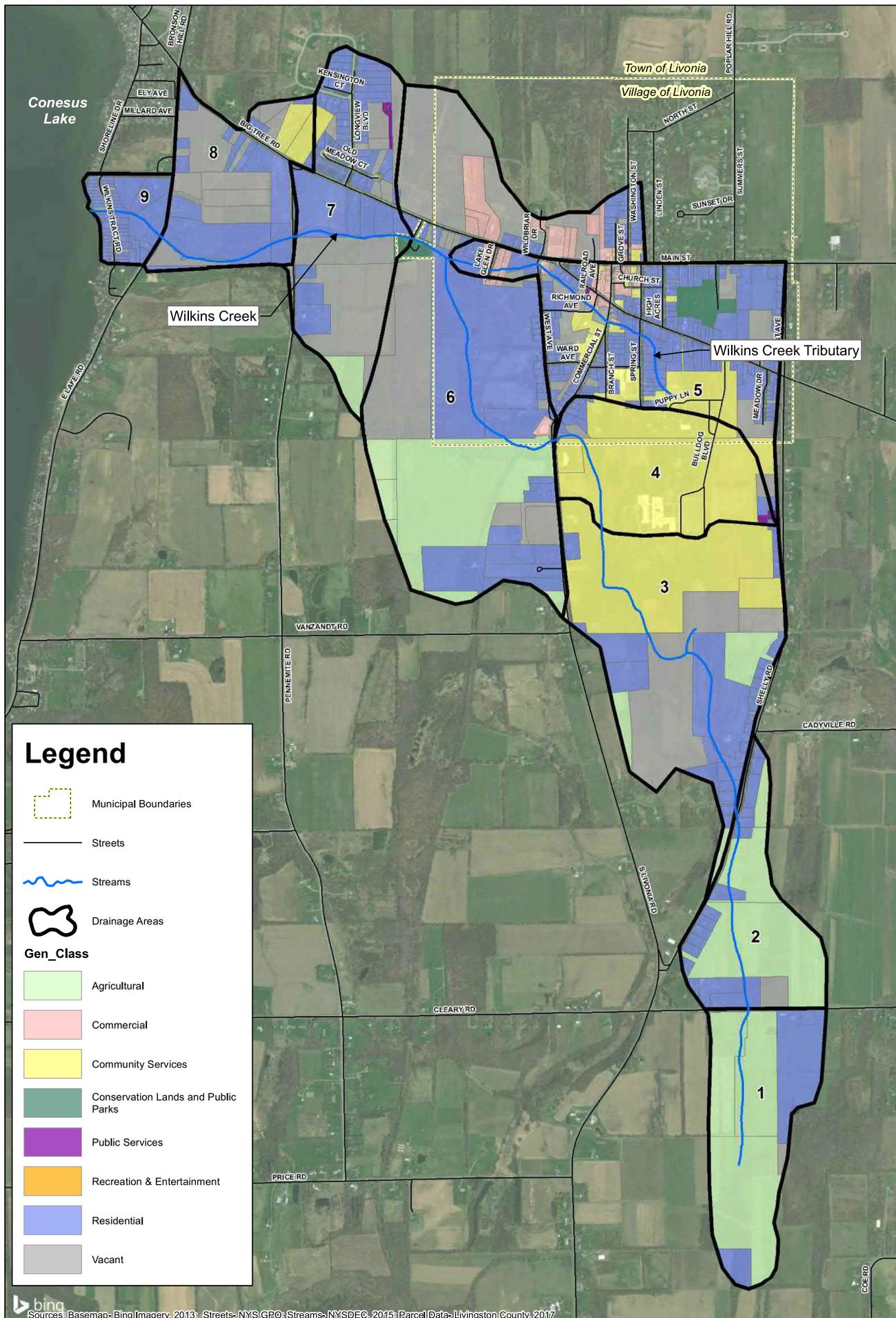
Legend

- Municipal Boundaries
- Streets
- Streams
- Drainage Areas

Depth to Groundwater

- <1 ft
- 1-2 ft
- 2-3 ft
- >3 ft

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Soils- USDA NRCS Web Soil Survey, 2017



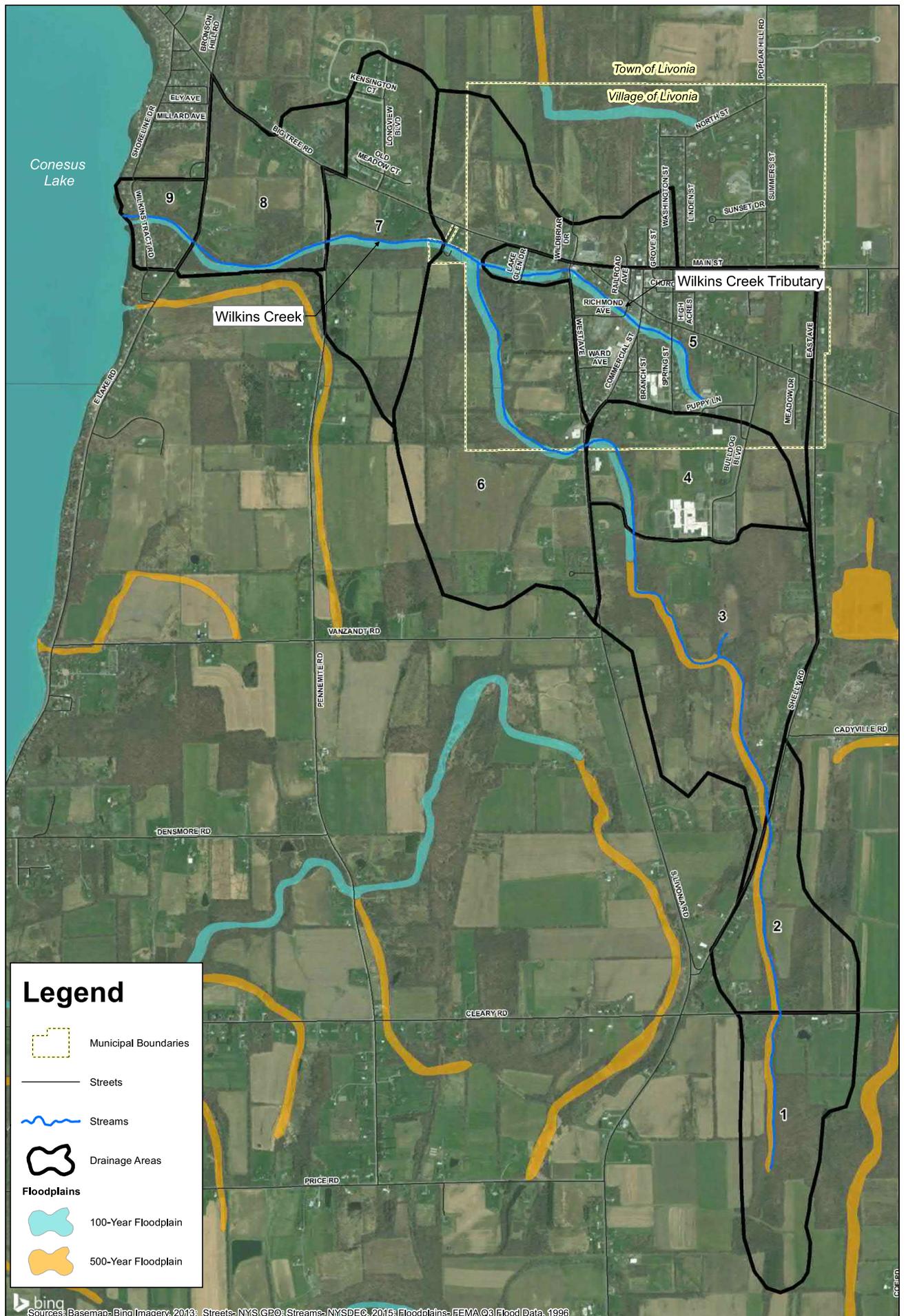
Legend

- Municipal Boundaries
- Streets
- Streams
- Drainage Areas

Gen_Class

- Agricultural
- Commercial
- Community Services
- Conservation Lands and Public Parks
- Public Services
- Recreation & Entertainment
- Residential
- Vacant

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Parcel Data- Livingston County, 2017



Legend

- Municipal Boundaries
- Streets
- Streams
- Drainage Areas
- Floodplains**
- 100-Year Floodplain
- 500-Year Floodplain

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Floodplains- FEMA Q3 Flood Data, 1996



1 inch = 1,250 feet

may have been a driving force causing erosion. Additionally, the filtering capacity of surrounding soils is greatly reduced which increases nutrient loads and peak flows downstream.

1.3 Prior Studies

Dr. Joseph Makarewicz of SUNY Brockport conducted an active research and monitoring program focused on the lake and its tributary streams. A study performed by Dr. Makarewicz and his associates in the 1990s estimated annual loads from Wilkins Creek to be 201.3 lbs of phosphorus, 4,809.8 lbs of nitrogen, and 81,273.4 lbs (40.6 tons) of sediment (Makarewicz and Lewis, 1991). It was found that, due to its smaller discharge, the total loading of nutrients and suspended solids from Wilkins Creek was not as large as other surrounding watersheds. Nonetheless, concentrations of TSS and phosphorus were the highest and second highest observed, respectively (Makarewicz and Lewis, 1991).

In September of 2006, Stantec Consulting Services, Inc. completed a stream corridor assessment by surveying 12 different streams that comprised over 52,000 linear feet of stream corridor. Two of the surveyed streams included Wilkins Creek and an unnamed tributary to Wilkins Creek (EcoLogic LLC and Livingston County Planning Department, 2013). A report documenting observations from the September 2006 investigation and remediation options was developed (Stantec Consulting Services, Inc., 2007). In summary, the following was observed:

1. Wilkins Creek at Livonia Community Park – double culvert within the park is misaligned with the stream channel that causes scour eddies during high flow.
2. Wilkins Creek from Livonia Community Park to Pennemite Road – significant bank erosion and disconnection of floodplain.
3. Wilkins Creek from East Lake Road to Wilkins Tract Road – lateral instability and large quantities of mass wasting of banks and terraces.
4. Wilkins Creek from Wilkins Tract Road to Lake – minor headcutting downstream of the culvert.

Through the fall and winter of 2012 to 2013, Barton & Loguidice, D.P.C., (B&L) conducted geomorphic assessments of existing conditions of the different sections along Wilkins Creek (see **Appendix A** located at the end of this report). On April 6th, 2015, B&L performed a site investigation along the portion of Wilkins Creek extending from the bridge at East Lake Road downstream to the culvert at Wilkins Tract Road a distance of approximately 1,020 feet. The purpose of the reconnaissance was threefold:

1. Evaluate the extent of streambank erosion along this reach, as well as provide a cursory evaluation of channel stability based upon visual observation;

2. Identify any existing conditions or evidence of past impacts contributing to streambank erosion and/or channel instability, or lending to the likelihood of continued deterioration of streambank conditions in the future, and;
3. Evaluate opportunities for effective erosion remediation or channel stabilization projects along this stream reach.

A memo documenting observations from the April 2015 reconnaissance and remediation options was developed and included as **Appendix B** (located at the end of this report). In summary, the primary areas of bank erosion were observed along the left bank where the stream is pinned against the toe of a relatively high embankment (~10-15 feet in height). Data derived from the assessments was utilized to develop a stabilization/erosion remediation alternative. Remediation options included reconnection of the floodplain along the straightened sections and construction of a floodplain bench with armored toe along the eroded embankment. A section of Wilkins Creek from Livonia Community Park to Pennemite Road was stabilized with 347 linear feet of rock toe protection and vegetated floodplain bench along the right bank in 2016.

Private owners along Wilkins Creek have also documented changes within the streambanks and stream bed throughout the years. The current resident of 4212 South Livonia Road has documented streambank erosion and lateral migration with photographs from 2013 and 2014 (see **Appendix C** located at the end of this report). The current resident of 6157 Wilkins Tract has documented measurements illustrating the sedimentation near the mouth (see **Appendix D** located at the end of this report).

2.0 Existing Facilities & Present Condition

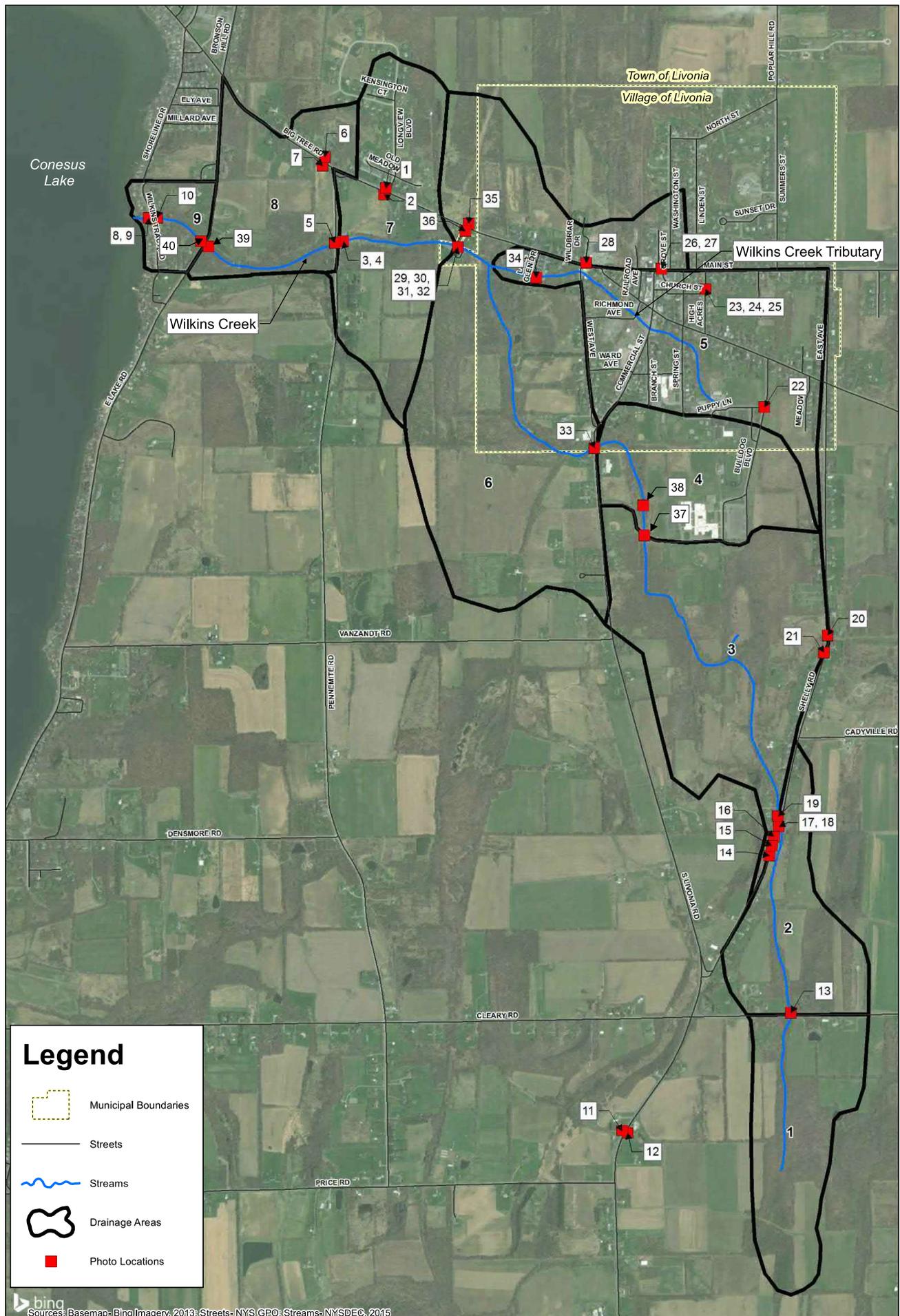
2.1 Field Data Collection

Issues arising from excessive nutrient and sediment runoff and localized flooding may be mitigated after a better understanding of the causes. A field reconnaissance was performed on May 1, 2018, June 6, 2018, and August 2, 2018, by B&L. Field reconnaissance involved conducting a hydrologic survey, delineating the drainage area and subwatersheds, identifying and evaluating condition of at-risk structures via a stormwater infrastructure inventory (see Section 2.3), and developing flow pathways. Additionally, B&L met with Mayor Calvin Lathan the Livingston County Planning Department. Discussions involved areas of potential flooding, historic drainage improvements, and current status of the watershed. B&L met with the Conesus Lake Watershed Manager/Planner and four land owners of the lower portion of the Wilkins Tract residents on the August 2, 2018, field reconnaissance. Property access was granted behind the Livonia Fire Department off South Livonia Road, within 4212 South Livonia Road, and the lower portion of Wilkins Creek near Wilkins Tract to expand on prior field investigations.

The existing watershed delineation was updated based on field findings, and photographs were taken to document findings. A photograph log of the May 1 and June 6 reconnaissance is included in **Appendix E** (located at the end of this report). A figure illustrating where each picture was taken is included in **Figure 6 (Photo Locations)**. At risk structures were field located for survey measurements by our teaming partner, Popli Design Group. Flow pathways (shown in **Figure 7 [Time of Concentration]**) were utilized to calculate time of concentration pathways for input into the hydrologic and hydraulic model (see Section 2.3). Photograph logs of the August 2 reconnaissance are included in **Appendices F, G, and H** (located at the end of this report) that include potential project locations, Wilkins Creek inspection between the Lake and Pennemite Road, and behind the Livonia Fire Department, respectively, with corresponding summaries.

2.2 Topographic Survey

A topographic map is included in **Figure 8 (Topography)**. Within the watershed, steeper slopes along Wilkins Creek and Wilkins Creek Tributary are generally located within the Village (*i.e.*, Drainage Areas 4, 5, and 6), and lower slopes are located within the most upstream and downstream sections (*i.e.*, Drainage Areas 1, 2, 3, 7, 8, and 9). The steeper sections within the Village generally show lateral confinement that can be attributed to the more densely populated areas.



