



Gilkey Creek Watershed Assessment Summary

January 2013

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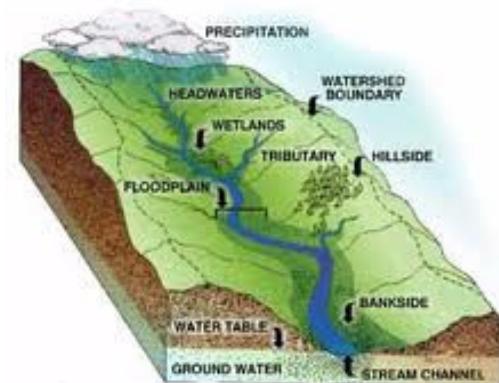
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Introduction

Information from the United States Environmental Protection Agency (EPA), Michigan Department of Environmental Quality (DEQ), Michigan Department of Natural Resources (DNR), City of Flint Water Pollution Control (WPC), Flint River Watershed Coalition (FRWC) and University of Michigan - Flint (UM-F) was compiled for producing this watershed assessment summary.

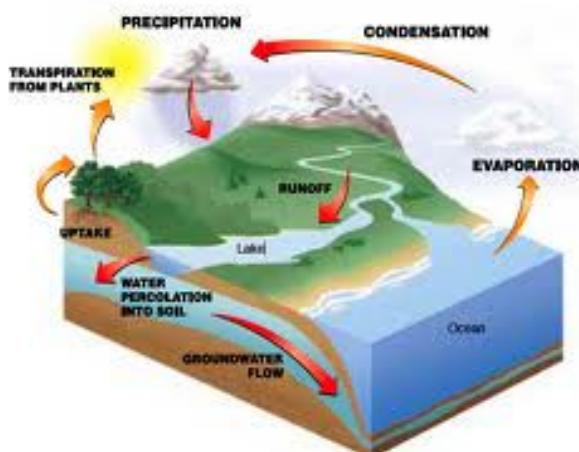
Watersheds

A watershed is an area of land where water from precipitation (rain and melting snow) flows over and under the ground to a certain location in a water body, such as a stream, lake, or wetland (see the illustration below).



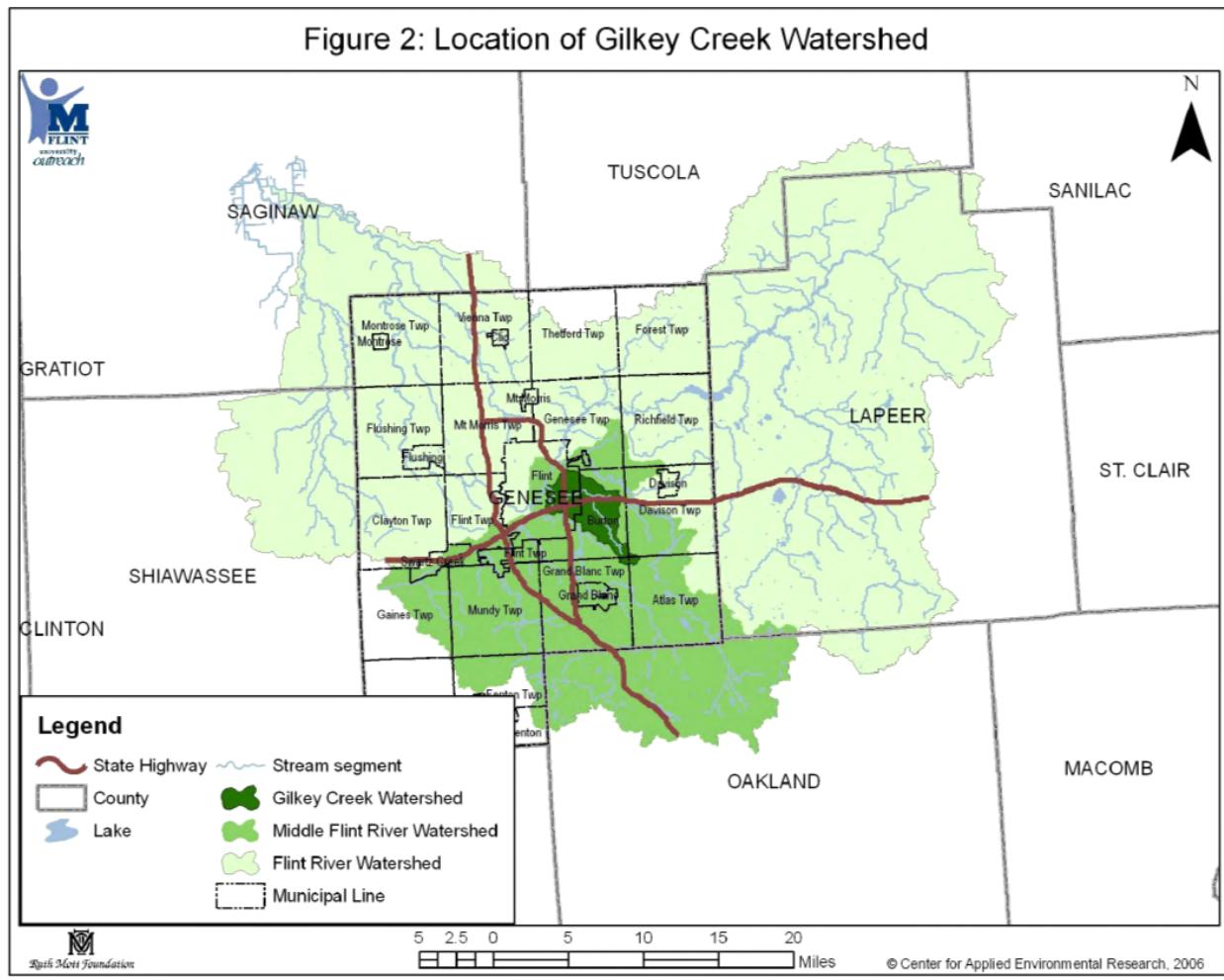
**Conceptual Watershed
Cross Section**

Water flows through watersheds via streams (above and below ground) eventually into oceans, where it evaporates into the atmosphere and returns to the land in watersheds as precipitation (see the illustration below). It also evaporates into the atmosphere from lakes and streams, and water beneath the ground evaporates into the atmosphere via plants, which is called "transpiration" (see the illustration below).