Legend

-  Municipal Boundaries
-  Streets
-  Streams
-  Drainage Areas
-  Photo Locations

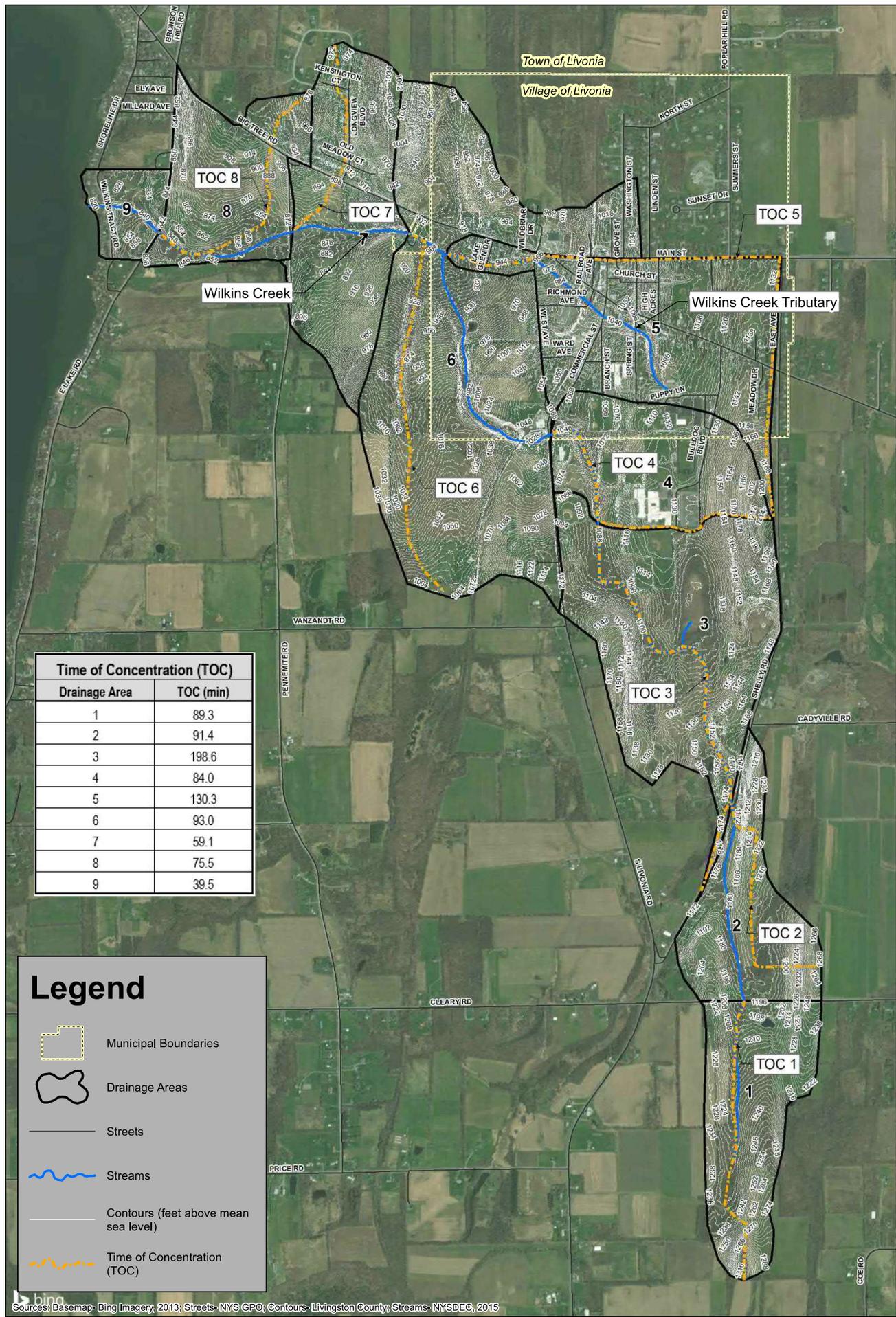
Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015



1 inch = 1,250 feet

Livingston County
 Wilkins Creek Subwatershed Stormwater Study
Photo Locations
 Livingston County June 2018 New York

Figure
 6
 Project
 No.
 338,008



Time of Concentration (TOC)	
Drainage Area	TOC (min)
1	89.3
2	91.4
3	198.6
4	84.0
5	130.3
6	93.0
7	59.1
8	75.5
9	39.5

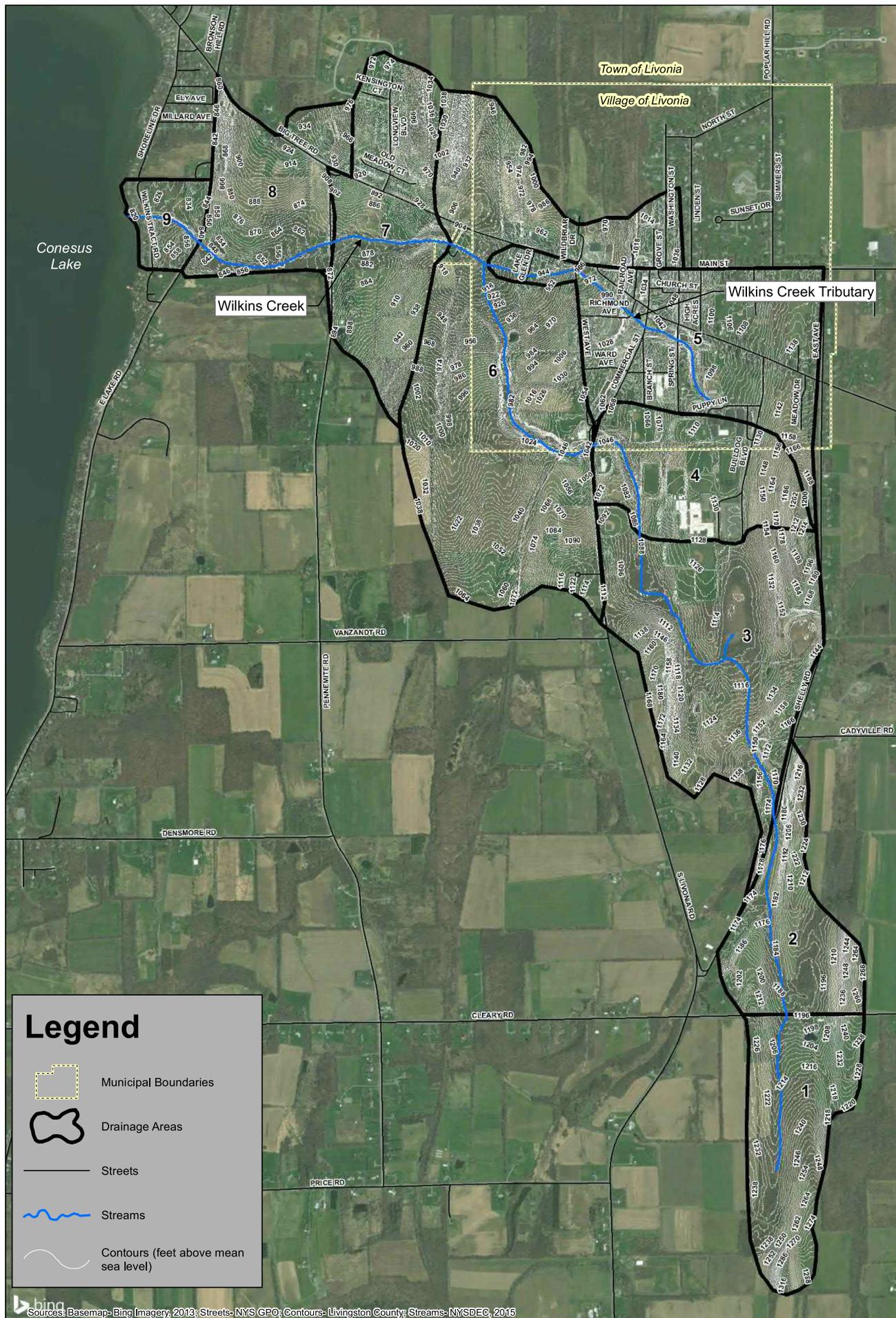
Legend

-  Municipal Boundaries
-  Drainage Areas
-  Streets
-  Streams
-  Contours (feet above mean sea level)
-  Time of Concentration (TOC)

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Contours- Livingston County; Streams- NYSDEC, 2015



1 inch = 1,250 feet



Legend

-  Municipal Boundaries
-  Drainage Areas
-  Streets
-  Streams
-  Contours (feet above mean sea level)

Sources: Basemap-Bing Imagery, 2013; Streets-NYS GPO; Contours-Livingston County; Streams-NYSDEC, 2015



1 inch = 1,250 feet

2.3 Hydrologic and Hydraulic Evaluation

A HydroCAD® model was developed to identify structures and areas at risk of flooding during specific storm events, and provide an existing conditions model that can be modified to incorporate recommended alternatives. Field personnel from Popli Design Group performed survey work on June 14, 2018, to collect field measurements and data to aid in the model development. Field measurements and data collection focused on existing infrastructure and locations that may potentially act as an inhibitor of flow (*i.e.*, culverts under major roadways), causing localized flooding during large storm events. Locations surveyed are shown in **Figure 9 (Wilkins Creek Study Area)**. Survey results are shown in **Appendix I** (located at the end of this report).

The Watershed Study Area was separated into nine (9) distinct drainage areas (Drainage Areas 1 through 9). Refer to Figure 2-1 for the watershed study area. Ponds (represented as triangles) were utilized within the model to represent a culvert that provides storage under a roadway. Reaches (represented as squares) were utilized to represent channelized flow. Subcatchments (represented as green hexagons) were utilized to represent contributing drainage areas. Modeling assumed reaches operate under free discharge conditions based on normal Manning's flow.



Figure 2-1: Modeled Watershed Study Area

The HydroCAD® model predicts areas of localized flooding by estimating peak flow and flow volume as a function of precipitation data, topography, soil type, land cover, and land use. Precipitation data is shown in **Appendix J** (located at the end of this report). Land cover is illustrated in **Figure 4 (Land Cover)**. The HydroCAD® summary report is included in **Appendix K** (located at the end of this report). StreamStats (see **Appendix L** located at the end of this report) was also utilized to compare flows with modeled results (see **Table 2 [Modeled Existing Conditions Peak Flows Summary Table]**). Generally modeled flows show greater variation than flows predicted by StreamStats. Modeled flows are less than flows predicted by StreamStats within the smaller year floods (*i.e.*, 1.5- and 2-year peak floods) and greater within the floods of 25 years and more. Unfortunately, there were no available USGS gaging stations within or connected to, the watershed study area that could be used to further calibrate the model. The model is considered to be a more accurate representation than StreamStats due to utilization

TABLE 2 - MODELED EXISTING CONDITIONS PEAK FLOWS SUMMARY TABLE

Wilkins Creek Peak Flows															
1 Year Peak Flood		1.5 Year Peak Flood		2 Year Peak Flood		10 Year Peak Flood		25 Year Peak Flood		50 Year Peak Flood		100 Year Peak Flood		500 Year Peak Flood	
StreamStats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)	Stream Stats (cfs)	Modeled Results (cfs)
-	31	83	44	105	58	197	193	243	337	277	489	310	691	386	1,405

of surveyed culverts and drainage pathways in lieu of drainage area delineation solely using contours.

Modeled water levels that peak above a reach’s modeled flood elevation presents flood risks to infrastructure such as residential houses. Modeled water levels that peak above modeled flood elevations associated with roadway culverts risk flooding major streets or the railroad. The model generally predicted localized flooding after the 25 year modeled storm downstream of the confluence of Wilkins Creek Tributary and Wilkins Creek. This can be attributed to the larger peak flow within Drainage Area 5 resulting from higher slopes and higher impervious area relative to other drainage areas. Graphic figures representing potential areas where flooding may occur during specific storm events are included in **Figures 10 to 14 (XX-Year Storm Potential Flooding Issues)**.

Drainage Area 1:

Peak flows from Drainage Area 1 are included within **Table 2-1**. Subcatchments provide rainfall and stormwater runoff as a function of area, weighted curve number, and time of concentration. Based on the site reconnaissance, the area upstream of Cleary Road did not contain much channelized flow susceptible to flooding, therefore no stormwater conveyance systems (*i.e.*, reaches) were included in the model. Cleary Road first showed signs of flooding in the HydroCAD® model during the 10-year storm event.

Table 2-1: Drainage Area 1 Peak Flow at Cleary Road Culvert	
Drainage Area 1	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	2
1.5-Year Flood	3
2-Year Flood	5
10-Year Flood	21
25-Year Flood	38
50-Year Flood	57
100-Year Flood	82
500-Year Flood	169

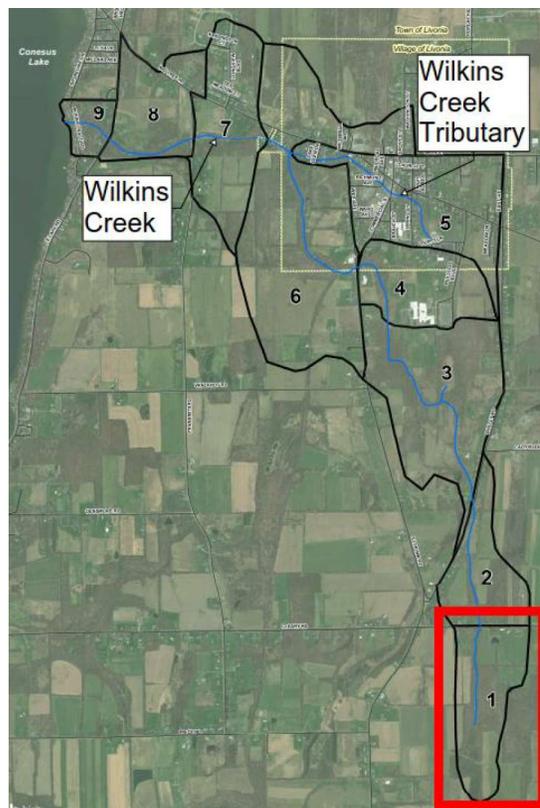
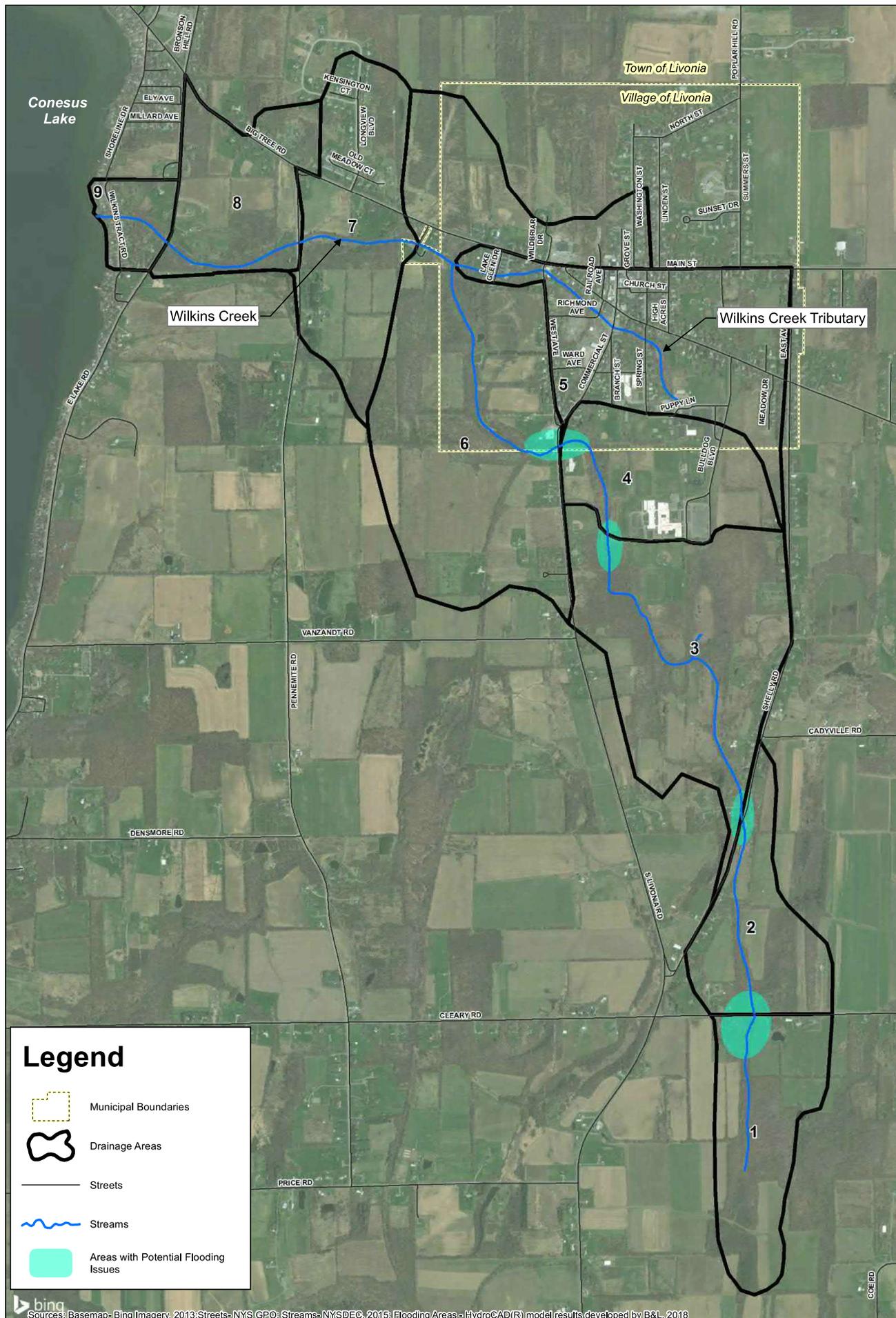


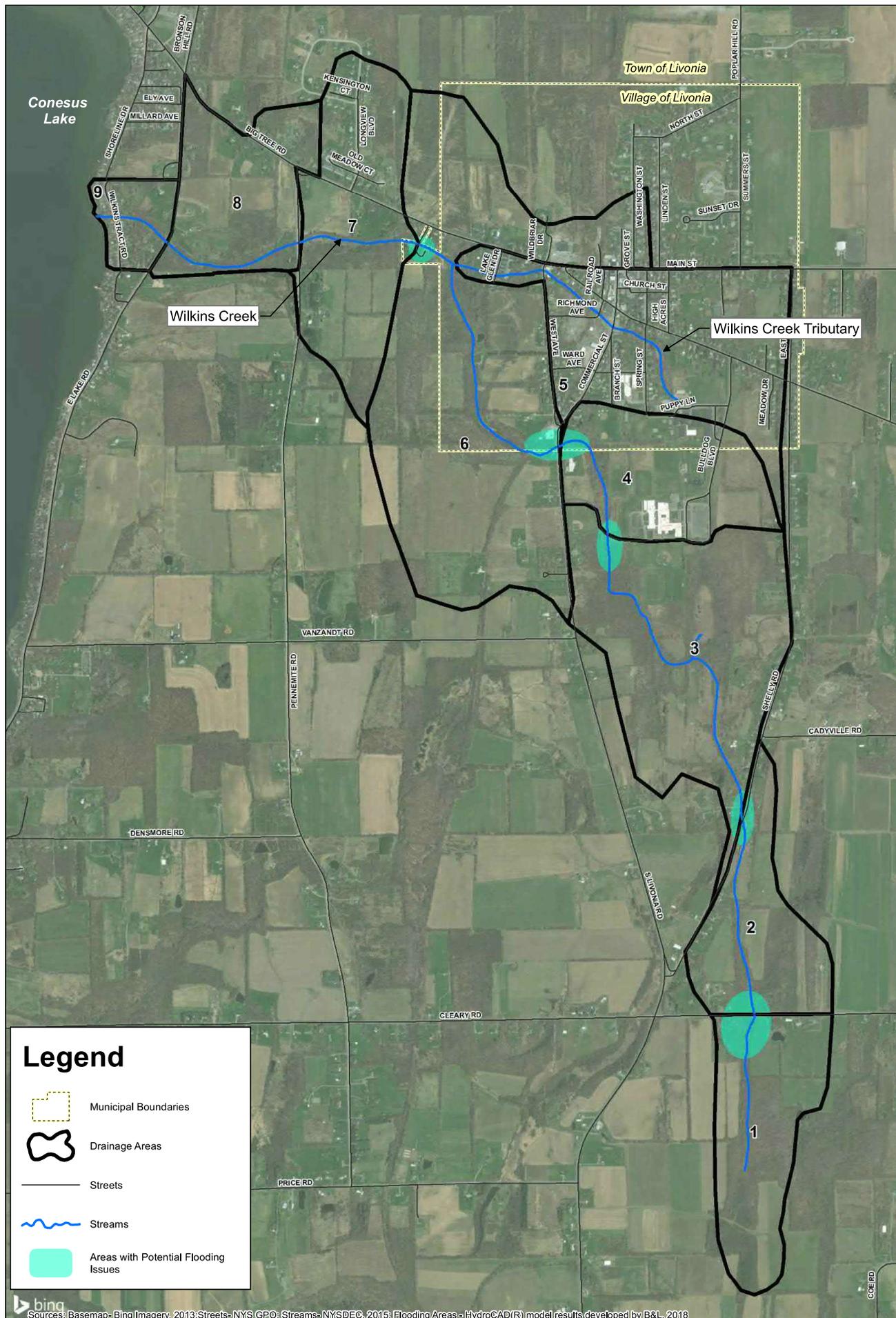
Figure 2-2: Drainage Area 1



Legend

- Municipal Boundaries
- Drainage Areas
- Streets
- Streams
- Areas with Potential Flooding Issues

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Flooding Areas- HydroCAD(R) model results developed by B&L, 2018



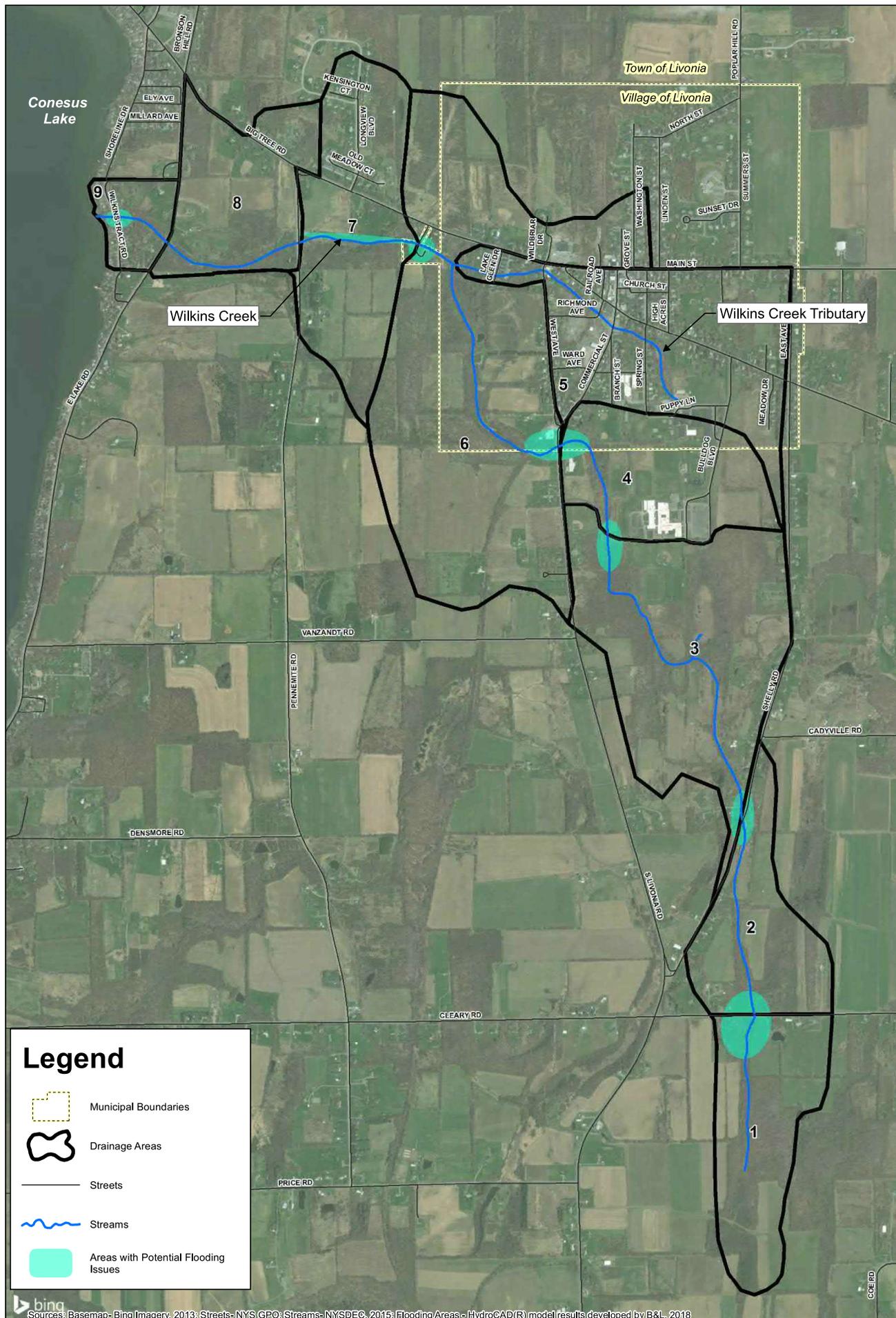
Legend

-  Municipal Boundaries
-  Drainage Areas
-  Streets
-  Streams
-  Areas with Potential Flooding Issues

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Flooding Areas- HydroCAD(R) model results developed by B&L, 2018



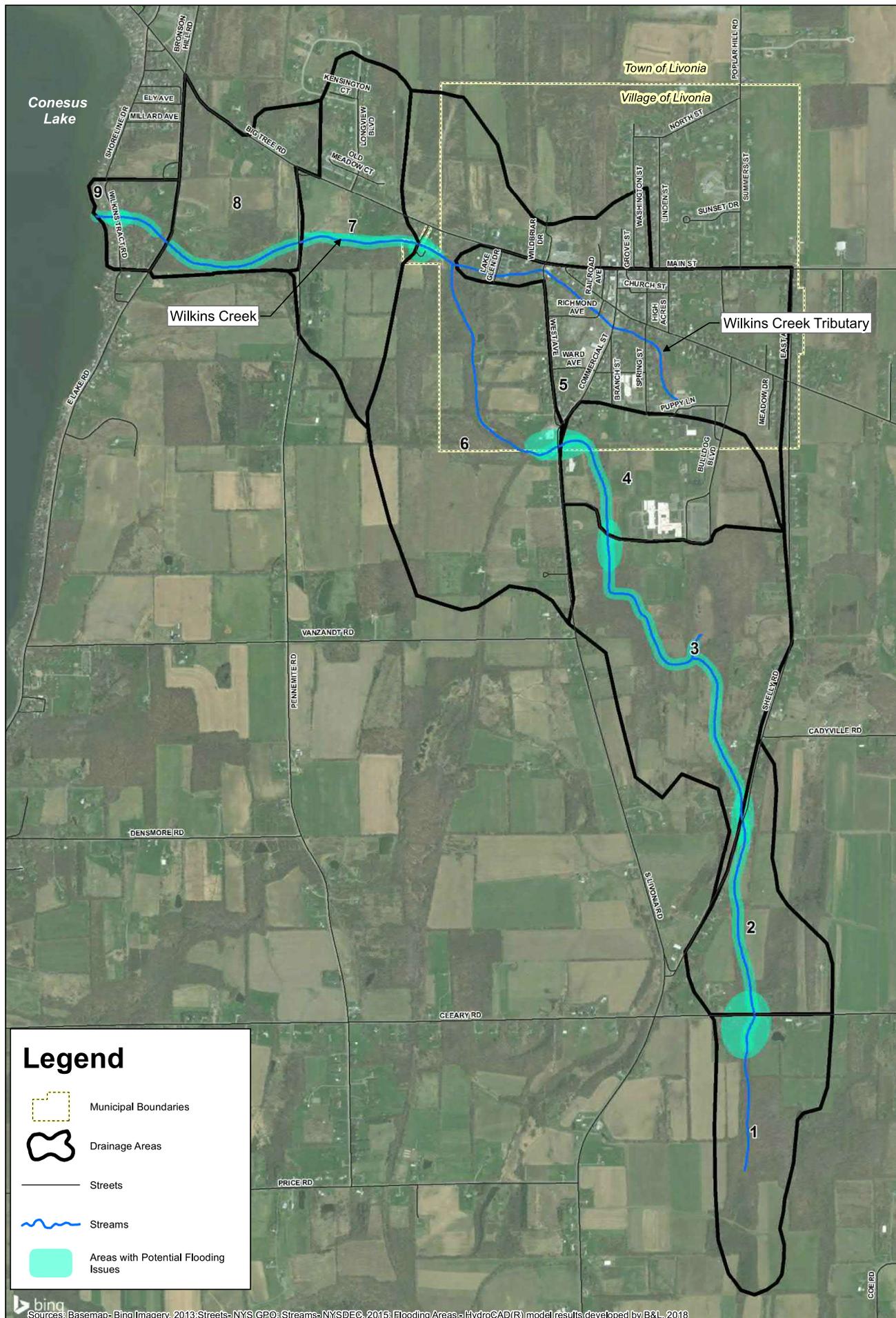
1 inch = 1,250 feet



Legend

- Municipal Boundaries
- Drainage Areas
- Streets
- Streams
- Areas with Potential Flooding Issues

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Flooding Areas- HydroCAD(R) model results developed by B&L, 2018



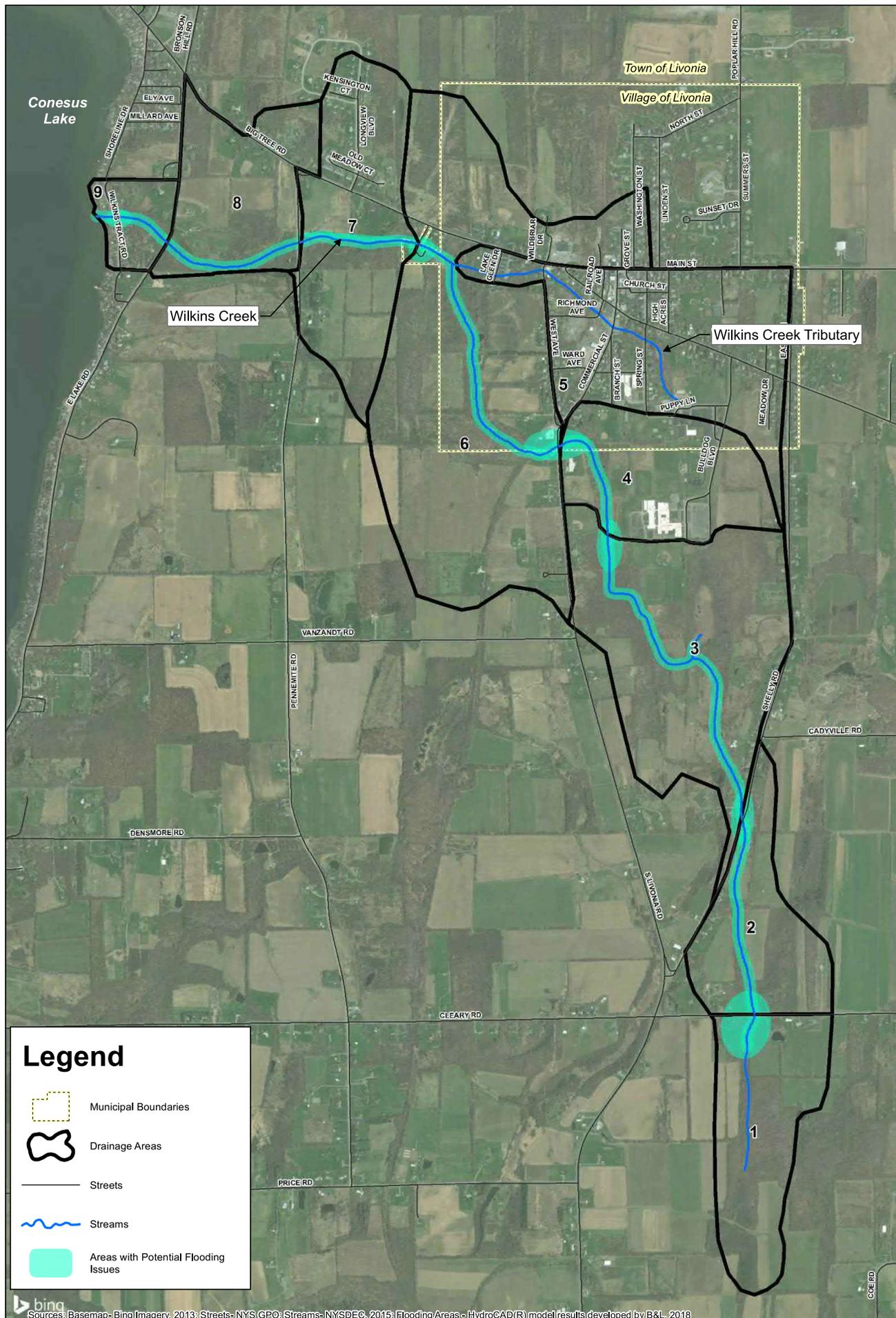
Legend

- Municipal Boundaries
- Drainage Areas
- Streets
- Streams
- Areas with Potential Flooding Issues

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015; Flooding Areas- HydroCAD(R) model results developed by B&L, 2018



1 inch = 1,250 feet



Legend

-  Municipal Boundaries
-  Drainage Areas
-  Streets
-  Streams
-  Areas with Potential Flooding Issues

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYS DEC, 2015; Flooding Areas- HydroCAD(R) model results developed by B&L, 2018



1 inch = 1,250 feet

Drainage Area 2:

Peak flows from Drainage Area 2 are included within **Table 2-2**. The HydroCAD® model predicted flooding during the 10-yr storm event at Shelly Road, and flooding in the reach between Cleary Road and Shelly Road during the 100-yr storm event.

Table 2-2: Drainage Area 2 Peak Flow at Shelly Road Culvert	
Drainage Area 2	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	0.4
1.5-Year Flood	0.7
2-Year Flood	1
10-Year Flood	9
25-Year Flood	19
50-Year Flood	32
100-Year Flood	50
500-Year Flood	115

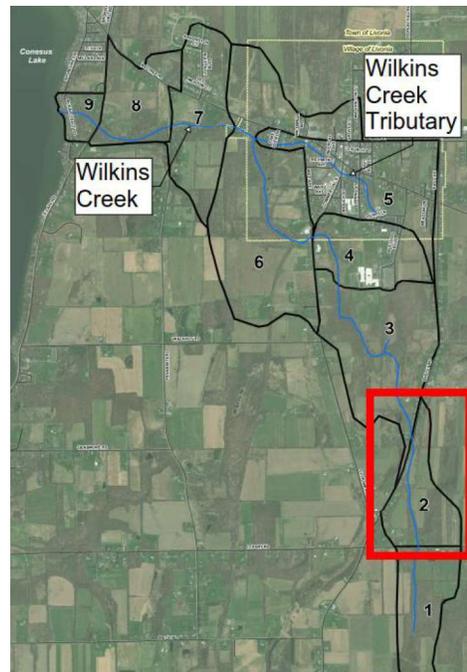


Figure 2-3: Drainage Area 2

Drainage Area 3:

Peak flows from Drainage Area 3 are included within **Table 2-3**. The model predicted flooding during the 10-yr storm event along the western entrance to Livonia High School (Bulldog Blvd.) as the culvert underneath the road exceeded capacity causing backwater flooding conditions. Flooding was also modeled to occur during the 100-yr storm event within the reach between Shelly Road and the entrance to the school.

Table 2-3: Drainage Area 3 Peak Flow at Bulldog Boulevard Culvert	
Drainage Area 3	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	2
1.5-Year Flood	3
2-Year Flood	4
10-Year Flood	19
25-Year Flood	36
50-Year Flood	55
100-Year Flood	80
500-Year Flood	169

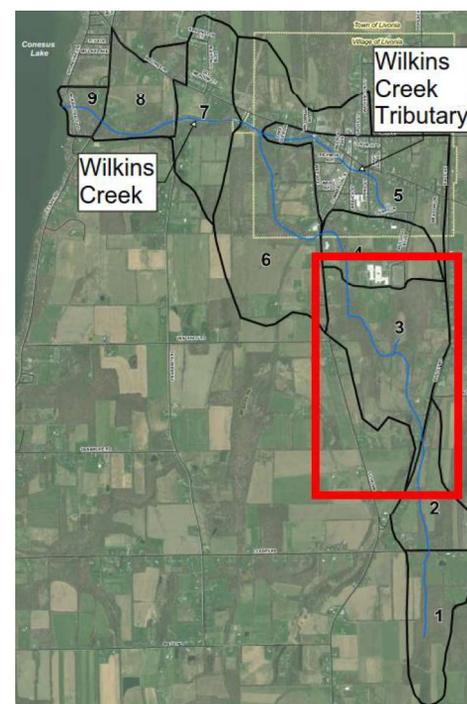


Figure 2-4: Drainage Area 3

Drainage Area 4:

Peak flows from Drainage Area 4 are included within **Table 2-4**. The model predicted flooding during the 10-yr storm event around Commercial Street as the culvert underneath the road exceeded capacity causing backwater flooding conditions. The next flooding event occurred during the 100-yr storm event where the model predicted flooding within the reach between the school entrance and Commercial Street.

Table 2-4: Drainage Area 4 Peak Flow at Commercial Street Culvert	
Drainage Area 4	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	3
1.5-Year Flood	4
2-Year Flood	6
10-Year Flood	24
25-Year Flood	43
50-Year Flood	64
100-Year Flood	92
500-Year Flood	185

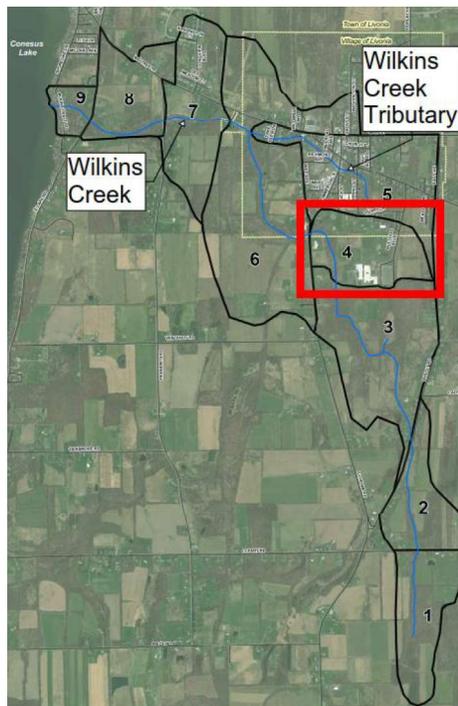


Figure 2-5: Drainage Area 4

Drainage Area 5:

Peak flows from Drainage Area 5 are included within **Table 2-5**. After conversations with Mayor Lathan, it was understood the Village has not experienced flooding, presumed to be attributed to the steep nature of channelized flow towards Drainage Area 6, where flows are conveyed directly to the Village’s closed drainage system.

Table 2-5: Drainage Area 5 Peak Flow at Wilkins Creek Confluence	
Drainage Area 4B	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	8
1.5-Year Flood	11
2-Year Flood	14
10-Year Flood	41
25-Year Flood	69
50-Year Flood	97
100-Year Flood	132
500-Year Flood	251

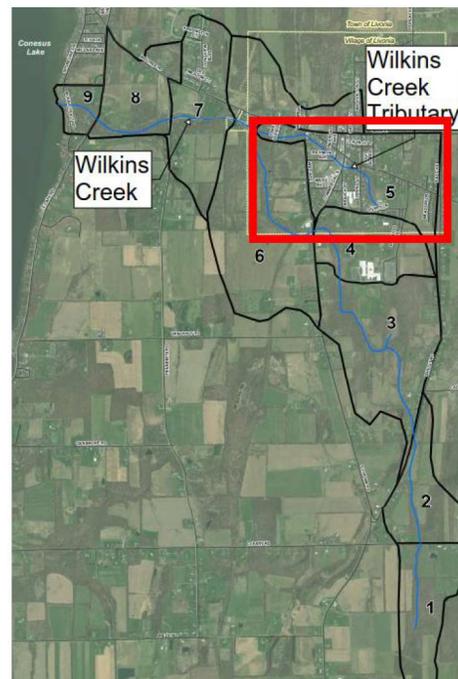


Figure 2-6: Drainage Area 5

Drainage Area 6:

Peak flows from Drainage Area 6 are included within **Table 2-6**. The model predicted flooding during the 25-yr storm event within the Livonia Community Park where the culvert underneath the entrance exceeded capacity, causing backwater flooding conditions. The next flooding event occurred during the 500-yr storm event within the reach between Commercial Street and the Park entrance.

Table 2-6: Drainage Area 6 Peak Flow at Livonia Community Park Culvert	
Drainage Area 5	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	22
1.5-Year Flood	29
2-Year Flood	38
10-Year Flood	113
25-Year Flood	187
50-Year Flood	261
100-Year Flood	354
500-Year Flood	660

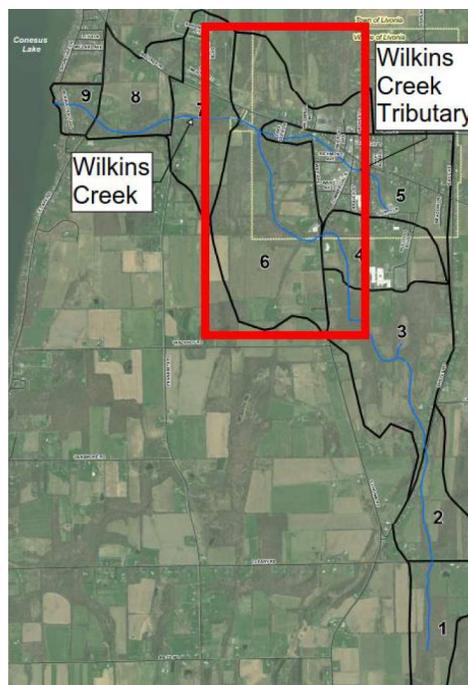


Figure 2-7: Drainage Area 6

Drainage Area 7:

Peak flows from Drainage Area 7 are included within **Table 2-7**. The model predicted flooding during the 50-yr storm event within the reach between the Livonia Community Park and Pennemite Road. The next flooding event occurred during the 100-yr storm event at the dual culverts under Pennemite Road.