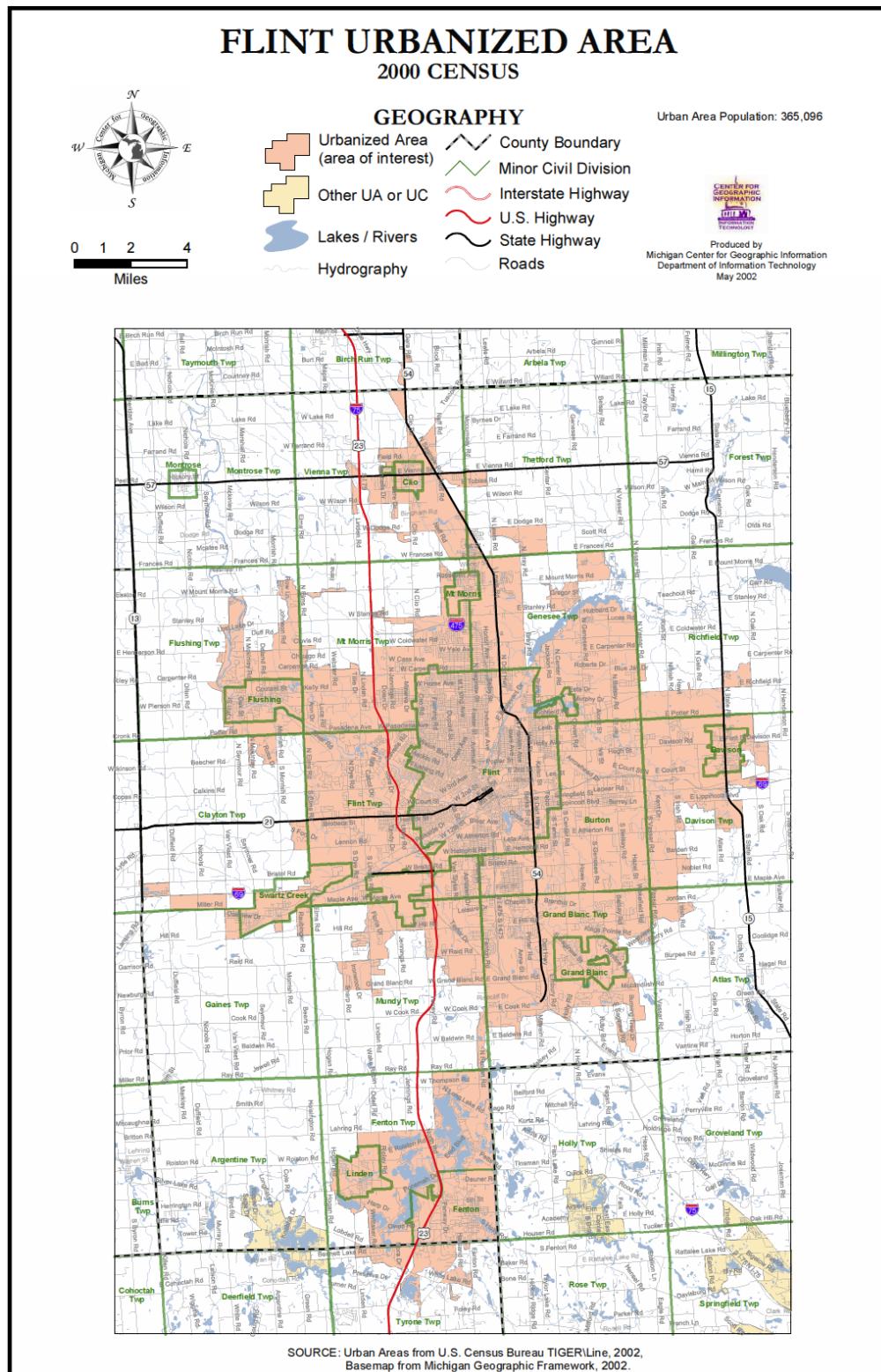


Physical Geography

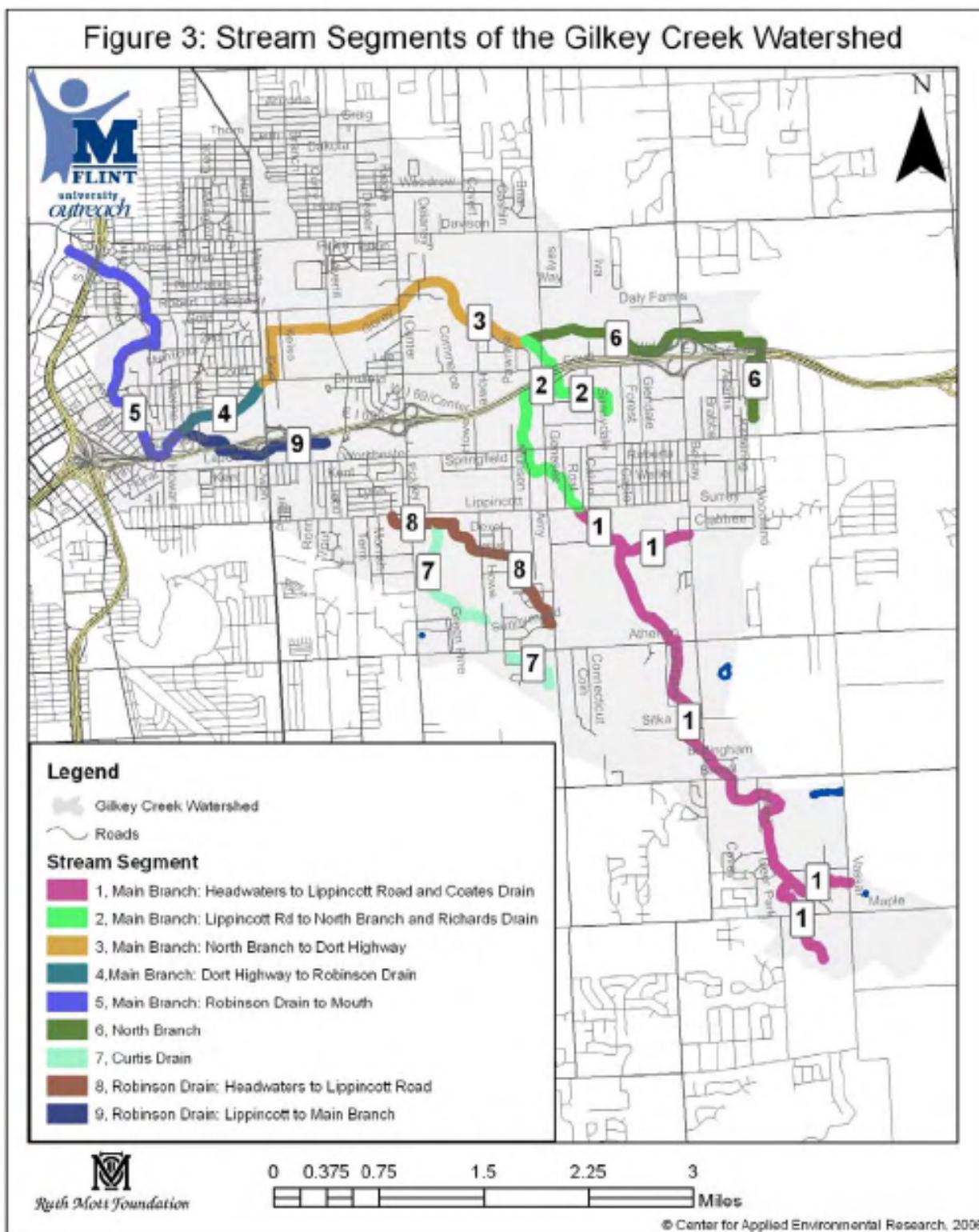
The Gilkey Creek Watershed is all the land where water from precipitation flows to Gilkey Creek. The watershed covers 13,721 acres (21.4 square miles) in Genesee County Michigan, and it is part of the Flint River Watershed as shown below:



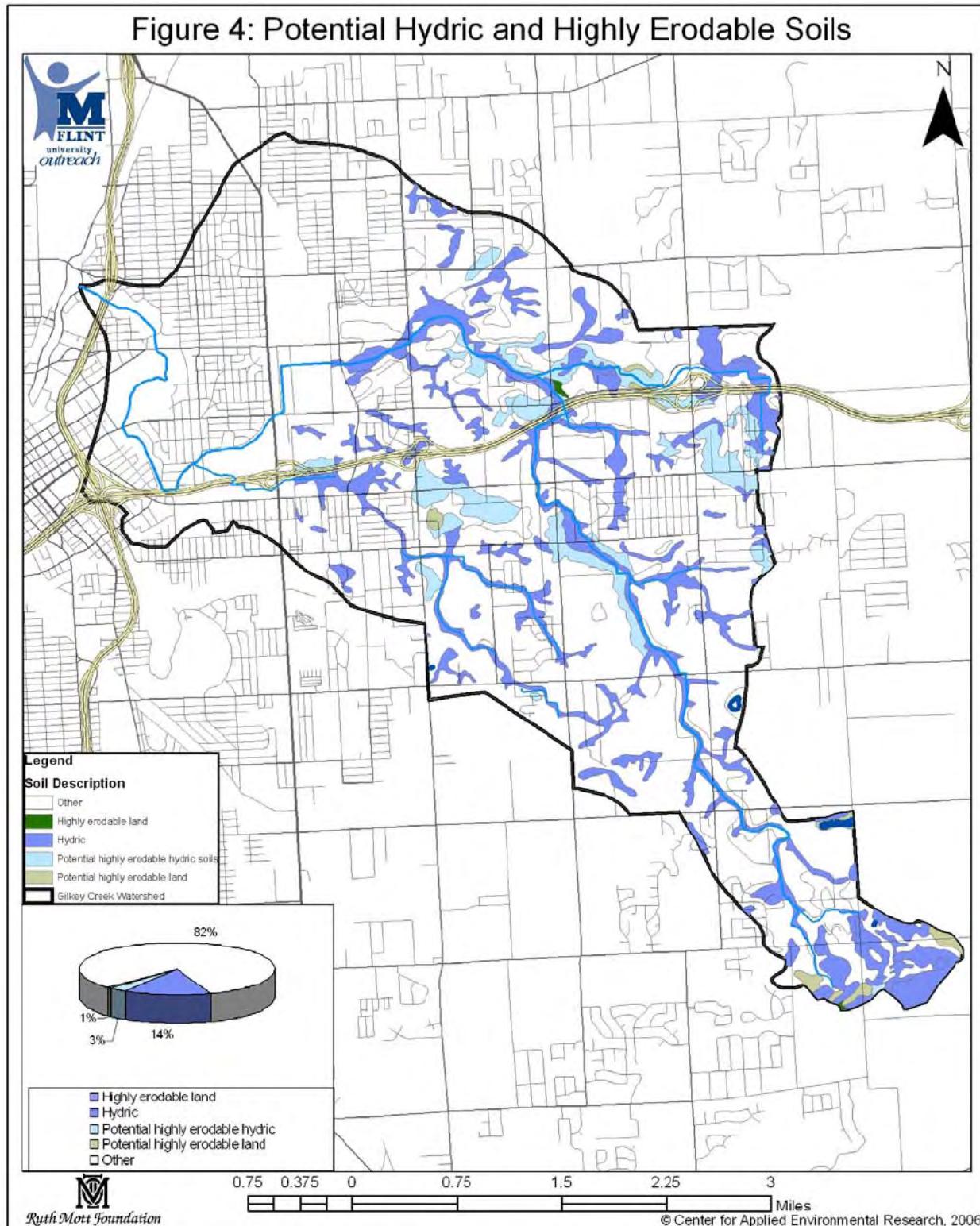
The watershed is nestled within the densely populated (1,580 people per square mile) Flint Urbanized Area (population 365,096) as shown below:



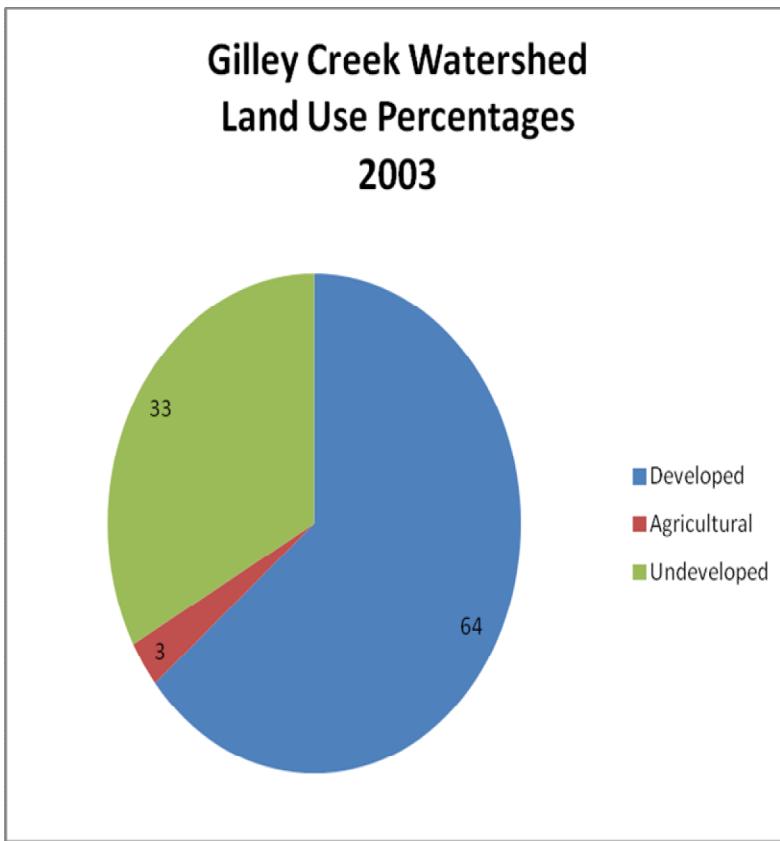
The stream segments of the watershed are mainly channelized ditches maintained as Genesee County drains in its upper reaches as shown below:



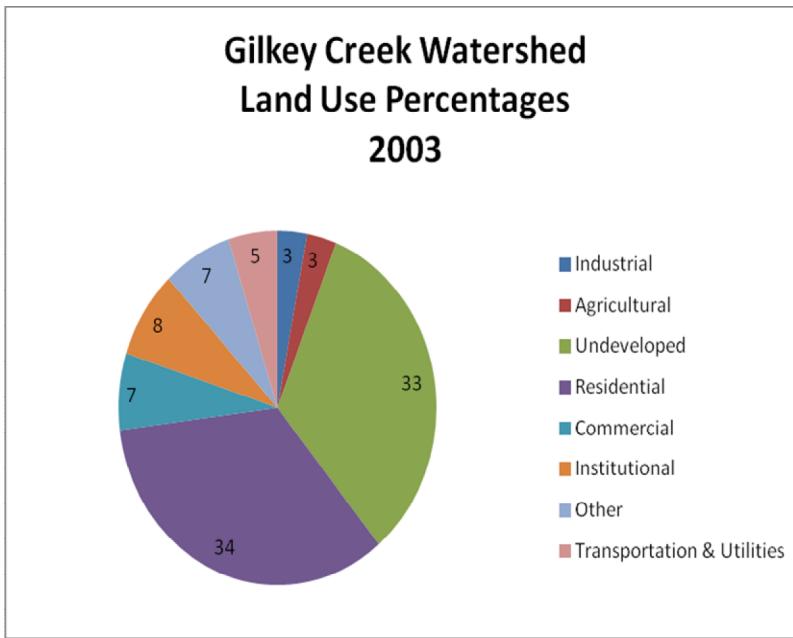
Potential hydric and highly erodible soils in the watershed are as shown below:



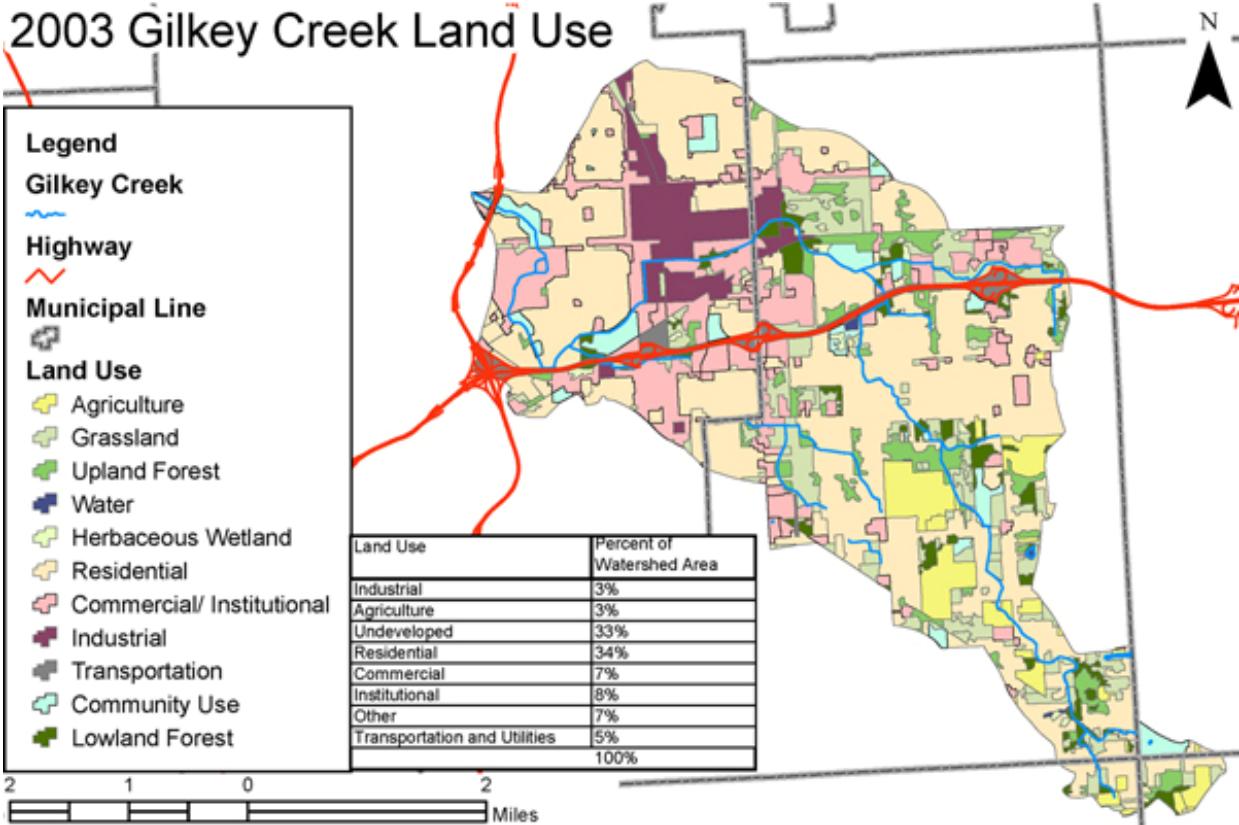
The location and proportion of land uses in the watershed are as shown below:



Data source: the Gilkey Creek Watershed Management Plan



Data source: the Gilkey Creek Watershed Management Plan



Source: UM-F Gilkey Creek Watershed Management Plan

Stream morphology and associated land uses and pollutants in the watershed are as follows:

Gilkey Creek Watershed Stream Morphology, Land Uses, and Pollutants				
Stream Segment		Morphology	Land Use	Pollutants
#	Description			
1	Vassar and Maple Roads to Lippincott	Channelized, average width less than 10 feet, average depth 1-3 feet, low bank erosion until Dallas Road. Stagnant flow.	Developing residential, scarce agriculture, some green spaces.	Sediment, bacteria, nutrients.
2	Lippincott to confluence with North Branch	Channelized average width of 15 feet, average depth of 2 feet. High amounts of erosion, high water mark over 3 feet.	Residential and open space (Kelly Lake Park and MDOT land).	Sediment, nutrients.
3	North Branch confluence to Dort Highway	Channelized, average width is 10-25 feet, average depth 1-3 feet, high water mark 3-5 feet, low flow, moderate erosion.	Large industrial sites and commercial corridor.	Sediment, trash, nutrients.
4	Dort Highway to confluence with Robinson Drain	Underground approx. 1/8 mile, high banks, severe erosion, average width 10-25 feet, average depth 1-3 feet, high water mark 3-5 feet.	Decreasing commercial, older dense residential and Pierce Park Golf Course.	LUST groundwater, nutrients, and illicit connections.

Gilkey Creek Watershed Stream Morphology, Land Uses, and Pollutants				
Stream Segment		Morphology	Land Use	Pollutants
#	Description			
5	Robinson Drain to confluence with Flint River	Channelized, average width 10-25 feet, average depth 1-3 feet, riffles near Robinson Drain, riffles in Kearsley Park.	Dense residential, MCC campus, Woodlawn, Burroughs and Kearsley Parks.	Sediment, nutrients, trash.
6	Headwaters to confluence with Main Branch	Channelized ditch, average depth less than 2 feet, average width 4-15 feet.	Residential in headwaters, undeveloped north of I-69, expanding commercial district.	Nutrients.
7	Curtis Drain	Designated drain, average depth less than 1 foot, average width 10-30 feet.	Residential in headwaters, undeveloped west of drain, commercial east of drain.	Nutrients, trash.
8	Headwaters to Lippincott Road	Designated drain, average depth less than 1 foot, avg. width 10-30 feet. High water mark >2 ft.	Mainly residential with some commercial along Center Rd.	Sediment, nutrients, trash.
9	Lippincott to confluence with Main Branch	Underground from Lippincott to north of Lapeer Rd. Some sand bars and undercutting near Scott Elementary. Armored banks near confluence with Gilkey.	Underground, high density residential neighborhood, through commercial / industrial along I-69, then through Pierce Park Golf Course.	Nutrients, trash, suspect metals from railroad, contaminated sediment.

Data source: the Gilkey Creek Watershed Management Plan

Designated Uses

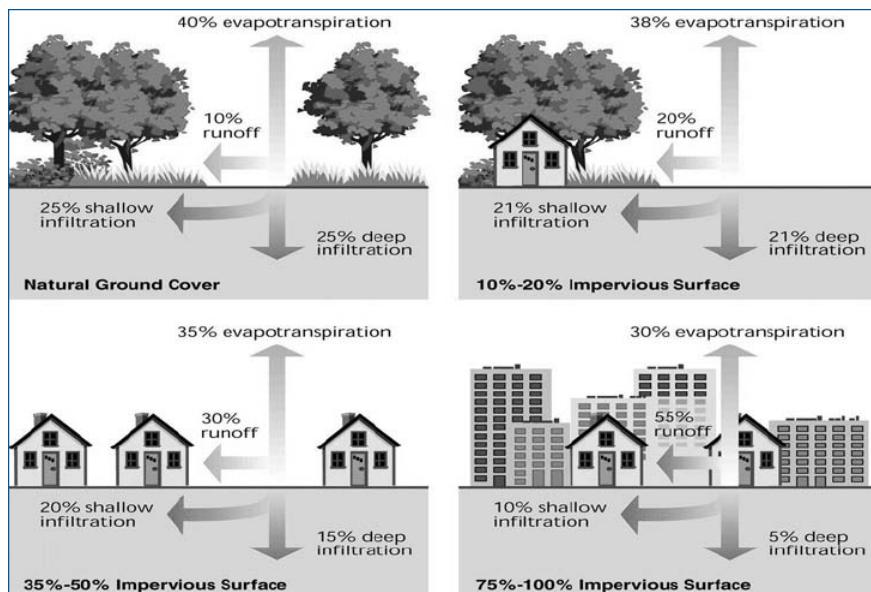
The following uses for Gilkey Creek Watershed streams are designated for protection under the Michigan Natural Resource and Environmental Protection Act (NREPA) and their status of attainment is summarized as follows:

Gilkey Creek Designated Use Status		
Designated Use	Status	Cause for Non-attainment
Agricultural Water Supply	Attaining	Not applicable
Industrial Water Supply	Attaining	Not applicable
Public Water Supply	Not applicable	Not applicable
Warm Water Fishery	Not attaining	Sediment (known), nutrients (suspected), heat (suspected)
Other Aquatic Life	Not attaining	Sediment (known), nutrients (known), heat (suspected), stream channelization (known)
Wildlife	Attaining	Not applicable
Partial Body Contact Recreation	Threatened	Bacteria (suspected)
Total Body Contact Recreation (May 1 – October 31)	Threatened	Bacteria (suspected)
Navigation	Not applicable	Not applicable

Data source: the Gilkey Creek Watershed Management Plan

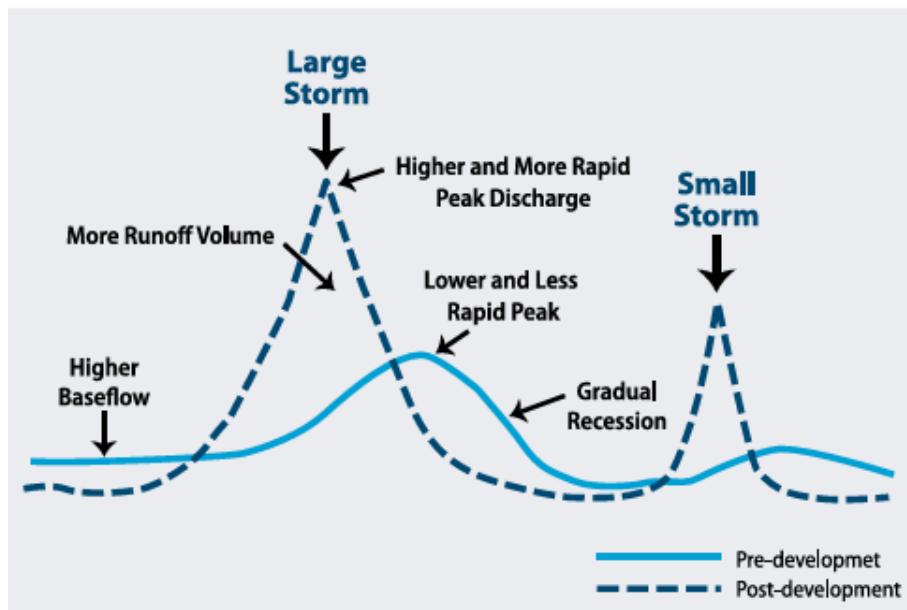
Urbanization

As shown above, the Gilkey Creek Watershed is 64% developed. Urban development changes the proportion of rainfall that infiltrates into the ground due to the amount of pavement and compacted soils that capture and divert it to surface waters via storm sewers as shown below:



Source: EPA [Managing Storm Water in Your Community](#)