Table 2-7: Drainage Area 7 Peak Flow at Pennemite Road Culvert	
Drainage Area 5B	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	6
1.5-Year Flood	10
2-Year Flood	13
10-Year Flood	48
25-Year Flood	84
50-Year Flood	121
100-Year Flood	168
500-Year Flood	327



Figure 2-8: Drainage Area 7

Drainage Area 8:

Peak flows from Drainage Area 8 are included within **Table 2-8**. The model predicted flooding during the 100-yr storm event within the culvert under East Lake Road and the reach between East Lake Road and Pennemite Road.

Table 2-8: Drainage Area 8 Peak Flow at East Lake Road Culvert	
Drainage Area 6	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	3
1.5-Year Flood	4
2-Year Flood	6
10-Year Flood	24
25-Year Flood	44
50-Year Flood	65
100-Year Flood	92
500-Year Flood	186



Figure 2-9: Drainage Area 8

Drainage Area 9:

Peak flows from Drainage Area 9 are included within **Table 2-9**. The model predicted flooding during the 50-yr event at the culvert under Wilkins Tract where flow exceeded capacity. The model also predicted flooding during the 100-yr event within the reach between Wilkins Tract and East Lake Road.

Table 2-9: Drainage Area 9 Peak Flow at Wilkins Tract Culvert	
Drainage Area 6	Modeled Peak Flow at Outlet (cfs)
1-Year Flood	8
1.5-Year Flood	10
2-Year Flood	12
10-Year Flood	26
25-Year Flood	39
50-Year Flood	51
100-Year Flood	66
500-Year Flood	112

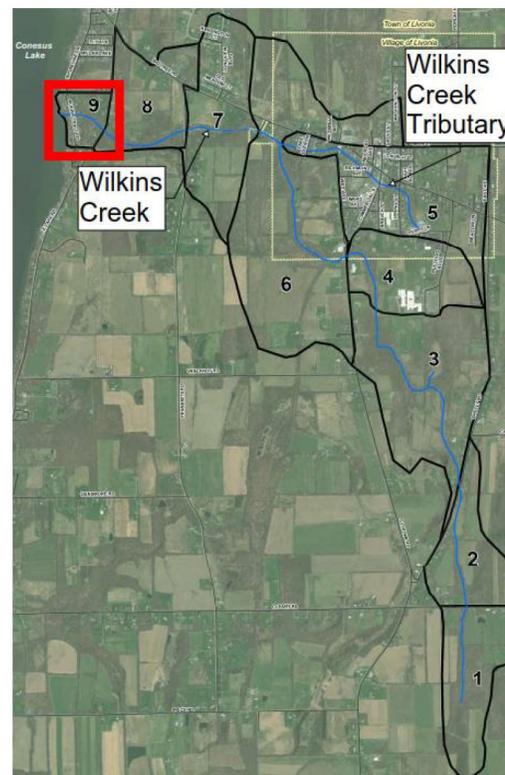


Figure 2-10: Drainage Area 9

Based on existing conditions, there appears to be some limitations within the culverts and adjoining areas from Commercial Street and upstream. Much of the flooding occurs within agricultural and wooded areas, therefore impacts are not as noticeable. However, in areas where land is privately owned and developed, flood impacts are more noticeable.

2.4. Modeled Nutrient and Sediment Loads

A Mapshed model was developed to model pollutant (*i.e.*, sediment, nitrogen, and phosphorus) loading to the Lake. The model is considered a general pollutant loading model that estimates nutrient and sediment loads as a function of precipitation data, land cover, topography, soil type, soil nutrients, groundwater nitrogen, baseflow, and animal farming operations. Total annual sediment load from the watershed was predicted to be approximately 137,640 lbs (69 tons). Total annual nitrogen load from the watershed was predicted to be approximately 10,829.6 lbs. Total annual phosphorus load from the watershed was predicted to be approximately 369.1 lbs. Pollutant loading rates and total loads for each basin are summarized in **Table 3 (Pollutant Loading Results)**. In comparison, a study performed by Dr. Makarewicz and his associates in the 1990s estimated annual loads from Wilkins Creek to be 201.3 lbs of phosphorus, 4,809.8 lbs of nitrogen, and 81,273.4 lbs (40.6 tons) of sediment (Makarewicz and Lewis, 1991). The increase in loads from the 1990s to present is presumed to result from a combination of urbanization and climate change, and summarizes the issues the watershed is experiencing.

Phosphorus loading rates and total annual loads are summarized by individual drainage areas in **Table 2-10**. It is estimated that approximately 0.26 lb/ac of phosphorus on average are emitted from non-point sources within the study area to the lake attributing 369.1 pounds of phosphorus released per year to the lake. Drainage Area 7 had the greatest annual phosphorus loading rate at 0.69 lb/ac (equating to 102.6 lbs per year). Drainage Area 8 had the second greatest annual phosphorus loading rate of 0.33 lb/ac, corresponding to 35.3 lbs per year.

TABLE 3 - POLLUTANT LOADING RESULTS

Wilkins Creek Basin 1 Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.08	1.5	0.21	1.72	0.13	0.03	0.01835	0.02	0	82.98	83.03	2.18	2.2	0	0	0	0	0
Feb	1.54	0.12	1.3	0.29	1.59	0.08	0.02	0.01855	0.02	0	76.35	76.39	2.49	2.49	0	0	0	0	0
Mar	2.82	0.37	1.96	0.47	2.43	0.84	0.18	0.02292	0.02	0	116.87	117.51	3.95	4.23	0	0	0	0	0
Apr	3.2	1.31	2.37	0.07	2.45	2.09	0.13	0.02334	0.02	0	118.41	118.87	1.94	2.14	0	0	0	0	0
May	3.47	2.91	1.61	0.06	1.67	2.45	0.21	0.01768	0.02	0	80.91	81.66	1.37	1.7	0	0	0	0	0
Jun	3.06	3.48	0.78	0.01	0.79	2.13	0.02	0.01111	0.02	0	38.36	38.4	0.55	0.57	0	0	0	0	0
Jul	3.65	3.19	0.29	0.14	0.43	3.01	0.64	0.00702	0	0	21.01	23.55	1.04	2.12	0	0	0	0	0
Aug	3.09	2.9	0.33	0.05	0.38	2.26	0.21	0.00531	0	0	19	19.82	0.57	0.93	0	0	0	0	0
Sep	3.7	2.3	0.22	0.06	0.28	2.09	0.54	0.00484	0	0	14.15	16.29	0.57	1.5	0	0	0	0	0
Oct	2.81	1.23	0.66	0.17	0.82	1.79	0.54	0.01063	0	0	39.75	41.87	1.39	2.31	0	0	0	0	0
Nov	3.04	0.49	1.37	0.24	1.61	3.67	1.25	0.01744	0.02	0	77.43	82.36	2.25	4.39	0	0	0	0	0
Dec	2.21	0.2	1.85	0.19	2.04	3.57	1.16	0.02043	0.02	0	98.59	103.11	2.29	4.25	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	14.8	1.5	1.12	0.22	3.77	4.65	1.63	2.01
Cropland	49.4	2.76	22.76	4.5	89.79	107.78	10.01	17.81
Forest	44.5	1.26	0.21	0.04	2.4	2.58	0.13	0.2
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	0	0	0	0	0	0	0	0
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	0	0	0	0	0	0	0	0
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage				0				0
Stream Bank				0.17747				0
Groundwater					687.84144	687.84144	8.84053	8.84053
Point Source					0	0	0	0
Septic Systems					0	0	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft³/s)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	6.78E+05	7
Feb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+09	1.23E+09	6.27E+05	6.9
Mar	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	9.57E+05	5
Apr	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+09	1.30E+09	9.66E+05	4.8
May	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	6.59E+05	7.2
Jun	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+09	1.30E+09	3.12E+05	14.8
Jul	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	1.70E+05	27.9
Aug	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	1.51E+05	31.5
Sep	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+09	1.30E+09	1.10E+05	41.7
Oct	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	3.25E+05	14.6
Nov	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+09	1.30E+09	6.36E+05	7.2
Dec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+09	1.35E+09	8.05E+05	5.9
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.59E+10	1.59E+10	6.40E+06	14.5
% of Total	0	0	0	0	1			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 2
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain N	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.13	1.44	0.17	1.61	0.15	0.07	0.05851	0.07	0.02	100.82	101.06	1.96	2.01	0	0	0	0	0
Feb	1.54	0.2	1.29	0.23	1.52	0.14	0.07	0.05984	0.07	0.04	91.09	91.56	2.25	2.29	0	0	0	0	0
Mar	2.82	0.59	1.91	0.36	2.28	0.2	0.11	0.07301	0.07	0.04	135.69	136.47	3.46	3.59	0	0	0	0	0
Apr	3.2	1.76	2.18	0.06	2.23	0.37	0.1	0.07325	0.07	0.04	149.54	149.54	1.81	1.87	0	0	0	0	0
May	3.47	3.38	1.31	0.04	1.35	0.44	0.1	0.0513	0.04	0.02	89.79	89.82	1.12	1.23	0	0	0	0	0
Jun	3.06	3.53	0.54	0	0.54	0.39	0.03	0.02941	0.02	0.02	37.04	37.04	0.37	0.37	0	0	0	0	0
Jul	3.65	3.15	0.19	0.1	0.3	0.54	0.15	0.01796	0.02	0	14.53	15.3	0.73	1.04	0	0	0	0	0
Aug	3.09	2.93	0.27	0.03	0.3	0.41	0.06	0.01421	0.02	0	18.65	18.89	0.35	0.44	0	0	0	0	0
Sep	3.7	2.57	0.18	0.03	0.2	0.37	0.12	0.01259	0.02	0	12.43	12.96	0.31	0.55	0	0	0	0	0
Oct	2.81	1.58	0.46	0.13	0.58	0.35	0.14	0.02665	0.02	0.02	32.76	33.49	1.08	1.32	0	0	0	0	0
Nov	3.04	0.68	1.08	0.2	1.28	0.8	0.32	0.04824	0.04	0.02	76.41	77.8	1.92	2.51	0	0	0	0	0
Dec	2.21	0.29	1.66	0.15	1.81	0.84	0.32	0.06184	0.07	0.04	115.74	117.02	2.03	2.6	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	64.2	1.5	4.94	0.97	16.36	20.24	8.58	10.76
Cropland	0	0	0	0	0	0	0	0
Forest	22.2	1.26	0.08	0.01	1.21	1.26	0.07	0.09
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	7.4	2.01	0	0.06	1.08	3.26	0.15	0.35
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	0	0	0	0	0	0	0	0
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								
Tile Drainage								
Stream Bank				0.5269				
Groundwater					831.53857	831.53857	8.62006	8.62006
Point Source					0	0	0	0
Septic Systems					24.58065831	24.58065831	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft³/s)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	6.70E+07	6.73E+08	7.40E+08	5.47E+05	4.8
Feb	0.00E+00	0.00E+00	0.00E+00	8.93E+07	6.14E+08	7.03E+08	5.17E+05	4.8
Mar	0.00E+00	0.00E+00	0.00E+00	1.41E+08	6.73E+08	8.14E+08	7.75E+05	3.7
Apr	0.00E+00	0.00E+00	0.00E+00	2.49E+07	6.52E+08	6.76E+08	7.61E+05	3.1
May	0.00E+00	0.00E+00	0.00E+00	1.65E+07	6.73E+08	6.90E+08	4.58E+05	5.3
Jun	0.00E+00	0.00E+00	0.00E+00	9.69E+05	6.52E+08	6.53E+08	1.86E+05	12.4
Jul	0.00E+00	0.00E+00	0.00E+00	3.74E+07	6.73E+08	7.11E+08	1.00E+05	25.1
Aug	0.00E+00	0.00E+00	0.00E+00	1.42E+07	6.73E+08	6.88E+08	1.00E+05	24.2
Sep	0.00E+00	0.00E+00	0.00E+00	8.49E+06	6.52E+08	6.60E+08	7.00E+04	33.3
Oct	0.00E+00	0.00E+00	0.00E+00	4.71E+07	6.73E+08	7.20E+08	1.99E+05	12.8
Nov	0.00E+00	0.00E+00	0.00E+00	7.42E+07	6.52E+08	7.26E+08	4.36E+05	5.9
Dec	0.00E+00	0.00E+00	0.00E+00	6.06E+07	6.73E+08	7.34E+08	6.17E+05	4.2
Total	0.00E+00	0.00E+00	0.00E+00	5.82E+08	7.93E+09	8.51E+09	4.77E+06	11.6
% of Total	0	0	0	0.068	0.932			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 3
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.11	1.52	0.12	1.65	0.37	0.13	0.12296	0.13	0.07	197.51	198.11	3.88	3.95	0	0	0	0	0
Feb	1.54	0.17	1.35	0.17	1.53	0.35	0.13	0.12447	0.13	0.07	178.42	179.3	4.32	4.41	0	0	0	0	0
Mar	2.82	0.52	2.03	0.26	2.3	0.82	0.31	0.15218	0.15	0.07	267.91	269.71	6.66	7.03	0	0	0	0	0
Apr	3.2	1.61	2.33	0.04	2.37	1.85	0.26	0.15717	0.15	0.07	294.21	294.65	3.88	4.1	0	0	0	0	0
May	3.47	3.21	1.44	0.03	1.46	2.17	0.3	0.11229	0.11	0.04	181.9	182.7	2.45	2.82	0	0	0	0	0
Jun	3.06	3.54	0.64	0	0.64	1.88	0.07	0.06747	0.07	0.02	80.6	80.6	0.93	0.95	0	0	0	0	0
Jul	3.65	3.17	0.24	0.07	0.31	2.68	0.65	0.03964	0.04	0.02	33.93	36.68	1.39	2.54	0	0	0	0	0
Aug	3.09	2.92	0.31	0.02	0.33	2.01	0.19	0.03178	0.02	0.02	40.21	41.01	0.73	1.04	0	0	0	0	0
Sep	3.7	2.47	0.2	0.02	0.22	1.85	0.49	0.0277	0.02	0.02	26.9	28.92	0.62	1.48	0	0	0	0	0
Oct	2.81	1.45	0.56	0.09	0.65	1.74	0.58	0.06133	0.07	0.02	74.6	77.12	2.12	3.11	0	0	0	0	0
Nov	3.04	0.61	1.24	0.15	1.39	3.55	1.31	0.1061	0.11	0.04	162.26	167.66	3.81	6.04	0	0	0	0	0
Dec	2.21	0.26	1.79	0.11	1.89	3.67	1.29	0.13298	0.13	0.07	229.83	235.03	4.08	6.24	0	0	0	0	0
														43.71					

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	106.3		1.5	9.83	1.94	27.05	34.79	12.46
Cropland	22.2		1.5	12.27	2.41	21.89	31.55	2.6
Forest	86.5	0.37	0.83	0.17	1.39	2.05	0.07	0.37
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	9.9	2.01	0	0.08	1.43	4.37	0.2	0.49
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	0	0	0	0	0	0	0	0
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage								0
Stream Bank				1.13648		2.2		0
Groundwater					1684.99107	1684.99107	19.51089	19.51089
Point Source					0	0	0	0
Septic Systems					31.60370355	31.60370355	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft³/s)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	4.97E+07	2.62E+09	2.67E+09	1.34E+06	7
Feb	0.00E+00	0.00E+00	0.00E+00	6.61E+07	2.39E+09	2.45E+09	1.25E+06	7
Mar	0.00E+00	0.00E+00	0.00E+00	1.05E+08	2.62E+09	2.72E+09	1.87E+06	5.1
Apr	0.00E+00	0.00E+00	0.00E+00	1.84E+07	2.53E+09	2.55E+09	1.93E+06	4.7
May	0.00E+00	0.00E+00	0.00E+00	1.20E+07	2.62E+09	2.63E+09	1.20E+06	7.8
Jun	0.00E+00	0.00E+00	0.00E+00	7.18E+05	2.53E+09	2.53E+09	5.25E+05	17
Jul	0.00E+00	0.00E+00	0.00E+00	2.78E+07	2.62E+09	2.65E+09	2.58E+05	36.2
Aug	0.00E+00	0.00E+00	0.00E+00	1.06E+07	2.62E+09	2.63E+09	2.70E+05	34.4
Sep	0.00E+00	0.00E+00	0.00E+00	6.24E+06	2.53E+09	2.54E+09	1.84E+05	48.7
Oct	0.00E+00	0.00E+00	0.00E+00	3.48E+07	2.62E+09	2.65E+09	5.34E+05	17.5
Nov	0.00E+00	0.00E+00	0.00E+00	5.50E+07	2.53E+09	2.59E+09	1.13E+06	8.1
Dec	0.00E+00	0.00E+00	0.00E+00	4.50E+07	2.62E+09	2.66E+09	1.54E+06	6.1
Total	0.00E+00	0.00E+00	0.00E+00	4.31E+08	3.09E+10	3.13E+10	1.20E+07	16.6
% of Total	0	0	0	0.014	0.986			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 4
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.12	1.43	0.2	1.63	0.25	0.1	0.08252	0.09	0.04	104.1	107.01	1.74	2.18	0	0	0	0	0
Feb	1.54	0.19	1.27	0.26	1.53	0.25	0.1	0.08417	0.09	0.04	94.8	99.45	1.96	2.49	0	0	0	0	0
Mar	2.82	0.55	1.9	0.41	2.3	0.62	0.24	0.10242	0.11	0.04	141.8	148.04	2.84	3.73	0	0	0	0	0
Apr	3.2	1.67	2.2	0.08	2.28	1.48	0.22	0.10364	0.11	0.04	151.5	151.5	1.74	2.09	0	0	0	0	0
May	3.47	3.28	1.35	0.06	1.41	1.73	0.23	0.07487	0.07	0.04	93.41	93.41	1.06	1.39	0	0	0	0	0
Jun	3.06	3.54	0.59	0.01	0.6	1.5	0.06	0.044	0.04	0.02	40.26	40.26	0.42	0.49	0	0	0	0	0
Jul	3.65	3.15	0.21	0.11	0.32	2.13	0.53	0.02659	0.02	0.02	17.68	21.8	0.6	1.5	0	0	0	0	0
Aug	3.09	2.92	0.27	0.05	0.32	1.6	0.22	0.02083	0.02	0	19.75	21.61	0.33	0.73	0	0	0	0	0
Sep	3.7	2.5	0.19	0.04	0.22	0.6	0.2	0.01949	0.02	0	14.26	16.95	0.33	0.75	0	0	0	0	0
Oct	2.81	1.5	0.49	0.15	0.65	1.7	0.62	0.04225	0.04	0.02	38.51	44.56	1.01	2.18	0	0	0	0	0
Nov	3.04	0.64	1.13	0.22	1.36	2.69	1.11	0.07056	0.07	0.04	84.44	91.89	1.74	3.64	0	0	0	0	0
Dec	2.21	0.27	1.68	0.19	1.86	3.05	1.15	0.08801	0.09	0.04	120.97	127.91	1.9	3.86	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	56.8	0.51	3.45	0.68	4.89	7.61	2.34	3.68
Cropland	19.8	1.5	14.08	2.78	19.44	30.56	2.4	7.89
Forest	7.4	0.37	0.06	0.01	0.11	0.15	0	0.02
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	14.8	2.01	0	0.12	2.16	6.55	0.29	0.73
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	9.9	9.96	0	0.42	10.71	32.47	1.37	3.4
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage				0				0
Stream Bank				0.75949				0
Groundwater					841.37118	841.37118	9.28145	9.28145
Point Source						0		0
Septic Systems					45.64979401	45.64979401	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft ³)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	1.66E+09	2.24E+08	1.89E+09	6.43E+05	10.4
Feb	0.00E+00	0.00E+00	0.00E+00	2.02E+09	2.05E+08	2.22E+09	6.03E+05	13
Mar	0.00E+00	0.00E+00	0.00E+00	3.26E+09	2.24E+08	3.48E+09	9.10E+05	13.5
Apr	0.00E+00	0.00E+00	0.00E+00	7.97E+08	2.17E+08	1.01E+09	9.00E+05	4
May	0.00E+00	0.00E+00	0.00E+00	5.15E+08	2.24E+08	7.40E+08	5.56E+05	4.7
Jun	0.00E+00	0.00E+00	0.00E+00	8.71E+07	2.17E+08	3.04E+08	2.37E+05	4.5
Jul	0.00E+00	0.00E+00	0.00E+00	8.85E+08	2.24E+08	1.11E+09	1.28E+05	30.7
Aug	0.00E+00	0.00E+00	0.00E+00	5.34E+08	2.24E+08	7.58E+08	1.27E+05	21.2
Sep	0.00E+00	0.00E+00	0.00E+00	3.49E+08	2.17E+08	5.66E+08	8.69E+04	23
Oct	0.00E+00	0.00E+00	0.00E+00	1.22E+09	2.24E+08	1.45E+09	2.55E+05	20.1
Nov	0.00E+00	0.00E+00	0.00E+00	1.69E+09	2.17E+08	1.90E+09	5.36E+05	12.5
Dec	0.00E+00	0.00E+00	0.00E+00	1.61E+09	2.24E+08	1.84E+09	7.34E+05	8.8
Total	0.00E+00	0.00E+00	0.00E+00	1.46E+10	2.64E+09	1.73E+10	5.71E+06	13.9
% of Total	0	0	0	0.847	0.153			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 5
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.13	1.33	0.29	1.62	0.29	0.87	0.68123	0.68	0.24	147.56	157.59	2.25	3.44	0	0	0	0	0
Feb	1.54	0.21	1.16	0.37	1.54	0.3	0.89	0.70397	0.71	0.24	133.86	149.58	2.47	3.92	0	0	0	0	0
Mar	2.82	0.61	1.73	0.58	2.31	0.36	1.09	0.8405	0.84	0.29	198.48	218.98	3.51	5.49	0	0	0	0	0
Apr	3.2	1.74	2.03	0.13	2.16	0.36	1.07	0.82857	0.84	0.29	209.17	209.17	2.23	2.87	0	0	0	0	0
May	3.47	3.28	1.28	0.09	1.37	0.25	0.82	0.62362	0.62	0.22	129.74	129.74	1.37	1.74	0	0	0	0	0
Jun	3.06	3.52	0.56	0.01	0.57	0.1	0.46	0.3603	0.35	0.13	55.87	55.87	0.57	0.73	0	0	0	0	0
Jul	3.65	3.14	0.19	0.16	0.35	0.06	0.36	0.22218	0.22	0.07	24.82	32.85	0.73	1.34	0	0	0	0	0
Aug	3.09	2.91	0.24	0.08	0.33	0.08	0.25	0.17055	0.18	0.07	27.43	31.48	0.49	0.86	0	0	0	0	0
Sep	3.7	2.44	0.18	0.06	0.24	0.08	0.26	0.17877	0.18	0.07	21.56	27.87	0.53	1.01	0	0	0	0	0
Oct	2.81	1.54	0.48	0.23	0.7	0.2	0.6	0.38775	0.4	0.13	57.23	70	1.37	2.38	0	0	0	0	0
Nov	3.04	0.68	1.06	0.31	1.37	0.31	0.93	0.58688	0.6	0.2	119.25	132.96	2.18	3.55	0	0	0	0	0
Dec	2.21	0.3	1.56	0.27	1.83	0.36	1.09	0.71239	0.71	0.24	172.67	184.95	2.6	4.1	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	61.8	0.51	2.66	0.52	5.31	7.41	1.92	2.65
Cropland	0	0	0	0	0	0	0	0
Forest	17.3	0.37	0.09	0.02	0.29	0.35	0.02	0.04
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	89	2.01	0	0.69	12.96	39.31	1.72	4.32
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	27.2	9.96	0	1.15	29.48	89.31	3.75	9.35
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage				0				0
Stream Bank				6.29639		6.61		2.2
Groundwater					980.61498	980.61498	12.89703	12.89703
Point Source					0	0	0	0
Septic Systems					277.4102867	277.4102867	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft^3)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	1.55E+10	5.24E+08	1.60E+10	1.15E+06	49.2
Feb	0.00E+00	0.00E+00	0.00E+00	1.95E+10	4.77E+08	2.00E+10	1.09E+06	64.7
Mar	0.00E+00	0.00E+00	0.00E+00	3.08E+10	5.24E+08	3.13E+10	1.64E+06	67.4
Apr	0.00E+00	0.00E+00	0.00E+00	7.09E+09	5.07E+08	7.60E+09	1.53E+06	17.5
May	0.00E+00	0.00E+00	0.00E+00	5.34E+09	5.24E+08	5.86E+09	9.72E+05	21.3
Jun	0.00E+00	0.00E+00	0.00E+00	7.19E+08	5.07E+08	1.23E+09	4.04E+05	10.7
Jul	0.00E+00	0.00E+00	0.00E+00	8.22E+09	5.24E+08	8.74E+09	2.47E+05	124.8
Aug	0.00E+00	0.00E+00	0.00E+00	4.54E+09	5.24E+08	5.06E+09	2.30E+05	77.7
Sep	0.00E+00	0.00E+00	0.00E+00	3.21E+09	5.07E+08	3.71E+09	1.66E+05	78.9
Oct	0.00E+00	0.00E+00	0.00E+00	1.21E+10	5.24E+08	1.26E+10	5.01E+05	88.9
Nov	0.00E+00	0.00E+00	0.00E+00	1.61E+10	5.07E+08	1.66E+10	9.70E+05	60.3
Dec	0.00E+00	0.00E+00	0.00E+00	1.46E+10	5.24E+08	1.52E+10	1.30E+06	41.2
Total	0.00E+00	0.00E+00	0.00E+00	1.38E+11	6.17E+09	1.44E+11	1.02E+07	58.6
% of Total	0	0	0	0.957	0.043			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 6
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.16	0.1	1.57	0.11	1.68	0.76	0.25	0.22694	0.22	0.11	356.88	359.66	5.58	6.02	0	0	0	0	0
Feb	1.54	0.16	1.39	0.15	1.54	0.72	0.25	0.22809	0.22	0.11	321.48	325.95	6.02	6.55	0	0	0	0	0
Mar	2.82	0.47	2.08	0.23	2.31	2	0.69	0.2783	0.29	0.13	484.4	491.72	8.99	10.36	0	0	0	0	0
Apr	3.2	1.51	2.41	0.04	2.44	4.84	0.58	0.29226	0.29	0.13	530.19	530.19	6.31	6.97	0	0	0	0	0
May	3.47	3.06	1.52	0.02	1.54	5.67	0.68	0.21261	0.22	0.11	334.86	335.61	3.99	4.87	0	0	0	0	0
Jun	3.06	3.44	0.7	0	0.7	4.93	0.14	0.13016	0.13	0.07	152.6	152.6	1.68	1.72	0	0	0	0	0
Jul	3.65	3.15	0.28	0.06	0.35	6.98	1.64	0.07608	0.07	0.04	69.56	77.58	1.81	4.67	0	0	0	0	0
Aug	3.09	2.89	0.36	0.02	0.37	5.22	0.5	0.06333	0.07	0.02	80.25	82.87	1.12	1.98	0	0	0	0	0
Sep	3.7	2.4	0.25	0.02	0.27	1.94	0.78	0.05715	0.07	0.02	57.43	61.73	0.95	2.34	0	0	0	0	0
Oct	2.81	1.37	0.69	0.09	0.78	5.2	1.66	0.1291	0.13	0.07	161.36	170.17	3.17	6.11	0	0	0	0	0
Nov	3.04	0.57	1.36	0.13	1.5	8.93	3.27	0.20642	0.2	0.09	313.39	328.4	5.62	11.24	0	0	0	0	0
Dec	2.21	0.24	1.87	0.09	1.96	9.88	3.34	0.2485	0.24	0.11	420.31	435.17	6.13	11.86	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	116.1	0.51	8.23	1.61	9.99	16.45	4.63	7.72
Cropland	86.5	1.5	47.98	9.39	85.1	122.69	10.21	28.15
Forest	133.4	0.37	0.84	0.17	2.16	2.82	0.11	0.42
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	34.6	2.01	0	0.28	5.05	15.3	0.66	1.68
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	4.9	9.96	0	0.21	5.36	16.23	0.68	1.7
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage				0				0
Stream Bank				2.1495				2.2
Groundwater					3067.15553	3067.15553	35.05346	35.05346
Point Source					0	0	0	0
Septic Systems					108.8572011	108.8572011	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft^3)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	7.11E+08	4.04E+09	4.75E+09	2.29E+06	7.3
Feb	0.00E+00	0.00E+00	0.00E+00	8.99E+08	3.68E+09	4.58E+09	2.09E+06	7.7
Mar	0.00E+00	0.00E+00	0.00E+00	1.44E+09	4.04E+09	5.48E+09	3.15E+06	6.1
Apr	0.00E+00	0.00E+00	0.00E+00	3.05E+08	3.91E+09	4.21E+09	3.33E+06	4.5
May	0.00E+00	0.00E+00	0.00E+00	1.95E+08	4.04E+09	4.23E+09	2.10E+06	7.1
Jun	0.00E+00	0.00E+00	0.00E+00	2.45E+07	3.91E+09	3.93E+09	9.58E+05	14.5
Jul	0.00E+00	0.00E+00	0.00E+00	3.88E+08	4.04E+09	4.43E+09	4.72E+05	33.1
Aug	0.00E+00	0.00E+00	0.00E+00	1.93E+08	4.04E+09	4.23E+09	5.11E+05	29.3
Sep	0.00E+00	0.00E+00	0.00E+00	3.88E+08	4.04E+09	4.43E+09	4.72E+05	33.1
Oct	0.00E+00	0.00E+00	0.00E+00	1.93E+08	4.04E+09	4.23E+09	5.11E+05	29.3
Nov	0.00E+00	0.00E+00	0.00E+00	1.20E+08	3.91E+09	4.03E+09	3.63E+05	39.2
Dec	0.00E+00	0.00E+00	0.00E+00	5.07E+08	4.04E+09	4.55E+09	1.06E+06	15.2
Jan	0.00E+00	0.00E+00	0.00E+00	7.51E+08	3.91E+09	4.66E+09	2.04E+06	8.1
Feb	0.00E+00	0.00E+00	0.00E+00	6.69E+08	4.04E+09	4.71E+09	2.67E+06	6.2

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 7
Online Mapshed GWLF-E Output

Month	Precip (in)	Evapo	Trar	Gr Wat	Flo Runoff (in)	Strm Flow	Erosion (toSediment (Stream Ser	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain I	Tile Drain I	Tile Drain I	Animal N	Animal P	
Jan	2.39	0.13	0.93	0.24	1.17	0.31	0.08	0.05303	0.04	0.04	25.49	38.67	2.73	5	0	0	0	12.52	2.05
Feb	2.21	0.17	1.29	0.46	1.76	0.51	0.13	0.07512	0.04	0.04	35.65	49.58	5.75	8.22	0	0	0	12.7	2.07
Mar	2.48	0.62	1.98	0.44	2.41	0.84	0.19	0.08674	0.07	0.07	42.13	49.6	5.75	7.61	0	0	0	6.04	1.32
Apr	2.74	1.68	1.88	0.1	1.99	1.58	0.2	0.08107	0.04	0.04	26.19	32.47	2.03	3.64	0	0	0	5.64	1.17
May	2.93	3.87	1.14	0.03	1.17	8.34	0.22	0.05548	0.04	0.04	14.29	23.02	0.86	3.04	0	0	0	8.62	1.72
Jun	3.28	5.44	0.47	0.06	0.53	11.45	0.9	0.03429	0.02	0.02	8.44	18.56	0.95	4.83	0	0	0	8.09	1.61
Jul	2.89	3.65	0.18	0.03	0.2	9.58	0.76	0.01884	0.02	0.02	3.73	12.76	0.42	3.84	0	0	0	7.41	1.46
Aug	3.78	3.56	0.06	0.06	0.11	13.04	1.19	0.01287	0	0	3.9	15.5	0.68	5.53	0	0	0	8.64	1.74
Sep	3.23	2.63	0.02	0.07	0.09	12.51	2.05	0.00985	0	0	4.17	22.27	0.9	9.02	0	0	0	13.38	2.8
Oct	2.76	1.63	0.04	0.07	0.11	7.51	2.47	0.0103	0	0	4.21	18.3	0.84	8.86	0	0	0	7.78	1.59
Nov	3.38	0.75	0.11	0.15	0.26	8.6	3.14	0.0166	0	0.02	8.49	27.49	1.7	11.86	0	0	0	10.78	1.92
Dec	3.2	0.26	0.65	0.33	0.97	29.29	9.66	0.0446	0.02	0.02	22.38	58.36	3.95	31.15	0	0	0	11.46	1.96

Source	Area (acre)	Runoff	Erosion (toSediment (Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)		
Hay/Past	64.2	1.69	24.33	4.8	23.5	35.71	10.91	23.68
Cropland	35.8	3.15	79.09	15.6	72.86	112.59	11.38	52.91
Forest	33.1	1.41	0.13	0.02	2.01	2.07	0.11	0.18
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Lanc	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Are	0	0	0	0	0	0	0	0
Unpaved_f	0	0	0	0	0	0	0	0
Ld_Mixed	14.6	2.25	0	0.07	1.17	3.51	0.15	0.37
Md_Mixed	0	7.73	0	0	0	0	0	0
Hd_Mixed	0	11.43	0	0	0	0	0	0
Ld_Resider	0	2.25	0	0	0	0	0	0
Md_Reside	0	4.18	0	0	0	0	0	0
Hd_Reside	0	6	0	0	0	0	0	0
Farm Anim						113.07		21.41
Tile Drain						0		0
Stream Bar			0.49935			0		0
Groundwat				99.51655	99.51655	4.03445		4.03445
Point Sourc						0		0
Septic Syst						0		0

Organisms/Month

Month	Farm Anim	WWTP	Septic Syst	Urban Are	Wildlife	Total	Stream Flo	Mean Concentration (cfu/100ml)
Jan	8.69E+11	0	0	2.01E+08	1E+09	8.7E+11	627000	4902.7
Feb	8.81E+11	0	0	3.72E+08	9.13E+08	8.82E+11	943000	3304.3
Mar	1.38E+12	0	0	3.54E+08	1E+09	1.38E+12	1290000	3758
Apr	1.14E+12	0	0	95900000	9.7E+08	1.14E+12	1070000	3767.4
May	1.62E+12	0	0	17200000	1E+09	1.62E+12	626000	9160.2
Jun	1.49E+12	0	0	38000000	9.7E+08	1.49E+12	284000	18545.8
Jul	1.33E+12	0	0	6590000	1E+09	1.33E+12	110000	42731.3
Aug	1.63E+12	0	0	37300000	1E+09	1.63E+12	60400	95222.3
Sep	2.78E+12	0	0	31300000	9.7E+08	2.78E+12	51200	191811.4
Oct	1.51E+12	0	0	56000000	1E+09	1.51E+12	60600	87987.1
Nov	1.23E+12	0	0	1.27E+08	9.7E+08	1.24E+12	138000	31672.9
Dec	1.05E+12	0	0	2.68E+08	1E+09	1.05E+12	522000	7130.3
Total	1.69E+13	0	0	1.6E+09	1.18E+10	1.69E+13	5780000	41666.1
% of Total	0.999	0	0	0	0.001			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 8
Mapshed GWLF-E Output

Month	Precip (in)	Evapo Trans (in)	Gr Wat Flow (in)	Runoff (in)	Strm Flow (in)	Erosion (tons)	Sediment (tons)	Stream Sed	Stream N	Stream P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain P	Tile Drain P	Tile Drain Sed	Animal N	Animal P
Jan	2.51	0.11	1.8	0.27	2.07	0.32	0.12	0.09948	0.11	0.07	134.48	135.65	2.91	3.11	0	0	0	0	0
Feb	1.67	0.17	1.47	0.26	1.74	0.25	0.1	0.09471	0.09	0.04	111.64	113.14	2.65	2.84	0	0	0	0	0
Mar	2.74	0.52	2.05	0.41	2.46	0.78	0.26	0.11148	0.11	0.07	156.31	158.82	3.92	4.48	0	0	0	0	0
Apr	2.99	1.53	2.13	0.02	2.15	2.11	0.11	0.1048	0.11	0.07	150.33	150.33	1.65	1.72	0	0	0	0	0
May	3.47	2.47	1.38	0.03	1.41	2.76	0.23	0.0769	0.07	0.04	98.17	98.59	1.19	1.57	0	0	0	0	0
Jun	3.12	2.75	0.76	0.02	0.77	2.46	0.11	0.05303	0.04	0.02	53.86	53.9	0.64	0.79	0	0	0	0	0
Jul	3.39	2.7	0.59	0.09	0.67	3.08	0.6	0.0448	0.04	0.02	43.89	46.19	0.95	2.12	0	0	0	0	0
Aug	3.42	2.8	0.57	0.01	0.58	3.05	0.15	0.04217	0.04	0.02	40.54	41.03	0.49	0.77	0	0	0	0	0
Sep	3.66	2.16	0.81	0.04	0.85	2.2	0.63	0.05566	0.07	0.02	58.84	61.11	0.86	2.07	0	0	0	0	0
Oct	2.73	1.36	1.29	0.09	1.39	1.22	0.5	0.07753	0.09	0.04	94.05	95.81	1.52	2.45	0	0	0	0	0
Nov	3.09	0.6	1.52	0.21	1.73	4.86	1.8	0.08875	0.09	0.04	113.34	121.14	2.36	6.04	0	0	0	0	0
Dec	2.43	0.24	1.91	0.21	2.11	6.36	2.3	0.10045	0.11	0.07	140.68	150.33	2.62	7.36	0	0	0	0	0

Source	Area	Runoff	Erosion (tons)	Sediment (tons)	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	42	1.43	2.56	0.51	10.19	12.21	5.36	6.48
Cropland	17.3	2.64	26.7	5.27	30.03	51.1	4.08	15.85
Forest	27.2	1.19	0.19	0.03	1.39	1.54	0.07	0.15
Wetland	0	0	0	0	0	0	0	0
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Land	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Areas	0	0	0	0	0	0	0	0
Unpaved_Road	0	0	0	0	0	0	0	0
Ld_Mixed	19.8	1.99	0	0.15	3	9.06	0.4	0.99
Md_Mixed	0	0	0	0	0	0	0	0
Hd_Mixed	0	0	0	0	0	0	0	0
Ld_Residential	0	0	0	0	0	0	0	0
Md_Residential	0	0	0	0	0	0	0	0
Hd_Residential	0	0	0	0	0	0	0	0
Farm Animals								0
Tile Drainage				0				0
Stream Bank				0.95019				0
Groundwater					1088.92796	1088.92796	11.83881	11.83881
Point Source					0	0	0	0
Septic Systems					63.20740709	63.20740709	0	0