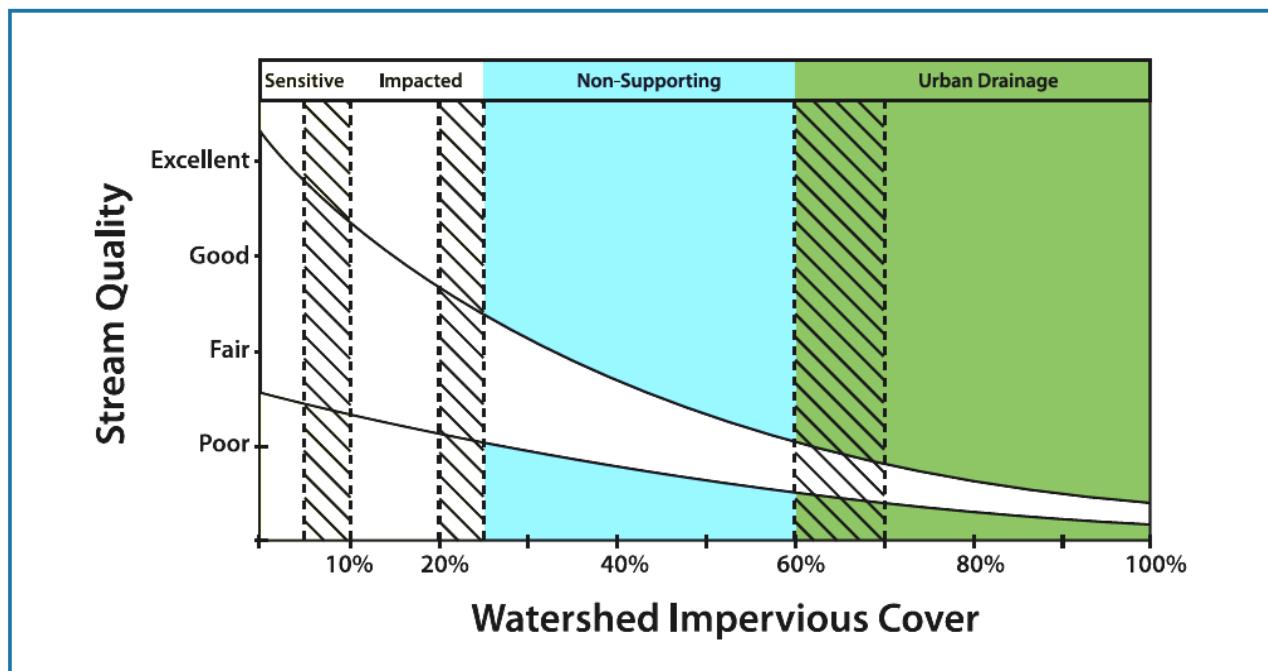
This results in excessive runoff flow to streams during wet weather and deficient ground water for sustaining stream flow during dry weather, which causes receiving stream flows to become unstable and fluctuate dramatically, as shown below:



Source: EPA [Managing Storm Water in Your Community](#)

The greater peak flows resulting from development causes changes in stream channel morphology due to greater bank erosion and sedimentation in the stream, and the channel becomes wider and shallower (unnatural).

The amount of impervious land cover in a watershed effects stream quality for supporting ecological health as shown below:



Source: [EPA Managing Storm Water in Your Community](#)

Erosion and Sedimentation

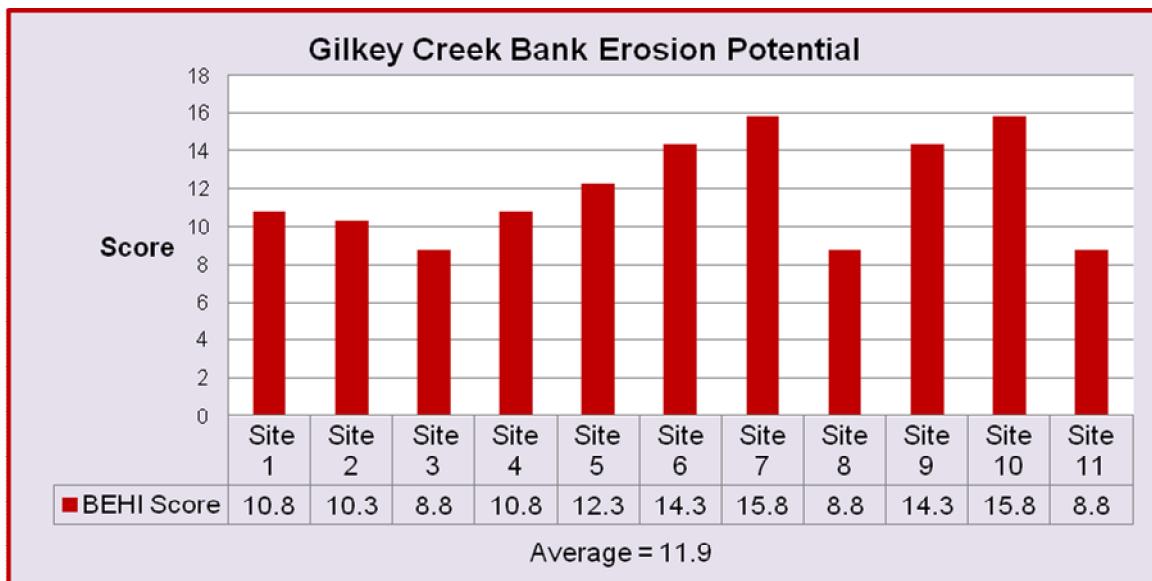
In 2009, the FRWC evaluated the potential for bank erosion in Gilkey Creek by determining soil textures and Bank Erosion Hazard Index (BEHI) scores (see Appendix A). This was done at 11 sites along the creek (see Appendix E).

The bank erosion potentials, based on soil texture, ranged from high to low.

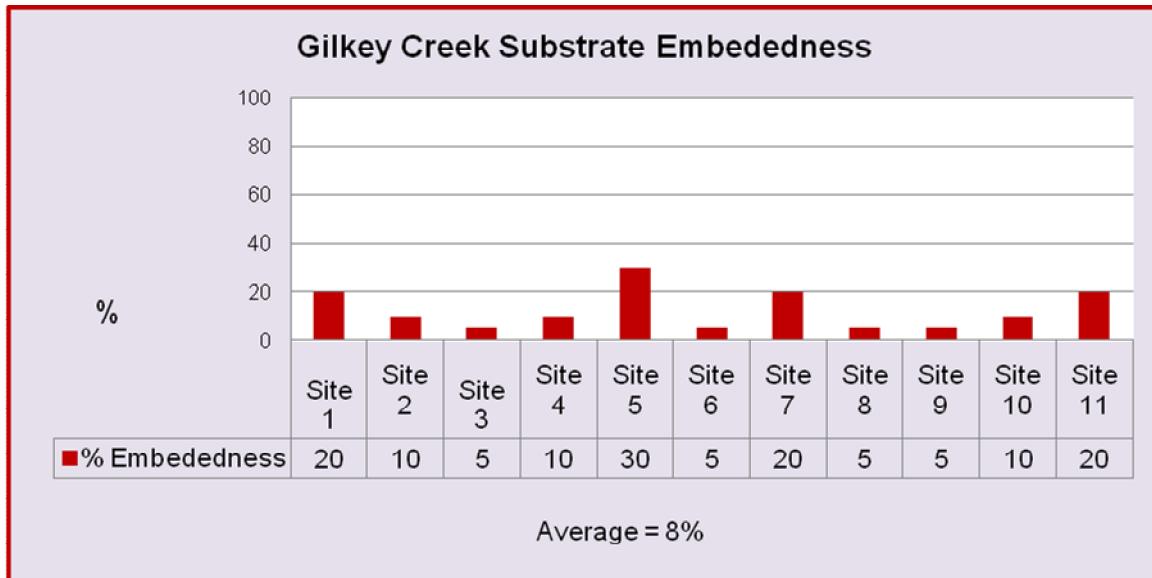
The bank erosion potentials based on BEHI scores were rated using the following scale:

Score	Rating
≤ 5.8	Very low
5.8 - 11.8	Low
11.9 - 19.8	Moderate
19.9 - 27.8	High
27.9 - 34.0	Very High
34.1 - 40	Extreme

The scores were as follows:



The FRWC also evaluated stream channel sedimentation (see Appendix A) in Gilkey Creek by estimating the percent imbeddedness of large substrate particles (i.e., gravel, cobble) by small particles (i.e. sand, silt). The imbeddedness measurements were as follows:



The bank erosion potential was greatest in the lower reaches of the creek, except at the Mott Applewood Estate creek restoration site (see Appendix E). Although the bank erosion potentials were generally low or moderate where assessed, there are erosion problems in the lower reach of Gilkey Creek (see the photographs below).



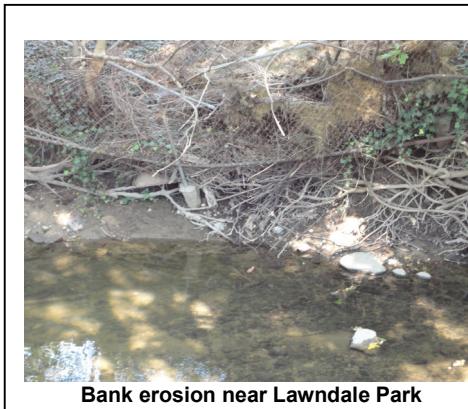
Bank failure in Kearsley Park



Channel down-cutting in Kearsley Park

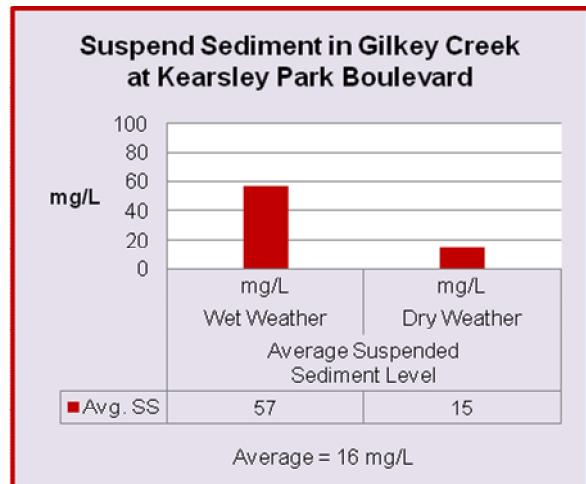


Bank erosion in Kearsley Park



Bank erosion near Lawndale Park

Average suspended sediment levels in Gilkey Creek at Kearsley Creek Boulevard (near the mouth), measured by the FRWC (see Appendix A), were much higher in wet weather (after significant precipitation) than in dry weather as shown below:

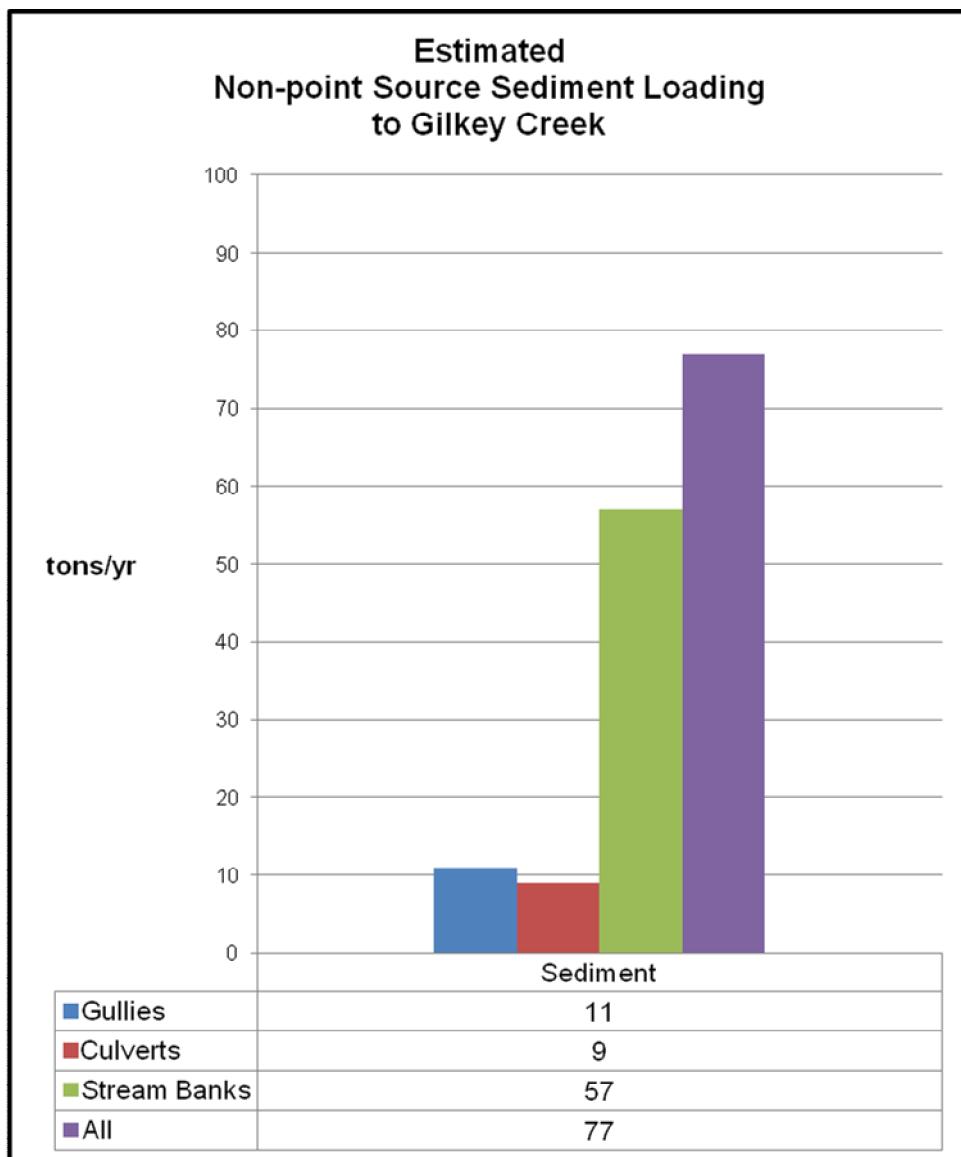


POLLUTION SOURCES

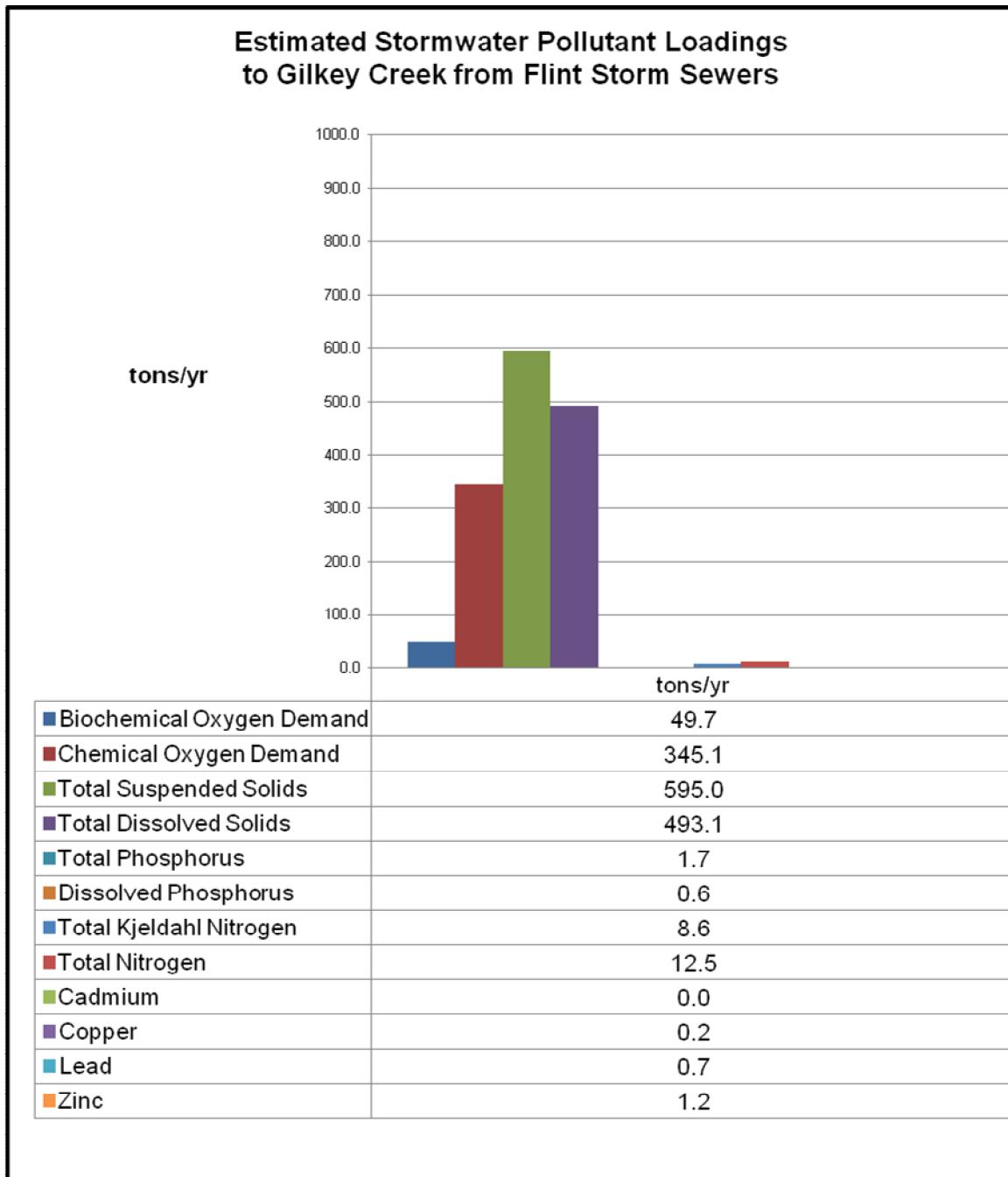
Known and potential water pollution sources in the Gilley Creek Watershed include pollution from non-point sources (i.e., soil erosion, contaminated groundwater discharges, and sanitary sewer exfiltration) and point sources (i.e., municipal storm water discharges and illegal direct and indirect discharges).

Non-point Source Pollution There are numerous leaking underground storage tank and other soil contamination sites near streams in the Gilkey Creek Watershed (see Appendix E).

The estimated non-point source sediment loadings resulting from soil erosion to streams in the watershed are as follows:



Point Source Pollution The City of Flint and City of Burton municipal storm sewers that drain roofs, parking lots and streets discharge stormwater, carrying pollutants such as motor oil, road salt, sediment (dirt), plant nutrients, animal feces, pesticides, and toxic metals, into streams in the watershed. These discharges are regulated by DEQ permits. According to the 1994 permit application for the Flint storm sewer system, the part of the watershed in the city (22% of the watershed area) is 35.8% impervious and the annual storm water pollutant loadings from the system to the creek were estimated to be as follows:



DEQ permitted discharges to streams in the Gilkey Creek Watershed are as follows:

Gilkey Creek NPDES Permitted Discharges				
Facility	Address	City	Permit Number	Permit Type
Barrett Paving Materials, Incorporated	2901 Bennett Avenue	Flint	MIS510159	Industrial Stormwater
Barrette Outdoor Living	3200 Robert T. Longway Boulevard	Flint	MIS510600	Industrial Stormwater
City of Burton	Not applicable	Burton	MIG610060	Municipal Stormwater
Delphi	1300 North Dort Highway	Flint	MIS510078	Industrial Stormwater
Flint MS4	Not applicable	Flint	MI0053864	Municipal Stormwater
Former Sunoco Station - 0354-5696	4012 Davison Road	Burton	MIG081117	LUST remediation
Former Sunoco Station - Burton	5479 Lapeer Road	Burton	MIG081080	LUST remediation
Genesee Packaging, Incorporated	2010 North Dort Highway	Flint	MIS510241	Industrial stormwater
Gilkey Creek Drain Improvements	Atherton Road	Burton	MIR111944	Soil erosion and sedimentation control
Mass Transportation Authority	1401 South Dort Highway	Flint	MIS510396	Industrial stormwater
Resource Recovery of Flint	5125 North Dort Highway	Flint	MIS510281	Industrial stormwater
Speedway SuperAmerica #6255	2617 North Dort Hwy	Flint	MIG081136	LUST remediation
Stokes Steel Treating Company	624 Kelso Street	Flint	MIS510295	Industrial stormwater

Data source: DEQ

Historic illegal discharges to streams in the watershed have included industrial and commercial wastewater, petroleum substance contaminated groundwater and stormwater, and sanitary wastewater.

Water Quality

The FRWC and WPC surveyed water quality in Gilkey Creek on 86 days during 2007 - 2011 for assessing its suitability for supporting ecological and human health (see Appendix A).

The FRWC collected samples at Horrigan Drive (at Mott College), Longway Boulevard (at the Mott Applewood Estate) and Kearsley Park Boulevard (in Kearsley Park); and WPC collected samples at Center Road and Chavez Boulevard (in Kearsley Park).

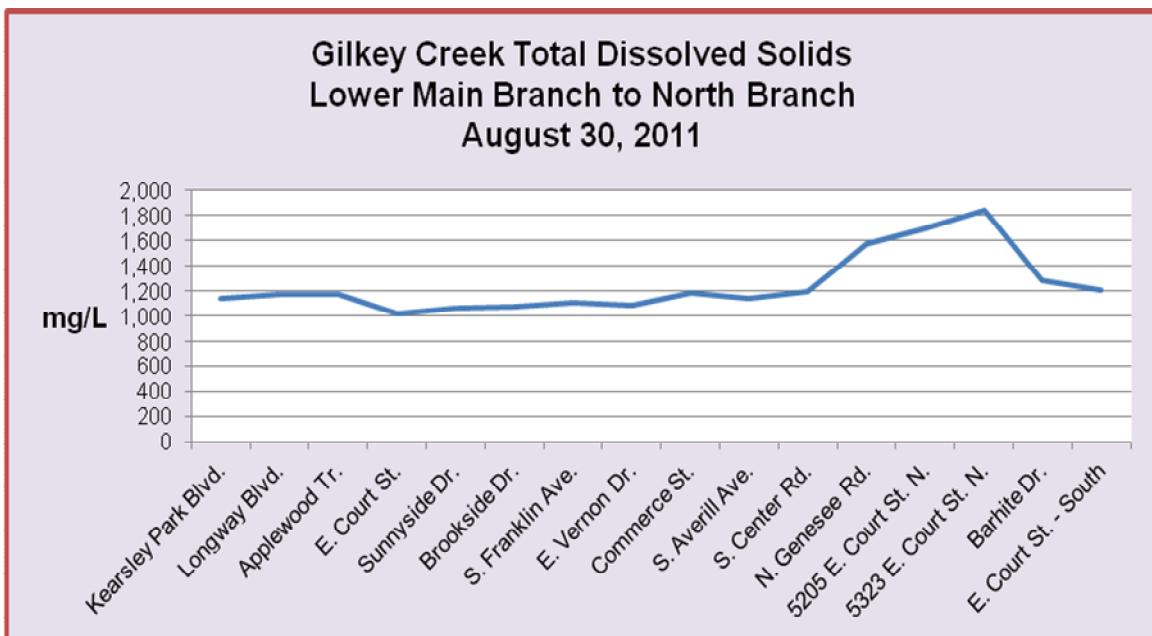
Water quality for supporting ecological health was assessed by chemical and physical analysis. A water quality index developed by the National Sanitation Foundation was used for evaluating the monitoring data. A numerical water quality score was calculated with the test results and a water quality rating was determined by the score, using the following scale:

Score	Rating
91 - 100	Excellent water quality
71 - 90	Good water quality
51 - 70	Medium water quality
26 - 50	Fair water quality
0 - 25	Poor water quality

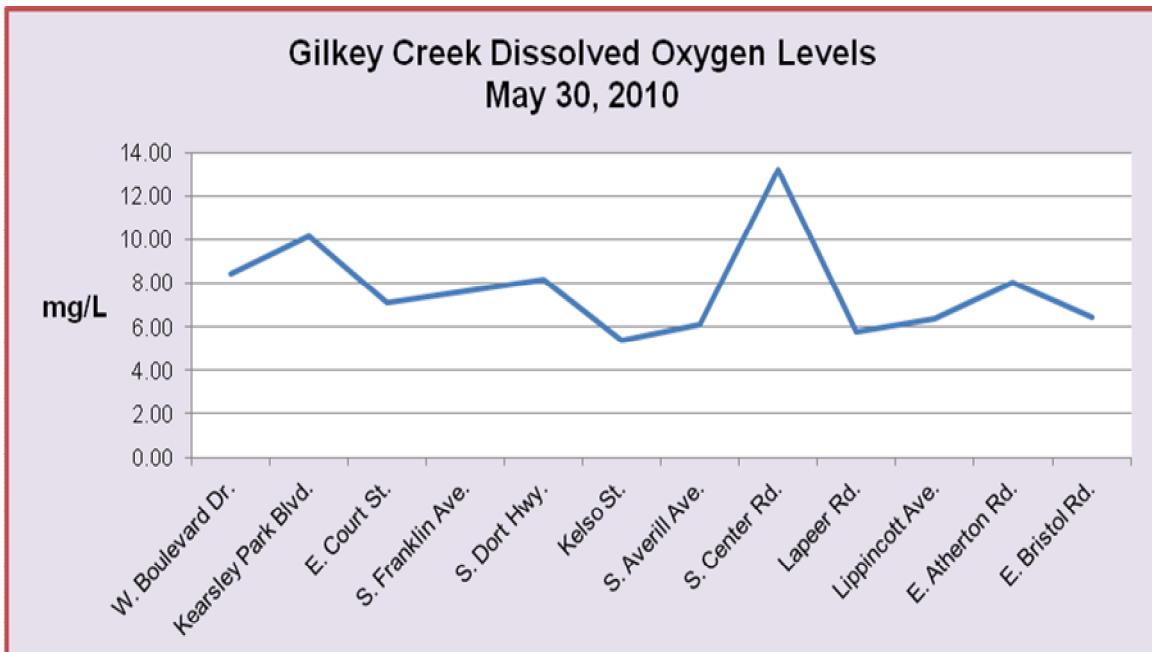
The average scores for each site were as follows:



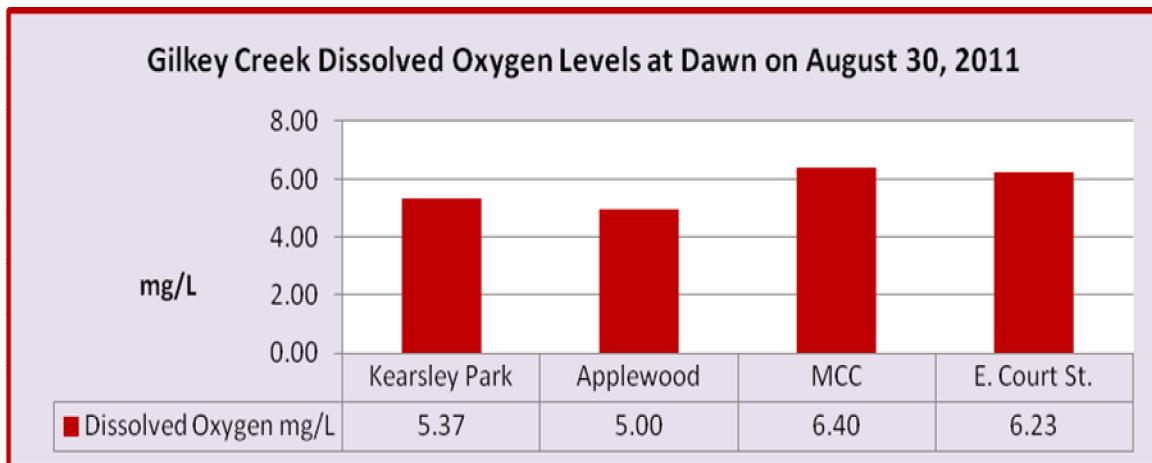
The FRWC surveyed Total Dissolved Solids levels (see Appendix A) which were as follows:



The FRWC surveyed Dissolved Oxygen levels (see Appendix A) which were as follows:



The FRWC surveyed dissolved oxygen levels at dawn (see Appendix A) which were as follows:



WPC surveyed toxicity, oil and grease, and Fecal Coliform bacteria levels at Center Road and Chavez Boulevard (see Appendix A). Toxicity was not detected, except on May 29, 2009 at Chavez Boulevard when the toxicity measured 94 Toxicity Units. Oil and grease was typically below the detectable level, but it measured 5 mg/L (a low level) on three occasions. Fecal Coliform bacteria were always present, and on August 17, 2009, the level at both locations was greater than 6,000 per 100 milliliters.

Pollutant levels observed by the FRWC and WPC generally met applicable DEQ water quality standards (see Appendix D). However, Total Solids levels often exceeded the standard for the pollutant.

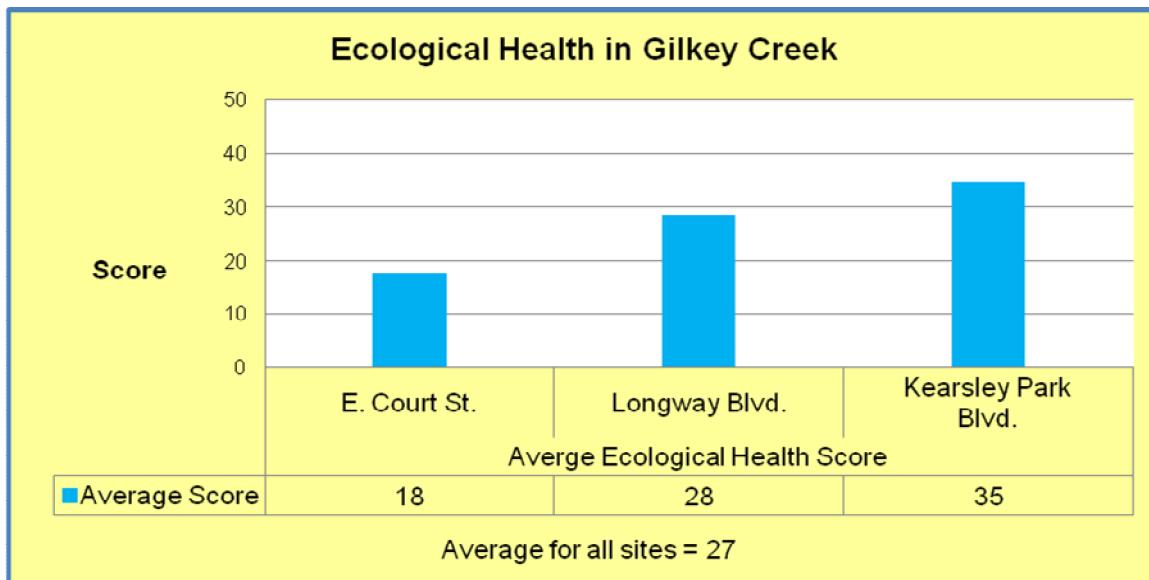
Ecological Health

The FRWC has evaluated ecological health in Gilkey Creek by sampling benthic macro-invertebrate organisms in the stream starting in 1999 (see Appendix B). Samples were collected at East Court Street, Longway Boulevard (in the Mott Applewood Estate) and Kearsley Park Boulevard (in Kearsley Park). Altogether 38 samples were collected.

Scores and ratings for indicating stream ecological health were determined based on the organism counts using the following scale:

Score	Rating
>48	Excellent
34 – 48	Good
19 - 33	Fair
<19	Poor

The average scores for each site were as follows:



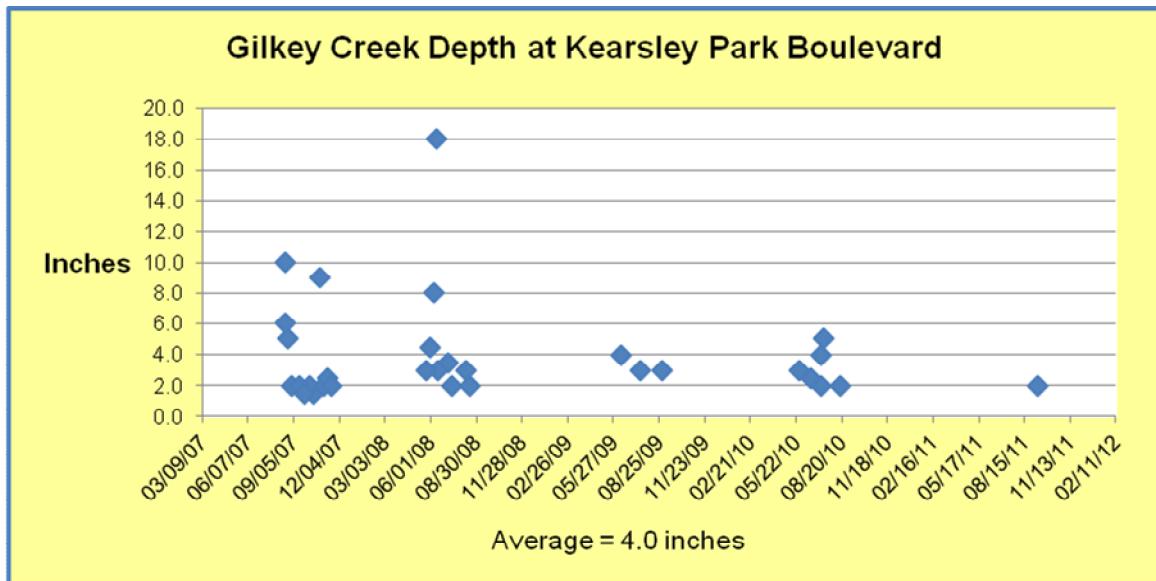
In addition, the DNR assessed the Gilkey Creek fishery in 1997, and according to its July, 2001 Flint River Assessment report, the fishery is rated as poor (impaired).

Hydrology

The FRWC measured water depth and flow in Gilkey Creek in the concrete flume at Kearsley Park Boulevard (near the mouth) shown below:



Measurements were made on 28 days during 2007 - 2011 (see Appendix C), which were as follows:



The average depth measurement was only 4 inches and the average flow measurement was less than 7 million gallons per day. And the estimated annual average flow in the creek is approximately 10 million gallons per day.

The DEQ characterizes the hydrology in Gilkey Creek as "Runoff-driven, with very low baseflow ...", and has found the mean low flow to be only 1.3 million gallons per day.

The creek nearly dries up in the summer (see the photographs below).