Organisms/Month	Farm Animals	WWTP	Septic Systems	Urban Areas	Wildlife	Total	Stream Flow (ft^3)	Mean Concentration (cfu/100ml)
Jan	0.00E+00	0.00E+00	0.00E+00	5.86E+08	8.23E+08	1.41E+09	7.99E+05	6.2
Feb	0.00E+00	0.00E+00	0.00E+00	5.76E+08	7.50E+08	1.33E+09	6.70E+05	7
Mar	0.00E+00	0.00E+00	0.00E+00	9.00E+08	8.23E+08	1.72E+09	9.49E+05	6.4
Apr	0.00E+00	0.00E+00	0.00E+00	5.93E+07	7.96E+08	8.56E+08	8.28E+05	3.6
May	0.00E+00	0.00E+00	0.00E+00	8.36E+07	8.23E+08	9.06E+08	5.44E+05	5.9
Jun	0.00E+00	0.00E+00	0.00E+00	3.27E+07	7.96E+08	8.29E+08	2.98E+05	9.8
Jul	0.00E+00	0.00E+00	0.00E+00	1.88E+08	8.23E+08	1.01E+09	2.60E+05	13.7
Aug	0.00E+00	0.00E+00	0.00E+00	2.88E+07	8.23E+08	8.52E+08	2.23E+05	13.5
Sep	0.00E+00	0.00E+00	0.00E+00	7.10E+07	7.96E+08	8.67E+08	3.30E+05	9.3
Oct	0.00E+00	0.00E+00	0.00E+00	1.87E+08	8.23E+08	1.01E+09	5.35E+05	6.7
Nov	0.00E+00	0.00E+00	0.00E+00	4.55E+08	7.96E+08	1.25E+09	6.67E+05	6.6
Dec	0.00E+00	0.00E+00	0.00E+00	4.65E+08	8.23E+08	1.29E+09	8.15E+05	5.6
Total	0.00E+00	0.00E+00	0.00E+00	3.63E+09	9.70E+09	1.33E+10	6.92E+06	7.9
% of Total	0	0	0	0.273	0.727			

TABLE 3 - POLLUTANT LOADING RESULTS (Continued)

Wilkins Creek Basin 9
Online Mapshed GWLF-E Output

Month	Precip (in)	Evapo	Trar	Gr	Wat	Flo	Runoff (in)	Strm	Flow	Erosion (to	Sediment (Stream	Se	Stream	N	Stream	P	Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)	Tile Drain	I	Tile Drain	I	Tile Drain	I	Animal N	Animal P
Jan	2.39	0.14	0.6	0.29	0.89	0.1	0.04	0.04457	0.02	0.02	2.8	5.03	0.24	0.64	0	0	0	1.76	0.29										
Feb	2.21	0.19	0.98	0.54	1.52	0.17	0.08	0.06908	0.04	0.04	3.59	6.24	0.46	0.93	0	0	0	1.79	0.29										
Mar	2.48	0.68	1.7	0.52	2.22	0.19	0.09	0.08384	0.04	0.07	5.14	6.92	0.49	0.88	0	0	0	0.84	0.18										
Apr	2.74	1.84	1.7	0.15	1.85	0.14	0.09	0.08212	0.04	0.04	4.21	5.2	0.22	0.49	0	0	0	0.79	0.15										
May	2.93	3.82	1.04	0.03	1.07	0.3	0.07	0.05368	0.04	0.04	2.36	3.22	0.09	0.35	0	0	0	1.21	0.24										
Jun	3.28	5.52	0.45	0.07	0.52	0.41	0.08	0.03386	0.02	0.02	1.17	2.23	0.09	0.37	0	0	0	1.12	0.22										
Jul	2.89	4.69	0.18	0.02	0.2	0.34	0.04	0.0191	0.02	0.02	0.49	1.37	0.02	0.26	0	0	0	1.04	0.2										
Aug	3.78	3.52	0.06	0.07	0.13	0.46	0.07	0.01399	0	0	0.4	1.74	0.07	0.4	0	0	0	1.21	0.24										
Sep	3.23	2.5	0.02	0.07	0.09	0.44	0.09	0.0106	0	0	0.29	2.07	0.07	0.57	0	0	0	1.87	0.4										
Oct	2.76	1.61	0.04	0.09	0.13	0.26	0.12	0.01232	0	0	0.49	2.05	0.09	0.53	0	0	0	1.08	0.22										
Nov	3.38	0.76	0.06	0.19	0.25	0.39	0.18	0.01799	0.02	0.02	0.84	3.11	0.15	0.77	0	0	0	1.52	0.26										
Dec	3.2	0.27	0.35	0.39	0.74	1.17	0.49	0.03882	0.02	0.02	2.01	5.27	0.33	1.63	0	0	0	1.61	0.26										

Source	Area (acre)	Runoff	Erosion (to	Sediment (Dis N (lbs)	Tot N (lbs)	Dis P (lbs)	Tot P (lbs)
Hay/Past	8.9	1.69	4.35	0.86	3.26	5.45	1.5	3.79
Cropland	0	0	0	0	0	0	0	0
Forest	3.7	2.63	0.02	0	0.42	0.42	0.02	0.02
Wetland	1.2	5.05	0	0	0.26	0.26	0.02	0.02
Disturbed	0	0	0	0	0	0	0	0
Turfgrass	0	0	0	0	0	0	0	0
Open_Lanc	0	0	0	0	0	0	0	0
Bare_Rock	0	0	0	0	0	0	0	0
Sandy_Are	0	0	0	0	0	0	0	0
Unpaved_f	0	0	0	0	0	0	0	0
Ld_Mixed	12.6	2.25	0	0.06	1.04	3.15	0.13	0.35
Md_Mixed	0.7	7.73	0	0.02	0.26	0.77	0.02	0.09
Hd_Mixed	0	11.43	0	0	0	0	0	0
Ld_Reside	0	2.25	0	0	0	0	0	0
Md_Reside	0	4.18	0	0	0	0	0	0
Hd_Reside	0	6	0	0	0	0	0	0
Farm Anim						15.85		2.96
Tile Drain						0		0
Stream Bar				0.4795		0		0
Groundwat					15.03551	15.03551	0.61729	0.61729
Point Sourc					0	0	0	0
Septic Syst					3.552386	3.552386	0	0

Organisms/Month

Month	Farm Anim	WWTP	Septic Syst	Urban Are	Wildlife	Total	Stream Flo	Mean Concentration (cfu/100ml)
Jan	1.24E+11	0	0	1.04E+09	1.12E+08	1.25E+11	87900	5020.9
Feb	1.25E+11	0	0	1.9E+09	1.02E+08	1.27E+11	150000	3003.3
Mar	1.96E+11	0	0	1.83E+09	1.12E+08	1.98E+11	219000	3186.6
Apr	1.62E+11	0	0	5.63E+08	1.09E+08	1.62E+11	182000	3149.7
May	2.31E+11	0	0	98000000	1.12E+08	2.32E+11	106000	7726.9
Jun	2.13E+11	0	0	2E+08	1.09E+08	2.13E+11	50900	14770.9
Jul	1.89E+11	0	0	43800000	1.12E+08	1.89E+11	20000	33350.6
Aug	2.32E+11	0	0	2.1E+08	1.12E+08	2.32E+11	12600	65317.1
Sep	3.96E+11	0	0	1.88E+08	1.09E+08	3.97E+11	9410	148889.3
Oct	2.15E+11	0	0	3.39E+08	1.12E+08	2.16E+11	12500	60844.6
Nov	1.76E+11	0	0	6.99E+08	1.09E+08	1.77E+11	24500	25470.7
Dec	1.5E+11	0	0	1.39E+09	1.12E+08	1.51E+11	73500	7274.5
Total	2.41E+12	0	0	8.51E+09	1.32E+09	2.42E+12	948000	31500.4
% of Total	0.996	0	0	0.004	0.001			

Table 2-10. Phosphorus Loading Summary				
Drainage Area	Area (ac)	P Loading Rates (lb/ac)	Total P Loading (lbs)	Percent of Total P Loading (%)
1	115	0.25	28.8	7.8%
2	98	0.20	19.8	5.4%
3	229	0.19	43.7	11.8%
4	115	0.22	25.0	6.8%
5	196	0.16	31.4	8.5%
6	386	0.19	74.7	20.2%
7	148	0.69	102.6	27.8%
8	107	0.33	35.3	9.6%
9	30	0.26	7.82	2.1%
Total	1,424 ac	0.26 lb/ac	369.1 lbs	100%

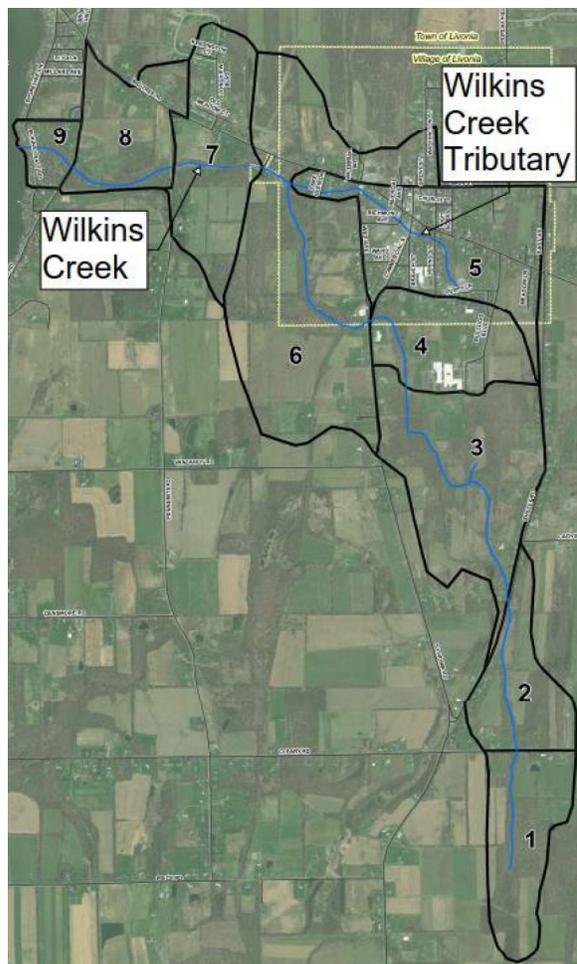


Figure 2-11: Drainage Areas

Total annual nitrogen load from the study area was predicted to be 10,829.6 lbs. Nitrogen loading rates and total annual loads for each basin are summarized in **Table 2-11**. It is estimated that the entire study area (*i.e.*, 9 drainage areas) releases nitrogen on average at an annual rate of 7.6 lb/ac, attributing to 10,829.6 lbs of nitrogen released per year from non-point sources to the lake.

Table 2-11. Nitrogen Loading Summary				
Drainage Area	Area (ac)	N Loading Rates (lb/ac)	Total N Loading (lbs)	Percent of Total N Loading (%)
1	115	7.0	802.9	7.4%
2	98	9.0	881.0	8.1%
3	229	7.8	1,791.5	16.5%
4	115	8.4	964.4	8.9%
5	196	7.1	1,401.0	12.9%
6	386	8.7	3,351.7	30.9%
7	148	2.5	366.6	3.4%
8	107	11.5	1,226.0	11.3%
9	30	1.5	44.5	0.4%
Total	1,424 ac	7.6 lb/ac	10,829.6 lbs	100%

Sediment loading rates and total sediment loads for each basin are summarized in **Table 2-12**. It is estimated that sediment is eroded at a rate of approximately 96.7 lb/ac on average within the entire study area, with annual sediment loads of approximately 137,640 lbs (69 tons) from non-point sources that ultimately deposit in the lake. This equates to approximately 5 dump truck loads of sediment to the Lake each year (based on 10 cubic yards per truck). Drainage Areas 7 and 8 have the greatest sediment loading rates. It should be noted that the Mapshed model is a generalized model and does not include localized streambank erosion encountered during the field reconnaissance. Therefore, it is reasonable to assume larger sediment loads are going to the Lake, especially in areas of high bank erosion (e.g., Drainage Area 7).



Figure 2-12¹: 69 tons equates to approximately 5 dump trucks of sediment

Table 2-12. Sediment Loading Summary				
Drainage Area	Area (ac)	Sediment Loading Rates (lb/ac)	Total Sediment Loading (lbs)	Percent of Total Sediment Loading (%)
1	115	85.7	9,860	7.2
2	98	32.4	3,180	2.3
3	229	49.9	11,420	8.3
4	115	83.1	9,560	6.9
5	196	88.7	17,380	12.6
6	386	71.4	27,560	20.0
7	148	283.6	41,980	30.5
8	107	129.2	13,820	10.0
9	30	96.0	2,880	2.1
Total	1,424 ac	96.7 lb/ac	137,640 lbs (69 tons)	100%

¹ Images acquired from clipart.larysadodz.com.

2.5 Evaluation of Conservation and Enhancement Opportunities

Existing natural areas may be better served to provide water quality or flood reduction benefits in lieu of development. The current zoning within the Town and Village (see **Appendix M** located at the end of this report) would generally have a negative impact on water quality and flood reduction if fully built-out as there would be an increase in impervious area. Typically, an increase in impervious area will result in higher peak flows downstream. Although preventing any build-out is unreasonable and does not adhere to the Town and Village's vision, conserving or enhancing select parcels that can maximize water quality and flood reduction benefits (*e.g.*, green infrastructure) will allow build-out while recognizing the importance for the Lake's health.

The following factors were reviewed to identify conservation and enhancement priority areas:

- Area
- Existing Land Use
- Ownership
- Zoning
- Soil Erodibility; and
- Hydrologic Soil Group

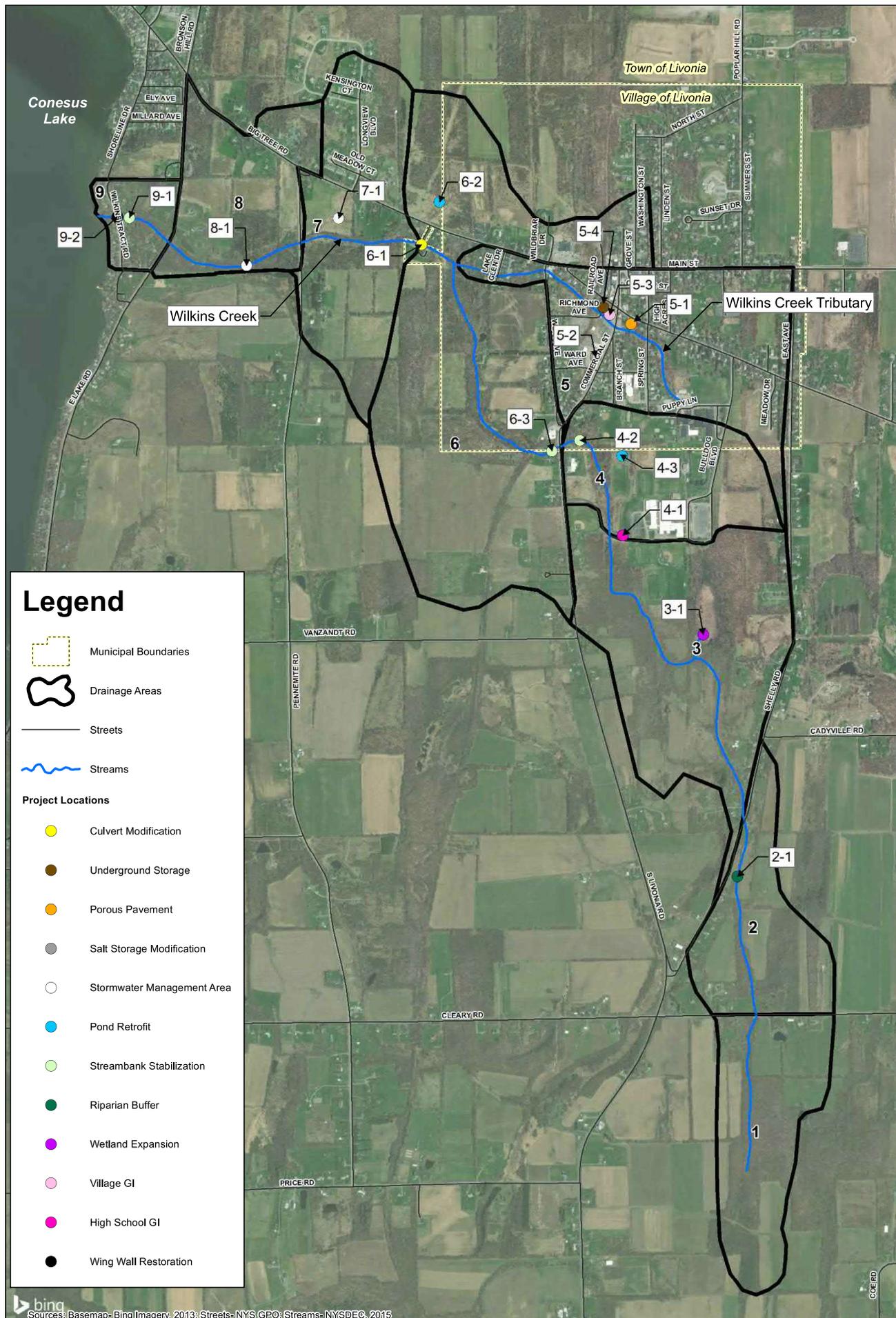
Larger areas were identified as more favorable for enhancement and conservation opportunities than smaller areas with similar characteristics. The larger areas can treat a larger volume of water quality and quantity from stormwater runoff when compared to smaller areas. The existing land use compared to the Town and Village's zoning was also reviewed. Areas that have higher attenuation (*e.g.*, wooded areas) that are zoned to be a more impervious area (*e.g.*, highway commercial) were identified as a favorable conservation or enhancement opportunity. Additionally, areas that are owned by the Town or Village were identified as the easiest to implement a conservation or enhancement opportunity.

The soil erodibility, or K factor, represents both the susceptibility of soil to erosion and the rate of runoff, with values used to predict the average annual rate of soil loss. Lower values represent soils with low erodibility, indicating a smaller presence of erosion than soils with higher values. Values typically range from 0.02 to 0.69 (USDA, 2017). Areas containing soils with higher K factors may be best suited for enhancement to limit existing soil erosion; whereas, areas containing soils with lower K factors are best suited for conservation.

The hydrologic soil group (HSG) represents the runoff potential for each soil. Soils assigned under HSG A have the highest infiltration rates, while those assigned to HSG D have the lowest rates. Soils assigned to dual hydrologic groups (*i.e.*, A/D, B/D, or C/D) represent varying levels of infiltration depending on saturation levels. For drained areas, the soil is

assigned to the first letter. For undrained areas, the soil is assigned to the second letter (USDA, 2017). Areas containing soils with higher infiltration rates (*e.g.*, HSG A) may be best suited for conservation; whereas, areas containing soils with lower infiltration rates (*e.g.*, HSG D) may be best suited for future development.

To maximize water quality and flood reduction benefits, the property with Tax Map ID 84.-1-4.922 (south of Livonia High School off Shelly Road) was identified to give the highest benefit that could serve for attenuation or infiltration areas. This area is identified as Project 3-1 (see **Figure 15 [Project Locations]**) and is currently a wetland that is zoned for a neighborhood residential district. This area provides beneficial attenuation that in addition to conservation, it is recommended to expand the wetland for increased attenuation and infiltration (further discussed in Section 3.1). Additional smaller areas that may be enhanced include impervious surfaces within the Village. This area is identified as Projects 5-1 and 5-3 (see **Figure 15 [Project Locations]**).



Legend

- Municipal Boundaries
- Drainage Areas
- Streets
- Streams
- Project Locations**
- Culvert Modification
- Underground Storage
- Porous Pavement
- Salt Storage Modification
- Stormwater Management Area
- Pond Retrofit
- Streambank Stabilization
- Riparian Buffer
- Wetland Expansion
- Village GI
- High School GI
- Wing Wall Restoration

Sources: Basemap- Bing Imagery, 2013; Streets- NYS GPO; Streams- NYSDEC, 2015



1 inch = 1,250 feet

3.0 Alternatives Analysis

Based on data collected, potential locations for new stormwater management practices or retrofit opportunities were identified. The potential locations were based on need to improve localized flooding, address water quality loads, and to provide upgradient detention to relieve the demand on the lower watershed drainage infrastructure. The locations were vetted based on land use considerations, public/private ownership, construction feasibility, and cost. Locations were evaluated for a range of stormwater management practices including retrofit opportunities, green infrastructure (infiltration opportunities), retention practices (constructed ponds or wetlands) and water quality treatment practices. A retrofit opportunity matrix was developed to evaluate potential stormwater mitigation alternatives based on information obtained from prior studies and field data collection activities. Recommended projects are included within this Study for the Town and Village to utilize when seeking future funding for implementation. Each recommended alternative includes a cost estimate and an evaluation of stormwater improvement in regards to flood reduction and/or water quality improvement. The potential alternatives include:

- Streambank restoration – this practice focuses on streambank manipulation to restore it to a more stable, healthy condition. Erosion is greatly reduced along the streambanks reducing total sediment loads downstream.
- Pond retrofits – this practice focuses on providing localized storage to a drainage area to allow either detention and sedimentation or retention and infiltration, reducing total nutrient and sediment loads and peak flows downstream.
- GI opportunities at the High School – this practice focuses on stormwater management while providing educational and wildlife benefits. Green infrastructure focuses on treating stormwater at the source primarily through methods that promote localized infiltration or reuse. Generally, peak flows are reduced while providing nutrient treatment.
- GI opportunities within the Village - this practice focuses on stormwater management within urbanized areas. Stormwater is reduced and treated at its source, reducing peak flows and roadway runoff contaminants, in lieu of being conveyed via conventional piped drainage.
- Reduction in impervious areas – this practice focuses on replacing existing or proposed impervious areas with permeable areas that capture and infiltrate stormwater runoff. As a result, peak flow and nutrient and sediment loads are reduced.

- Wetland creation/expansion – this practice focuses on utilizing existing or suitable areas to create suitable vegetated areas typically influenced by groundwater that provide extended detention storage to treat significant water quality and reduce peak flows.
- Riparian buffer restoration – this practice focuses on restoring the naturally-vegetated areas which serve as the transition zone between terrestrial (land) and aquatic (water) habitats. If sufficiently structured, protected, and maintained, riparian buffers serve to mitigate the volume and intensity of stormwater runoff entering the adjacent waterbody, and can act to mitigate the discharge of pollutants to the waterway often associated with stormwater runoff.
- Stormwater Management Area – this practice focuses on stormwater management such as retention and infiltration. Generally, peak flows are reduced downstream.
- Culvert Modification – this practice focuses on reducing potential for scour eddies that would otherwise cause localized erosion and stream instability.
- Salt Storage Modification – this practice focuses on reducing or eliminating the potential of stored road salt to be washed into the storm drainage network that flows to the Lake.
- Wing Wall Restoration – this practice focuses on restoring a culvert wing wall to reduce potential of property loss and bank failure.

The projects were ranked based on criteria associated with stormwater benefits (quantity and quality), constructability, cost and co-benefits. The rankings were based on the following criteria with total available points for each criterion in parentheses (see **Appendix N** located at the end of this report for the detailed ranking matrix).

- Stormwater Benefits (total 44 out of 100 points)
 - Water Quantity Flood Reduction (10 points)
 - Total Suspended Solids (TSS) reduction (12 points)
 - Phosphorus reduction (12 points)
 - Nitrogen reduction (5 points)
 - Other contaminant reduction (5 points)
- Constructability (total 20 out of 100 points)
 - Ownership: public or private and interest level (10 points)
 - Known constraints (5 points)
 - Permitting (5 points)

- Cost (total 20 out of 100 points)
 - Construction Cost (5 points)
 - Maintenance Cost (5 points)
 - Fundability (10 points)
- Co-Benefits (total 10 out of 100 points)
 - Energy and air quality impacts (2 points)
 - Habitat and biodiversity (2 points)
 - Community and aesthetic benefits (2 points)
 - Human health benefits (2 points)
 - Educational Opportunities/Visibility (2 points)
- Other (total 6 out of 100 points)
 - Public Access (2 points)
 - Partner Involvement (2 points)
 - Innovation (2 points)

Projects were prioritized according to the above criteria to normalize and assign a rank. Project locations are provided on **Figure 15 (Project Locations)**.

3.1 Recommended Improvement Projects

The following projects are ranked in priority based on the criteria detailed in Section 3.0. It should be noted that the inclusion of a potential project in this report does not represent an endorsement by the property owner(s), nor any obligation to allow or participate in a future project. Potential projects will not be implemented on private properties without landowner approval.

Project No. 4-1: Livonia High School Green Infrastructure (GI) incorporates multiple GI practices strategically located to treat higher concentrated flows. One GI practice includes expansion of an existing rain garden (see Photo 8 in **Appendix F** located at the end of this report) to manage and treat stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. Currently, the existing rain garden is not strategically located as it is above a culvert that discharges stormwater runoff from upper parking lots where it is unable to filter runoff.

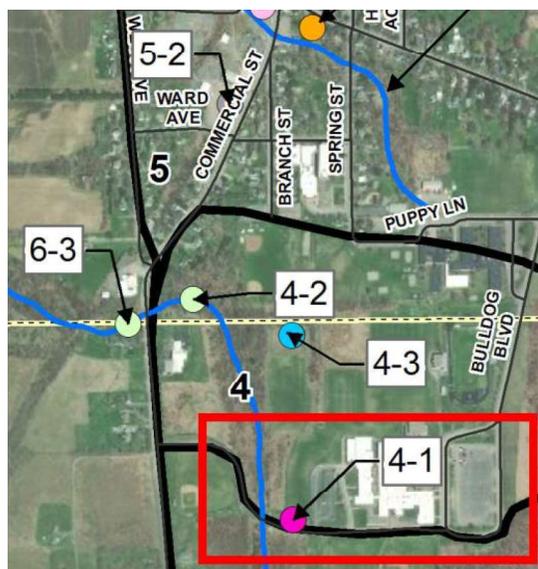


Figure 3-1: Project 4-1 Location

There is a downgradient drainage swale with check dams that discharge to Wilkins Creek (see Photo 7 in **Appendix F**). It is proposed that the drainage swale be converted to a vegetated open swale to provide infiltration prior to discharge to Wilkins Creek. The swale retrofit could transform an existing drainage swale into a shallow gradient swale that reduces water velocity, allows infiltration, promotes bio-filtration and biodiversity, and provides a habitat for songbirds and pollinators. Swale retrofit incorporates an enhanced vegetated filter strip and wetland pockets to store/convey runoff, remove pollutants, and provide valuable habitat.

Another opportunity for a GI practice at the School includes a vegetated open swale along an existing depression that drains the northern athletic fields prior to discharging to Wilkins Creek (see Photo 10 in **Appendix F**). The vegetated swale can increase time of concentration, reduce peak discharge, and provide infiltration. Incorporation of GI practices also serve as an educational aspect for students. In addition to the aforementioned GI practices, there are opportunities for other practices including rain barrels, porous pavement, or rooftop disconnect (see Photo 9 in **Appendix F**). To quantify the water quality benefits, the Spreadsheet Tool for Estimating Pollutant Load (STEPL) program developed by the EPA was used. The program anticipated the approximate nutrient and sediment load reductions below:

- Rain Garden (assumed 800 square feet)
 - Total Phosphorus: 2.9 lb/yr reduction
 - Total Nitrogen: 20.8 lb/yr reduction
 - Sediment: 1,000 lbs/yr reduction
- Swale Retrofit downgradient of Rain Garden (assumed 300 linear feet)
 - Total Phosphorus: 2.1 lb/yr reduction
 - Total Nitrogen: 10.9 lb/yr reduction
 - Sediment: 1,000 lbs/yr reduction
- Vegetated Swale along northern athletic fields (assumed 400 linear feet)
 - Total Phosphorus: 0.7 lb/yr reduction
 - Total Nitrogen: 2.6 lb/yr reduction
 - Sediment: 600 lbs/yr reduction

A key component to the above projects is not only the water quantity/quality benefit, but the educational opportunity they would provide. Each practice can be equipped with educational signage to promote the use of green infrastructure. Additionally, long-term monitoring of the systems including field data collection can be incorporated into science and technology curriculums.

Project No. 4-3: Livonia High School Pond Retrofit transforms an unused field on school grounds adjacent to Myers Field (see Photo 20 in **Appendix F**) into an opportunity to provide additional stormwater storage and reduce peak flows downstream. Currently, three 12-inch culvert drain into Wilkins Creek that are believed to be coming from the school parking lot. An opportunity exists to disconnect and reroute drainage from the parking lot and fields to the pond. A pond could be constructed between Wilkins Creek and the parking lot to increase stormwater storage capacity, reduce peak flows downstream, and increase aquatic and riparian vegetation. An outflow control device could be installed to allow more aquatic and riparian vegetation to thrive enhancing pollutant removal and reducing peak flows, further reducing downstream erosion. Water quality benefits are summarized below:

- Pond Retrofit (assumed 34,800 square feet)
 - Total Phosphorus: 12.5 lb/yr reduction
 - Total Nitrogen: 34.6 lb/yr reduction
 - Sediment: 9,000 lb/yr reduction



Figure 3-2: Project 4-3 Location

Project No. 9-1: Streambank Stabilization within 6143 Wilkins Tract, 6073 Wilkins Tract, 3890 East Lake Road, and 3900 East Lake Road incorporates improved floodplain connectivity, riparian vegetation, and stabilized streambanks to protect residential properties from erosion along Wilkins Creek. As a result, peak flows and sediment loads can decrease, improving water quality. The existing Creek widened by eroding adjacent banks (see Photos 2 and 3 in **Appendix F**) due to the absence of an adequate floodplain to absorb excess flows and reduce water velocities, can be transformed into a stabilized, riparian vegetated, Creek. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) program developed by the EPA estimated the approximate nutrient and sediment load reductions below:

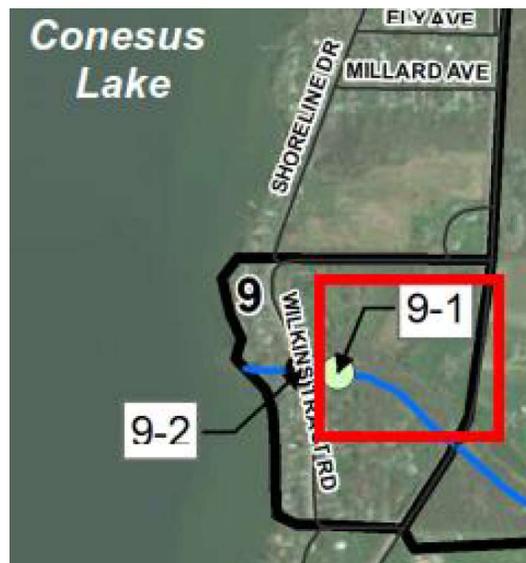


Figure 3-3: Project 9-1 Location

- Streambank Stabilization (assumed 700 linear feet mitigated)
 - Total Phosphorus: 59.7 lb/yr reduction
 - Total Nitrogen: 135.7 lb/yr reduction
 - Sediment: 45.2 ton/yr reduction

Project No. 6-2: Pond retrofit within 6241 Big Tree Road and adjacent lot with Tax Map ID 74.8-1-1 on Big Tree Road transforms an overgrown field into an opportunity to provide additional stormwater storage and reduce peak flows downstream. Currently, an existing drainage path contributes flow to Wilkins Creek north of Big Tree Street (see Photo 21 in **Appendix F**). A pond could be constructed adjacent to the drainage path to increase stormwater storage capacity, reduce peak flows downstream, and increase aquatic and riparian vegetation. An outflow control device could be installed to allow more aquatic and riparian vegetation to thrive enhancing pollutant removal and reducing peak flows, further reducing downstream erosion. Water quantity and quality benefits are summarized below:

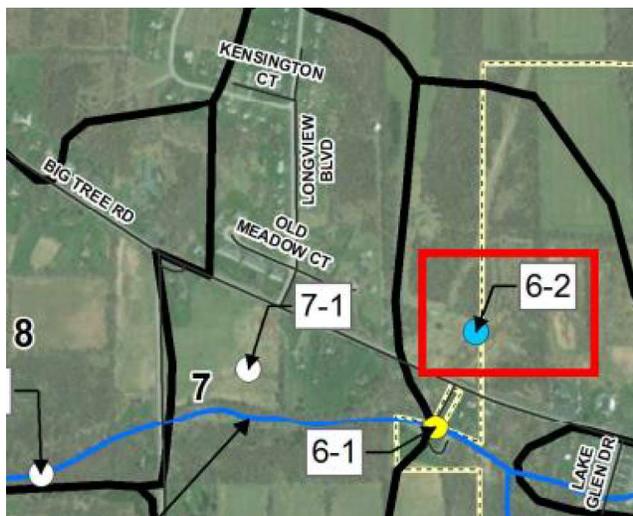


Figure 3-4: Project 6-2 Location

- Pond Retrofit (assumed 80,000 square feet)
 - Total Phosphorus: 14.8 lb/yr reduction
 - Total Nitrogen: 50.2 lb/yr reduction
 - Sediment: 9,600 lb/yr reduction
 - Provides an additional 780,000 of storage capacity

HydroCAD® was used to approximate and compare existing peak flows and proposed after incorporation of the pond. Results are shown in Table 3-1.

Table 3-1. Peak Flows		
	Existing Condition	Proposed Condition
1 Year Storm	21.6	0.82
2 Year Storm	37.6	5.38
10 Year Storm	113.4	36.01
25 Year Storm	187.4	89.48

Project No. 5-1: Reduction in impervious area (porous pavement):

incorporates a green infrastructure retrofit of public parking lots (*i.e.*, Gazette, Keystone, Prettejohn, Field, and Brooks) within the Village of Livonia (see Photo 17 in **Appendix F**). As technology allows, porous pavement can be used to reduce impervious area. The reduction in impervious area transforms existing impermeable parking lots into a green infrastructure practice that can provide significant benefits for stormwater management, while at the same time educating the public by incorporating signage. Educational kiosks can provide interpretive information on the green infrastructure practice deployed within the Village. The kiosks can utilize graphically oriented visual displays to educate visitors about the important links between the built environment and water quality in the Lake. The reduction in impermeable area can reduce peak flows and pollutant runoff. STEPL estimated the approximate nutrient and sediment load reductions below:



Figure 3-5: Project 5-1 Location

- Reduction in Impervious Area (assumed 71,300 square feet mitigated)
 - Total Phosphorus: 0.6 lb/yr reduction
 - Total Nitrogen: 8.1 lb/yr reduction
 - Sediment: 400 lb/yr reduction

Project 4-2: Streambank Stabilization

behind the Livonia Fire Department on South Livonia Road within Village owned property (Tax Map IDs 75.13-1-19.1 and 75.-1-45.11) incorporates improved floodplain connectivity, riparian vegetation, and stabilized streambanks to reduce lateral migration and erosion of the streambanks. As a result, peak flows and sediment loads can decrease, improving water quality. The Creek has been experiencing lateral migration, presumed to be caused by increased peak flows upstream after the addition of athletic fields that channelized flow to the Creek (see Photo 5 in **Appendix F**). The Creek can be transformed into a stabilized, riparian vegetated Creek. STEPL estimated the approximate nutrient and sediment load reductions below:



Figure 3-6: Project 4-2 Location

- Streambank Stabilization (assumed 110 linear feet mitigated)
 - Total Phosphorus: 1.5 lb/yr reduction
 - Total Nitrogen: 3.5 lb/yr reduction
 - Sediment: 2,400 lb/yr reduction

Project No. 8-1: Stormwater Management Area within 3895 East Lake Road and adjacent lot with Tax Map ID 74.-1-13.132 between East Lake Road and Pennemite Road incorporates a constructed wetland between Pennemite Road and East Lake Road. The Stormwater Management Area transforms an existing wooded area with a relatively high groundwater table upstream of major bank erosion near Wilkins Tract that can provide significant water quality and quantity benefits (see Photo 4 in **Appendix F**). The constructed



Figure 3-7: Project 8-1 Location

wetland system could be designed to maximize the removal of pollutants through settling of sediments and both uptake and filtering by native wetland vegetation. The marsh wetland could mimic the Creek's sinuous pathways, however, can be extended laterally to increase retention time and contact area. Collateral benefits include improved biodiversity and wildlife habitat, and reduced peak flows within Wilkins Creek. The overall concept of the Stormwater Management Area can improve water quality, allow infiltration and retention, and improve biodiversity and wildlife habitat. STEPL estimated the following nutrient and sediment load reductions to the Lake.

- Stormwater Management Area (assumed 45,000 square feet mitigated)
 - Total Phosphorus: 7.4 lb/yr reduction
 - Total Nitrogen: 12.3 lb/yr reduction
 - Sediment: 3,000 lb/yr reduction

Project 5-3: Village GI incorporates a green infrastructure retrofit of Commercial and Main Street within the Village center. The GI transforms an existing impermeable sidewalk into a suite of green infrastructure practices enhancing the traditional charm of the Village center (see Photos 13 to 15 in **Appendix F**). The project includes a Permeable Interlocking Concrete Pavement System and a stormwater tree trench with Cornell University structural soils. The conventional impervious sidewalk could be replaced with a Permeable Interlocking Concrete Pavement (PICP). PICP systems are solid concrete paving units that form an interlocking pattern. Small joints between the units are filled with pervious material that allow water to infiltrate to a

structurally supportive reservoir course of open graded aggregates. The reservoir course stores water and allows it to infiltrate into the soil subgrade, or release gradually downstream. Perforated underdrains in the reservoir course are used to remove water that does not infiltrate within a given design period. In addition to providing water quantity and quality benefits, the concept can provide public education to the local community. Educational kiosks can provide interpretive information on the green infrastructure practices deployed within the Village. The kiosks can utilize graphically oriented visual displays to educate visitors about the important links between the built environment and water quality in the Lake. The overall concept of Village GI can provide public education, water quantity and quality benefits, improve air quality, and reduce urban heat island effects. The following STEPL benefits were calculated:



Figure 3-8: Project 5-3 Location

- Village GI (assumed 11,000 square feet mitigated)
 - Total Phosphorus: 0.1 lb/yr reduction
 - Total Nitrogen: 0.8 lb/yr reduction
 - Sediment: 41.1 lb/yr reduction

Project No. 7-1: Stormwater Management Area within 6241 Big Tree Road incorporates a constructed wetland with bioretention basins at the property south of Big Tree Street (see Photo 22 in **Appendix F**). The Stormwater Management Area could transform an existing overgrown field with a relatively high groundwater table downgradient of the recently built Longview development to a sustainable area that can provide significant water quality and quantity benefits. Bioretention basins or bioswales could collect and treat runoff from the Longview development prior to discharge to the wetland. Flow from the bioretention basin/bioswales could be diverted through the wetland for treatment before returning to the Creek prior to the Pennemite Road culvert. The constructed wetland system could be designed to maximize the removal of pollutants through settling of sediments and both uptake and filtering by native wetland vegetation. A marsh wetland designed with sinuous pathways can

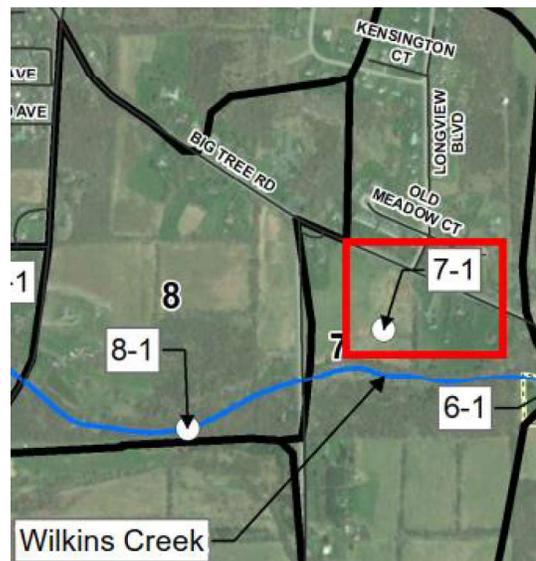


Figure 3-9: Project 7-1 Location

increase retention time and contact area. Collateral benefits include improved biodiversity and wildlife habitat, and reduced peak flows within Wilkins Creek that cause erosion issues. The overall concept of the Stormwater Management Area can improve water quality, allow infiltration and bioretention, and improve biodiversity and wildlife habitat. STEPL estimated the following nutrient and sediment load reductions to the Lake.