Recreation

There are a number of city parks in Flint and Burton in the Gilkey Creek Watershed, including Dayton, Kearsley, Burroughs, Lawndale, Pierce and Kelly Lake Parks, which Gilkey Creek flows through (see Appendix E).

Protection and Restoration

Non-point Source Pollution Potential non-point source pollution from contaminated groundwater leaking from underground storage tanks and other soil contamination sites are regulated by the DEQ under the NREPA, Parts 213 and 201, respectively, which require soil and water remediation if contamination impacts or threatens surface waters.

Point Source Pollution Point source wastewater discharges to surface waters are regulated by the DEQ under NREPA Part 31 by issuing National Pollutant Discharge Elimination System (NPDES) permits, which set pollutant discharge limits and/or require best management practices for ensuring that DEQ water quality standards are met in receiving streams to protect their designated uses.

The City of Flint and City of Burton storm sewer systems are regulated under NPDES permits that require various measures for reducing stormwater pollution and prohibiting non-stormwater discharges, such as:

- public education;
- public involvement;
- regulating sewer use;
- regulating new development and redevelopment; and
- good housekeeping practices.

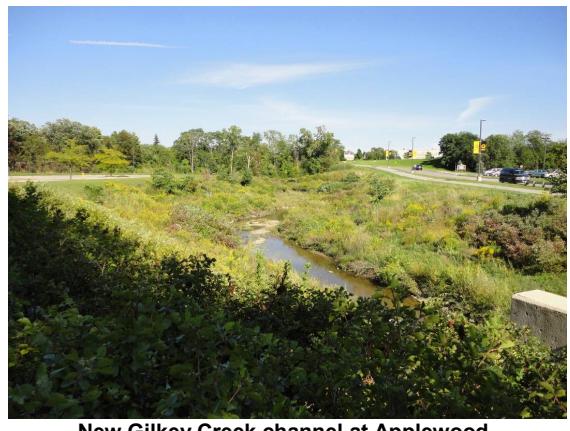
The Gilkey Creek Watershed Management Plan The UM-F has produced a Gilkey Creek Watershed Management Plan for the Ruth Mott Foundation, which has been approved for Federal Clean Water Act Section 319 funding by the DEQ. The goals and objectives of the plan are as follows:

1. Improve wildlife and other aquatic life habitat
 - Reduce stormwater runoff
 - Reduce sediment loading
 - Reduce plant nutrient runoff
 - Increase wildlife corridors
 - Increase shading of creek
2. Improve warm-water fishery
 - Reduce stormwater inputs (from impervious surfaces)
 - Reduce sediment loading

- Maintain temperature at or below the water quality standard for warm-water fishery
 - Maintain dissolved oxygen levels at or above the water quality standard for warm-water fishery
 - Minimize plant nutrient loadings
3. Increase creek aesthetics, educational opportunities and recreation use (for partial and total body contact)
 - Bacteria levels to meet partial and full body contact water quality standard
 - Reduce amount of litter, trash and floating substances to meet desired use of the Gilkey Creek
 - Reduce turbidity in creek to meet the water quality standard for physical characteristics
 - Increase visibility of creek along major thoroughfares
 - Promote current recreational and educational opportunities in watershed
 - Identify potential recreational and educational opportunities in watershed
 - Reduce oil/gas sheen found on water through municipal stormwater programs
 - Reduce plant nutrient levels
 - Enhance in-stream habitat
 4. Reduce Flooding and Improve Navigation
 - Reduce amount of stormwater runoff
 - Remove man-made and natural in-stream barriers that promote flooding and hinder navigation
 - Facilitate no net loss of wetland areas
 - Increase width of riparian buffers to accommodate 100-year storm event
 - Improve stormwater management practices
 - Bring together key agency, educational, technical and community stakeholders to facilitate solutions to flooding and protecting water quality
 5. Improve creek for public health and drinking water
 - Support wellhead protection program
 - Bacteria levels to meet partial body contact water quality standards
 - Toxicant levels in the water column to meet the water quality standard for toxic substances

The plan recommends various best management practices for meeting the objectives for reaching the goals.

[The Applewood Restoration Project](#) In 2007, a project to protect the Mott Applewood Estate from flooding and enhance wildlife habitat in Gilkey Creek was carried out in the reach encompassed by the estate. This stream rehabilitation project involved excavating a new stream channel and contouring stream banks to correct hydrological problems caused by channelization. And a stormwater retention pond and wetland were constructed next to the creek; bank armoring was installed; and riffles, check dams, pools and other types of aquatic habitat were created in the new channel (see the photographs below).



New Gilkey Creek channel at Applewood

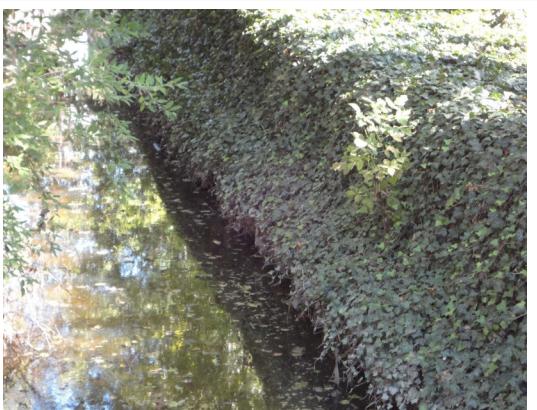


Gilkey Creek bank armoring at Applewood

Stream Bank Rehabilitation Bank armoring has been installed to stop erosion in Gilkey Creek in Kearsley Park and in Robinson Drain from Pierce Park to its mouth at Brookside Drive (see the photographs below).



Gilkey Creek bank armoring in Kearsley Park



Robinson Drain bank armoring

Discussion

The Gilkey Creek Watershed is highly urbanized, and it receives a relatively large amount of municipal stormwater, carrying pollutants such as motor oil, road salt, sediment (dirt), plant nutrients, animal feces, pesticides, and toxic metals, into streams.

Although, water quality in Gilkey Creek for supporting ecological health, assessed by chemical and physical analysis was typically rated good; the ecological health of the stream, assessed by benthic macro-invertebrate analysis, was typically rated as poor or fair (degraded) and only sometimes good. And the DNR rated its fishery as poor. This is consistent with the ecological condition predicted by the amount of urban development in the watershed.

Dissolved solids levels in the creek often exceeded the DEQ water quality standard. This may be contributing to its degraded ecological condition.

The DEQ characterizes the water chemistry in Gilkey Creek as "Eutrophic, with high nutrients". This observation is supported by the presence of abundant algal growth observed in the creek, which may be depressing dissolved oxygen levels at night. This is because algae generates dissolved oxygen, through photosynthesis, during the day and consumes oxygen, both day and night, through respiration. Excessively high dissolved oxygen concentrations were often observed at Applewood (Longway Boulevard) and in Kearsley Park (Kearsley Park Boulevard) where there was abundant filamentous algae growth and full sun exposure. Therefore, while it is producing very high dissolved oxygen levels on sunny days, it may be severely depleting dissolved oxygen at night, when oxygen is not being produced. However, dissolved oxygen levels were found to be low, but above the DEQ water quality standard (5 mg/L), at dawn. In addition, low dissolved oxygen levels were observed in the creek at other locations. This may be a problem, as periodic low oxygen levels could also be contributing to ecological degradation.

Fecal Coliform bacteria is an indicator of warm-blooded animal feces in surface waters. Therefore, the levels of this organism observed in the creek may indicate a serious pollution problem that could endanger human health.

Although, the stream bank erosion potential for Gilkey Creek was typically moderate as determined by BEHI score, severe erosion is occurring in the lower reach of the creek, especially in Kearsley Park, where the stream channel has an unnatural morphology. In addition, the creek is normally extremely shallow during dry weather. These problems have degraded fish habitat, such that the fishery is impaired.

The designated uses for Gilkey Creek for fish and other indigenous wildlife habitat are impaired and the designated uses for both partial and full-body recreation are threatened.

Conclusion

The Gilkey Creek Watershed is highly urbanized; and therefore, the streams in the watershed are impacted by urban stormwater quality and quantity, unstable hydrology, and stream chanellization to the extent that habitat for fish and other indigenous aquatic organisms is significantly degraded and opportunities for water recreation may be impaired as well.

Appendix A

Water Quality Monitoring Data

Gilkey Creek Bank Erosion Potential Determined by Soil Texture		
Site #	Soil Texture	Erosion Potential
1	Silty clay	Low
2	Silty clay	Low
3	Clayey sand/sand clay loam	Moderate
4	Clay	Low
5	Clay	Low
6	Silty clay	Low
7	Silty clay	Low
8	Sandy silt/silt loam	High
9	Clayey sand/sand clay loam	Moderate
10	Sandy silt/silt loam	High
11	Clayey sand/sand clay loam	Moderate

Data source: FRWC

Gilkey Creek Bank Erosion Potential Determined by BEHI Score		
Site #	BEHI Score	Erosion Potential
1	10.8	Low
2	10.3	Low
3	8.8	Low
4	10.8	Low
5	12.3	Moderate
6	14.3	Moderate
7	15.8	Moderate
8	8.8	Low
9	14.3	Moderate
10	15.8	Moderate
11	8.8	Low
Avg.	11.9	Moderate

Data source: FRWC

Gilkey Creek Substrate Embeddedness	
Site #	% Embeddedness
1	20
2	10
3	5
4	10
5	30

Gilkey Creek Substrate Emededness	
Site #	% Embeddedness
6	5
7	20
8	5
9	5
10	10
11	20
Avg.	13

Data source: FRWC

Gilkey Creek Suspended Sediment Levels at Kearsley Park Boulevard										
Weather	Date	Weather		Depth	Velocity	Flow		TSS		
		Precipitation				2-d Avg	7-d Avg			
						in	in			
						inches	ft/s			
Wet	07/28/11	2.53	0.73					69		
	06/20/09	0.53	0.64					88		
	08/08/09	1.95	0.56					139		
	08/25/07	0.61	0.52	5.0	1.83	15.3	9.86	77		
	06/17/09	1.73	0.50					211		
	05/20/11	0.39	0.49					24		
	06/13/08	0.36	0.39	18.0	3.78	113.4	73.29	308		
	07/04/08	0.02	0.30	3.5	<	1.31	7.6	4.94		
	09/02/07	0.00	0.29	2.0	<	1.31	4.4	2.82		
	06/08/08	0.82	0.28	8.0	1.85	24.7	15.94	63		
	06/12/09	0.01	0.26	4.0	<	1.31	8.7	5.64		
	06/09/09	0.88	0.26					9		
	08/20/07	0.82	0.25	10.0	2.73	45.5	29.41	42		
	10/13/07	0.00	0.20	1.5	<	1.31	3.3	2.12		
	07/11/10	0.09	0.18	2.0	<	1.31	4.4	2.82		
	06/15/08	0.06	0.17	3.0	<	1.31	6.6	4.23		
	08/12/07	0.05	0.17					27		
	10/27/07	0.38	0.16	9.0	1.68	25.2	16.29	60		
	07/09/10	0.55	0.16	4.0	<	1.31	8.7	5.64		
	07/16/10	0.39	0.16	5.0	1.31	0.8	0.55	37		
	10/07/07	0.00	0.15	2.0	<	1.31	4.4	2.82		
	07/19/07	0.31	0.13					43		
	08/30/09	0.02	0.13	3.0	<	1.31	6.6	4.23		
	08/10/08	0.22	0.13	3.0	<	1.31	6.6	4.23		
	07/21/07	0.00	0.12					8		
Dry	07/15/07	0.06	0.10					8		
	09/15/07	0.02	0.10	2.0	<	1.31	4.4	2.82		
	06/20/10	0.00	0.05	2.5	<	1.31	5.5	3.53		
	08/19/07	0.19	0.05	6.0	1.83	18.3	11.83	24		