- Stormwater Management Area (assumed 150,000 square foot)
 - Total Phosphorus: 9.6 lb/yr reduction
 - Total Nitrogen: 38.0 lb/yr reduction
 - Sediment: 5,400 lb/yr reduction

Project 6-3: Streambank Stabilization within 4212 South Livonia Road incorporates improved floodplain connectivity, cross vane, riparian vegetation, and stabilized streambanks to reduce lateral migration and erosion of the streambank that is causing property loss (see Photo 12 in **Appendix F**). The Creek could be transformed into a stabilized, riparian vegetated Creek. The cross vane could be installed just downstream of the culvert carrying flow under Commercial Street to channelize flow away from the eroded streambanks. As a result of the transformation, peak flows and sediment loads can decrease, improving water quality. STEPL estimated the approximate nutrient and sediment load reductions below:

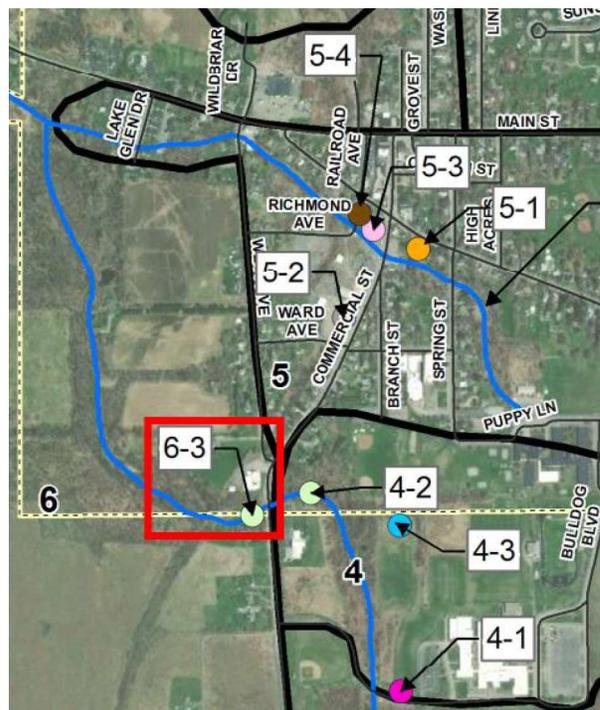


Figure 3-10: Project 6-3 Location

- Streambank Stabilization (assumed 30 linear feet mitigated)
 - Total Phosphorus: 1.9 lb/yr reduction
 - Total Nitrogen: 4.4 lb/yr reduction
 - Sediment: 3,000 lb/yr reduction

Project 3-1: Wetland Expansion within lot with Tax Map ID 84.-1-4.922 south of Livonia High School off Shelly Road expands on an existing wetland to provide additional stormwater storage, water quality treatment, and reduce peak flows downstream. Currently, an existing wetland treats flow along Wilkins Creek south of Livonia High School. A wetland could

be constructed adjacent with the existing wetland, and an outflow control device installed to further reduce peak flows. Water quantity and quality benefits are summarized below:

- Wetland Expansion (assumed 100,000 square feet mitigated)
 - Total Phosphorus: 2.4 lb/yr reduction
 - Total Nitrogen: 4.3 lb/yr reduction
 - Sediment: 1,200 lb/yr reduction

Project 5-4: Underground Storage under the Brooks Public Parking Lot incorporates subsurface stormwater detention to capture and store stormwater runoff collected from surrounding impervious areas (*i.e.*, Gazette, Keystone, Prettejohn, Field, and Brooks Public Parking Lots). The underground storage facility could be sized to capture runoff originating from a 10-year storm from the public parking lots within the Village by incorporating two 10-foot effective diameter chambers measuring 120 feet long. The storage facility could decrease the peak flow when used with a controlled flow orifice at the outlet. Although minimal water quality benefits would be achieved, this recommendation could greatly reduce peak flows downstream. This approach could be paired with porous pavement (see Project 5-1) or used as a standalone practice.

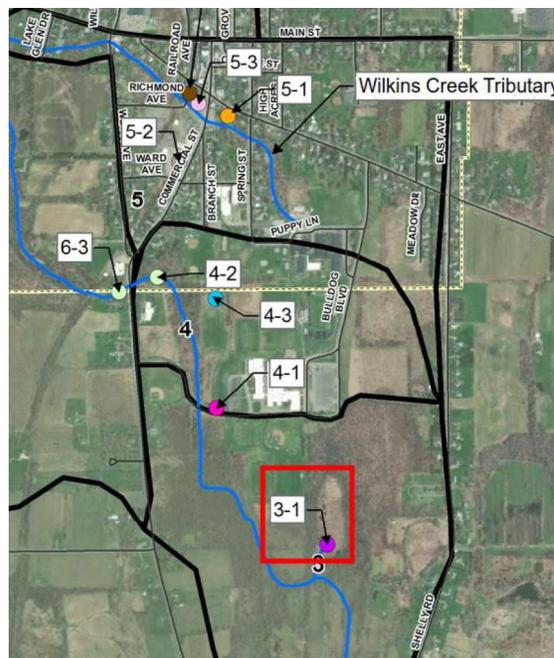


Figure 3-11: Project 3-1 Location



Figure 3-12: Project 5-4 Location

Project 2-1: Riparian Buffer within 4589 Shelly Road transforms a section along Wilkins Creek that cows have direct access to into a riparian buffer with floodplain and riparian vegetation with fencing (see Photo 19 in **Appendix F**). The fencing can be installed to prevent the direct access for agricultural animals that otherwise increase pollutant loadings to the Creek that allow nutrient uptaking algae to flourish. As a result, the riparian buffer can provide water quality treatment while providing increased biodiversity and wildlife habitat. Water quality benefits are summarized below:

- Riparian Buffer (assumed 15,000 square feet mitigated)
 - Total Phosphorus: 3.5 lb/yr reduction
 - Total Nitrogen: 9.1 lb/yr reduction
 - Sediment: 2,600 lb/yr reduction

Project 6-1: Culvert Modification within the Livonia Community Park transforms an existing culvert under the Park entrance that conveys flow along Wilkins Creek to an arch-shaped culvert with corresponding floodplain bench culverts (see Photo 18 in **Appendix F**). The proposed transformation closer mimics stream hydraulics with a prescribed low flow culvert and floodplain bench to reduce potential for scour eddies downstream. As a result, the localized erosion and stream instability can be reduced, further reducing sediment load. Water quality benefits are summarized below:

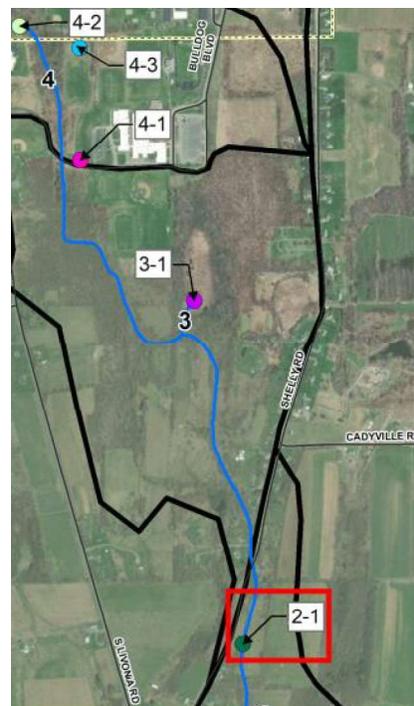


Figure 3-13: Project 2-1 Location

- Culvert Modification (assumed 20 linear feet mitigated)
 - Total Phosphorus: 0.3 lb/yr reduction
 - Total Nitrogen: 0.6 lb/yr reduction
 - Sediment: 400 lb/yr reduction

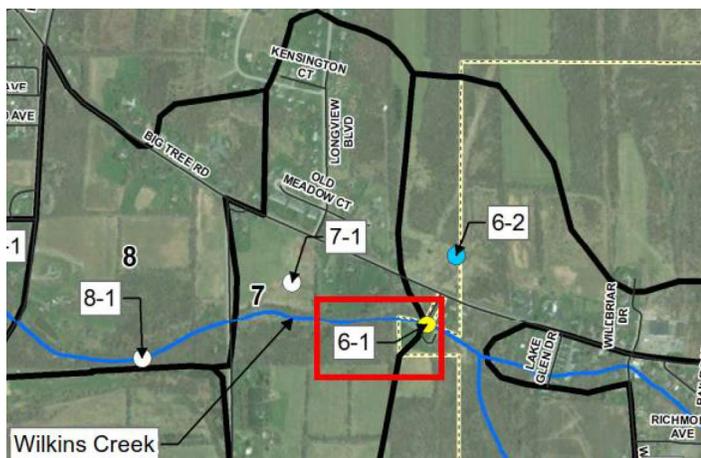


Figure 3-14: Project 6-1 Location

Project 5-2: Salt Storage Modification on the Town and Village of Livonia properties along Commercial Street could transform two existing salt storage buildings (see Photos 11 and 23 in **Appendix F**) somewhat exposed to the environment

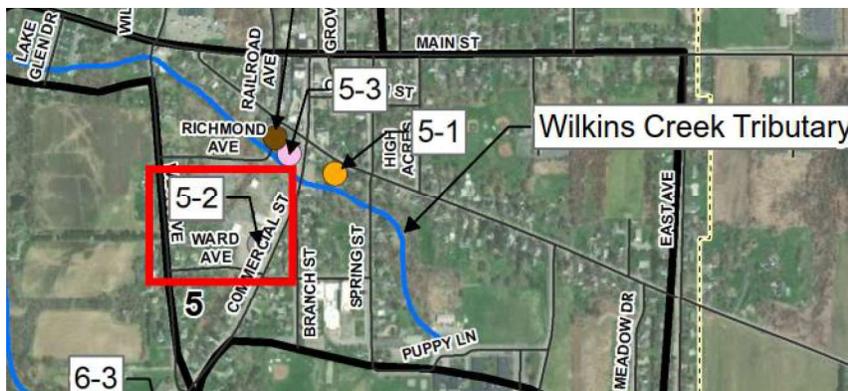


Figure 3-15: Project 5-2 Location

into buildings closed from the environment.

The roof overhang could be modified, and a berm installed near the opening. Additionally, procedural goals could be established that prohibit salt from being stored near the entrance along with routine good housekeeping sweeping measures. The proposed transformation can reduce or eliminate the potential of stored road salt to be washed into the storm drainage network that flows to the Lake. It is currently unknown how much sodium chloride washes into the storm drainage network, therefore, water quantity benefits were not calculated.

Project 9-2: Wing Wall Restoration adjacent to 6144 Wilkins Tract transforms an existing wing wall that has been on the verge of failure into a stabilized structure. The wing wall is currently settling, with heavy storm events eroding the surrounding soil. In time, the wing wall and portions of the adjacent residential yard can cave into the Creek creating sediment deposits. Water quantity benefits can be approximated by the assumed amount of sediment the wing wall is holding back which is approximately 200 lbs of sediment. In addition to the water quantity benefits, wing wall restoration is believed to be necessary as a safety precaution due to the proximity to Wilkins Tract and residential property.

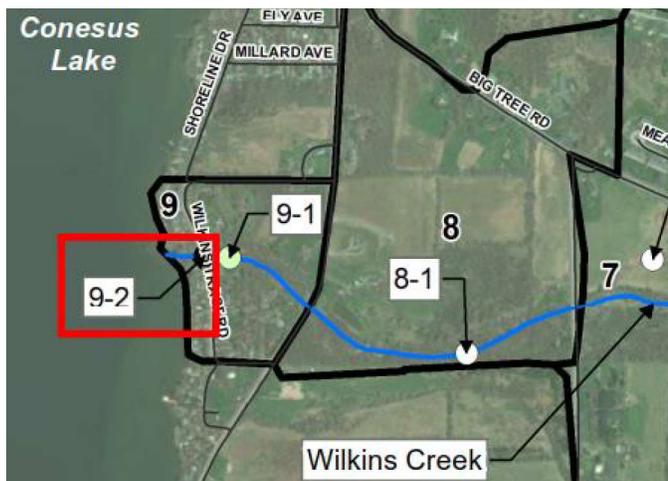


Figure 3-16: Project 9-2 Location



Figure 3-17: Project 9-2 Wing Wall Degradation

Another potential project that has not been discussed includes construction of a retention pond within Drainage Area 1. After B&L presented the Subwatershed Stormwater Study at a Public Meeting on Wednesday, November 7, 2018, it was brought to B&L's attention that the property with Tax Map IDs 84.-1-4.921 and 84.-1-4.922 had tile drainage installed over the past couple years to drain springwater to Wilkins Creek that otherwise fed to a natural retention area. An opportunity exists to disconnect and reroute the springwater fed tile drainage to a newly developed retention area. The feasibility and benefits for this potential project should be further evaluated, however, could transform an unused field into an opportunity to provide additional stormwater and springwater storage, reducing peak flows and nutrient loads downstream.

3.2 Cost Estimate

Each project was compared based on a benefit-cost analyses. Approximate costs and the water quality and quantity benefit calculations (as applicable) for each project are included in **Appendix O** located at the end of this report. Table 3-2 summarizes these approximations (ordered by drainage area). Note that cost estimates assume a 20% contingency, unless otherwise noted (see **Appendix O**).

Although water quality enhancements are minimal for projects focused in the Village (Projects 5-1 and 5-3) in comparison to the other project alternatives, these concepts offer more of a behavioral and educational shift to the local community. Additionally, these projects provide visually appealing green infrastructure and recreational value to the Lake. The streambank stabilization near Wilkins Tract (Project 9-1) is extremely cost effective as it provides a considerable water quality benefit. The swales at the high school (Project 4-1) and riparian buffer (Project 2-1) are the least expensive alternatives, and still provide enhanced water quality benefits when compared per dollar value.

Table 3-2. Cost Estimate and Benefit-Cost Analysis

Rank	Potential Project	Total Cost Estimate (\$)	Construction Cost (\$)	Annual O&M Cost (\$)	Other Cost (\$)	Water Quantity Benefit (ft³)	Water Quality Benefit (ft³)	Other Benefit
#13	2-1: Riparian Buffer	\$5,400	\$3,400	\$1,000	\$1,000	Reduced peak flows to Wilkins Creek	Phosphorus Reduction 3.5 lb/yr Nitrogen Reduction of 9.1 lb/yr Sediment Reduction of 2,600 lb/yr	Biodiversity Benefits
#11	3-1: Wetland Expansion	\$22,600	\$18,000	\$1,000	\$3,600	Reduced peak flows to Wilkins Creek	Phosphorus Reduction 2.4 lb/yr Nitrogen Reduction of 4.3 lb/yr Sediment Reduction of 1,200 lb/yr	Biodiversity Benefits
#1	4-1: Livonia High School Green Infrastructure (GI)	Rain Garden: \$29,300 Swale Retrofit: \$2,300 Vegetated Swale: \$3,000	Rain Garden: \$24,000 Swale Retrofit: \$1,800 Vegetated Swale: \$2,400	Rain Garden: \$500 Swale Retrofit: \$100 Vegetated Swale: \$100	Rain Garden: \$4,800 Swale Retrofit: \$400 Vegetated Swale: \$500	Reduced peak flows to Wilkins Creek	Rain Garden: Phosphorus Reduction of 2.9 lb/yr Nitrogen Reduction of 20.8 lb/yr Sediment Reduction of 1,000 lb/yr Swale Retrofit: Phosphorus Reduction of 2.1 lb/yr Nitrogen Reduction of 10.9 lb/yr Sediment Reduction of 1,000 lb/yr Vegetated Swale Phosphorus Reduction of 0.7 lb/yr Nitrogen Reduction of 2.6 lb/yr Sediment Reduction of 600 lb/yr	Educational, Biodiversity, and Habitat Benefits
#6	4-2: Streambank Stabilization behind Livonia Fire Department	\$11,000	\$8,500	-	\$2,500	Reduced peak flows to the Lake	Phosphorus Reduction of 1.5 lb/yr Nitrogen Reduction of 3.5 lb/yr Sediment Reduction of 2,400 lb/yr	Property Loss Reduction
#2	4-3: Livonia High School Pond Retrofit	\$18,200	\$13,500	\$2,000	\$2,700	Reduced peak flows to Wilkins Creek	Phosphorus Reduction 12.5 lb/yr Nitrogen Reduction of 34.6 lb/yr Sediment Reduction of 9,000 lb/yr	Biodiversity Benefits
#5	5-1: Reduction in Impervious Area (Porous Pavement)	\$743,000	\$684,000	\$2,000	\$57,000	Reduced peak flows to Wilkins Creek	Phosphorus Reduction of 0.6 lb/yr Nitrogen Reduction of 8.1 lb/yr Sediment Reduction of 400 lb/yr	Educational Benefits
#15	5-2: Salt Storage Modification along Commercial Street	\$43,200	\$36,000	-	\$7,200	-	Chloride load reduction	-
#8	5-3: Village Green Infrastructure (GI)	\$205,500	\$185,000	\$2,000	\$18,500	Reduced peak flows to Wilkins Creek	Phosphorus Reduction of 0.1 lb/yr Nitrogen Reduction of 0.8 lb/yr Sediment Reduction of 41.1 lb/yr	Educational and Habitat Benefits
#12	5-4: Underground Storage	\$1,304,600	\$831,300	\$25,600	\$447,700	Reduced peak flows to Wilkins Creek	-	Ability to Capture a 10-Year Storm Runoff from Public Parking Lots
#14	6-1: Culvert Modification within Livonia Community Park	\$246,200	\$205,200	-	\$41,000	Reduced peak flows to the Lake	Phosphorus Reduction 0.3 lb/yr Nitrogen Reduction of 0.6 lb/yr Sediment Reduction of 400 lb/yr	Property Loss Reduction
#4	6-2: Pond Retrofit	\$39,500	\$31,200	\$2,000	\$6,300	Peak flow reduction of 95% in 1-year storm (peak flows up to 25 year storm reduced between 50% to 90%)	Phosphorus Reduction of 14.8 lb/yr Nitrogen Reduction of 50.2 lb/yr Sediment Reduction of 9,600 lb/yr	Localized Flood Reduction
#10	6-3: Streambank Stabilization	\$7,000	\$5,000	-	\$2,000	Reduced peak flows to the Lake	Phosphorus Reduction of 1.9 lb/yr Nitrogen Reduction of 4.4 lb/yr Sediment Reduction of 3,000 lb/yr	Property Loss Reduction
#9	7-1: Stormwater Management Area	\$77,200	\$60,000	\$5,200	\$12,000	Reduced peak flows to Wilkins Creek	Phosphorus Reduction of 9.6 lb/yr Nitrogen Reduction of 38.0 lb/yr Sediment Reduction of 5,400 lb/yr	Biodiversity Benefits
#7	8-1: Stormwater Management Area	\$12,500	\$10,400	\$1,000	\$1,100	Reduced peak flows to the Lake	Phosphorus Reduction of 7.4 lb/yr Nitrogen Reduction of 12.3 lb/yr Sediment Reduction of 3,000 lb/yr	Biodiversity Benefits
#3	9-1: Streambank Stabilization	\$72,000	\$60,000	-	\$12,000	Reduced peak flows to the Lake	Phosphorus Reduction of 59.7 lb/yr Nitrogen Reduction of 135.7 lb/yr Sediment Reduction of 90,400 lb/yr	Property Loss Reduction
#16	9-2: Wing Wall Restoration	\$136,000	\$108,800	-	\$27,200	-	Sediment Reduction of 200 lb	Property Loss Reduction

3.3 Regulatory Review

A review of existing municipal regulations and permit application materials applicable to stormwater and water quality in the Conesus Lake Watershed was conducted for the Town and Village of Livonia and included within a Regulatory Review Memo found in **Appendix P** located at the end of this report. Recommendations provided in the Regulatory Review Memo should, if followed, strengthen stormwater management and permit requirements and encourage best management practices for water quality and quantity improvement.

3.4 Conclusion

This Study and recommendations provided within serve to benefit the County, Town, and Village in hopes to provide a positive impact on the environmental health of Conesus Lake and address flood mitigation. The recommendations and potential alternatives comprised within include a wide range of practices for flood mitigation and water quality improvement, and should be further progressed as future funding becomes available. The goal of all parties involved is to protect the Lake and its resources in a sustainable manner.

4.0 Resources

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