Gilkey Creek Suspended Sediment Levels at Kearsley Park Boulevard										
Weather	Date	Weather		Depth	Velocity	Flow		TSS		
		Precipitation				2-d Avg	7-d Avg			
		in	in			inches	ft/s			
						cfs	mgd	mg/L		
	09/10/11	0.02	0.04	2.0	<	1.31	4.4	2.82	7	
	08/18/07	0.04	0.03						5	
	08/29/11	0.00	0.03						10	
	05/31/08	0.09	0.03	4.5	<	1.31	9.8	6.35	11	
	05/24/08	0.00	0.02	3.0	<	1.31	6.6	4.23	4	
	07/13/08	0.01	0.02	2.0	<	1.31	4.4	2.82	7	
	08/16/10	0.00	0.02	2.0	<	1.31	4.4	2.82	8	
	11/13/07	0.01	0.01						32	
	11/03/07	0.00	0.01	2.0	<	1.31	4.4	2.82	6	
	11/10/07	0.03	0.01	2.5	<	1.31	5.5	3.53	46	
	11/18/07	0.01	0.01	2.0	<	1.31	4.4	2.82	5	
	07/18/09	0.03	0.01	3.0	<	1.31	6.6	4.23	7	
	08/18/08	0.01	0.00							
	05/28/10	0.00	0.00	3.0	<	1.31	6.6	4.23	28	
	08/17/08	0.01	0.00	2.0	<	1.31	4.4	2.82	9	
	09/25/07	0.01	0.00	1.5	<	1.31	3.3	2.12	55	

Data source: FRWC

Gilkey Creek Water Quality Index Scores					
Date	Location				
	Center Rd.	Horriigan Dr.	Longway Blvd.	Kearsley Park Blvd.	Chavez Blvd.
07/15/07				73	
07/21/09				83	
08/12/07				78	
08/18/07				73	
08/19/07	84			85	
08/25/07	80			80	
09/02/07				78	
09/15/07				84	
09/25/07				74	
10/07/07				81	
10/13/07				64	
10/27/07	82			83	
11/03/07	82			79	
11/10/07	82			78	
11/18/07	77			72	
05/24/08	80			77	
05/31/08	81			77	
06/08/08	78			79	
06/15/08	81			80	
07/04/08	84			80	
07/13/08	82			68	

Gilkey Creek Water Quality Index Scores					
Date	Location				
	Center Rd.	Horriigan Dr.	Longway Blvd.	Kearsley Park Blvd.	Chavez Blvd.
08/10/08		85	86	83	
08/17/08		72	67	75	
05/27/09			78		
05/29/09	80				80
06/12/09		76		77	
06/21/09			77		
07/01/09	77				77
07/03/09			79		
07/18/09		82		64	
07/30/09	84				80
08/17/09	71				68
08/23/09			85		
08/30/09		78		72	
09/09/09	73				80
09/15/09			58		
03/29/10	81				82
04/19/10	84				84
05/19/10	85				85
05/23/10			74		
05/28/10		81		65	
06/07/10		79			
06/10/10	65				74
06/20/10		74		66	
07/11/10		77		70	
07/13/10			85		
07/20/10	68				81
08/16/10		77		71	
08/18/10			69		
08/28/11			72		
08/29/11		80		74	
09/05/10			65		
09/10/11		68		73	
09/12/11			75		
09/20/11			82		
10/05/11			70		
10/21/11			84		
11/02/11			81		
11/12/11			79		
Average	77	79	76	76	79

Data source: FRWC and WPC

Gilkey Creek Total Dissolved Solids Survey						
Date	Time	Location			TDS	
		Branch	Segment	Road Crossing	mg/L	
08/30/11	7:58 AM	Lower Main	5	Kearsley Park Blvd.	1,140	
08/30/11	8:07 AM	Lower Main	5	Longway Blvd.	1,180	
08/30/11	8:12 AM	Lower Main	5	Applewood Tr.	1,180	
08/30/11	8:17 AM	Lower Main	5	E. Court St.	1,014	
08/30/11	8:25 AM	Lower Main	5	Sunnyside Dr.	1,066	
08/30/11	8:30 AM	Lower Main	4	Brookside Dr.	1,073	
08/30/11	8:38 AM	Lower Main	4	S. Franklin Ave.	1,110	
08/30/11	8:45 AM	Lower Main	4	E. Vernon Dr.	1,087	
08/30/11	8:53 AM	Lower Main	3	Commerce St.	1,188	
08/30/11	9:00 AM	Lower Main	3	S. Averill Ave.	1,145	
08/30/11	9:08 AM	Lower Main	3	S. Center Rd.	1,196	
08/30/11	8:30 AM	Robinson Dr.	9	Kensington Ave.	1,036	
08/30/11	10:24 AM	North	6	N. Genesee Rd.	1,573	
08/30/11	9:54 AM	North	6	5205 E. Court St. N.	1,693	
08/30/11	10:00 AM	North	6	5323 E. Court St. N.	1,842	
08/30/11	10:10 AM	North	6	Barhite Dr.	1,290	
08/30/11	10:42 AM	North	6	E. Court St. - South	1,206	
08/30/11	9:20 AM	Upper Main	2	N. Genesee Rd.	843	
08/30/11	10:30 AM	Upper Main	2	S. Genesee Rd. at I-69	663	
08/30/11	9:40 AM	Upper Main	2	Lapeer Rd.	ND	

Data source: FRWC

Dissolved Oxygen Survey								
Date	Time	Location			Dissolved Oxygen		Temperature	
		Branch	Segment	Road Crossing	mg/L	% Saturation	°C	°F
05/30/10	6:10 PM	Main	5	W. Boulevard Dr.	8.45	109.4	26.6	79.9
05/30/10	6:25 PM	Main	5	Kearsley Park Blvd.	10.15	133.0	27.2	81.0
05/30/10	6:35 PM	Main	5	E. Court St.	7.08	85.0	22.5	72.5
05/30/10	6:45 PM	Main	4	S. Franklin Ave.	7.66	91.6	22.3	72.1
05/30/10	6:50 PM	Main	4	S. Dort Hwy.	8.19	98.5	22.6	72.7
05/30/10	6:57 PM	Main	3	Kelso St.	5.35	63.4	22.8	73.0
05/30/10	7:02 PM	Main	3	S. Averill Ave.	6.11	67.7	18.4	65.1
05/30/10	7:14 PM	Main	3	S. Center Rd.	13.22	169.1	25.9	78.6
05/30/10	7:49 PM	Main	2	Lapeer Rd.	5.78	75.0	26.5	79.7
05/30/10	7:55 PM	Main	2	Lippincott Ave.	6.36	80.0	25.4	77.7
05/30/10	8:10 PM	Main	1	E. Atherton Rd.	8.02	99.8	24.3	75.7
05/30/10	8:17 PM	Main	1	E. Bristol Rd.	6.41	76.9	22.4	72.3
05/30/10	8:30 PM	Main	1	S. Vasser Rd.	ND	ND	ND	ND

Data source: FRWC

Gilkey Creek Dissolved Oxygen Survey August 30, 2011					
Time	Location	Dissolved Oxygen		Temperature	
		mg/L	% Saturation	°C	°F
6:00 AM	Kearsley Park	5.37	51.8	17.7	63.9
@ 6:00AM	Applewood	5.00	53.4	17.1	62.8
@ 6:00AM	MCC	6.40	68.4	17.1	62.8
@ 6:00AM	E. Court St.	6.23	66.5	17.1	62.8

Data source: FRWC

Gilkey Creek Toxicity Levels		
Date	Center Rd.	Chavez Blvd.
	TUs	TUs
05/29/09	0	94
07/01/09	0	0
07/30/09	0	0
08/17/09	0	0
09/09/09	0	0
Average	0	19

Data source: WPC

Gilkey Creek Oil and Grease Levels		
Date	Center Rd.	Chavez Blvd.
	mg/L	mg/L
05/29/09	0	5
07/01/09	5	5
07/30/09	0	0
08/17/09	0	0
09/09/09	0	0
Average	1	2

Data source: WPC

Gilkey Creek Fecal Coliform Bacteria Levels		
Date	Center Rd.	Chavez Blvd.
	#/100 ml	#/100 ml
05/29/09	>600	>600
07/01/09	1,400	286
07/30/09	133	144
08/17/09	>6,000	>6,000

Gilkey Creek Fecal Coliform Bacteria Levels		
Date	Center Rd.	Chavez Blvd.
	#/100 ml	#/100 ml
09/09/09	320	140
03/29/10	219	204
04/19/10	270	560
05/19/10	350	273
06/10/10	390	>600
07/20/10	600	400
Geometric Mean	>503	>416

Data source: WPC

Appendix B

Ecological Health Monitoring Data

Gilkey Creek Ecological Health Scores			
Date	Location		
	E. Court St.	Longway Blvd.	Kearsley Park Blvd.
Jun-99	30		
Sep-99	11		
May-00	13		
Oct-00	19		
Apr-01	5		
Oct-01	15		
Apr-02	10		
Oct-02	24		
Apr-03	11		
Oct-03	4		
Apr-04	16		
Apr-05	16		
Oct-05	18		
Apr-06	19		
Oct-06	12		
Apr-07	18		
Oct-07	21		
Apr-08	14		
Oct-08	25		
Apr-09	24	18	41
Oct-09	35	36	29
Apr-10	13	19	33
Oct-10	29	38	36
May-11	11		22
Oct-11	35	35	42
May-12	11	25	40
Average	18	28	35

Data source: FRWC

Appendix C

Hydrology Monitoring Data

Gilkey Creek Water Depth and Flow at Kearsley Park Boulevard				
Date	Depth inches	Velocity ft/s	Flow cfs	Flow mgd
08/25/07	5.0	<	1.83	15.3
06/13/08	18.0	<	3.78	113.4
07/04/08	3.5	<	1.31	7.6
09/02/07	2.0	<	1.31	4.4
06/08/08	8.0	<	1.85	24.7
06/12/09	4.0	<	1.31	8.7
08/20/07	10.0	<	2.73	45.5
10/13/07	1.5	<	1.31	3.3
07/11/10	2.0	<	1.31	4.4
06/15/08	3.0	<	1.31	6.6
10/27/07	9.0	<	1.68	25.2
07/09/10	4.0	<	1.31	8.7
07/16/10	5.0	<	1.31	0.8
10/07/07	2.0	<	1.31	4.4
08/30/09	3.0	<	1.31	6.6
08/10/08	3.0	<	1.31	6.6
09/15/07	2.0	<	1.31	4.4
06/20/10	2.5	<	1.31	5.5
08/19/07	6.0	<	1.83	18.3
09/10/11	2.0	<	1.31	4.4
05/31/08	4.5	<	1.31	9.8
05/24/08	3.0	<	1.31	6.6
07/13/08	2.0	<	1.31	4.4
08/16/10	2.0	<	1.31	4.4
11/03/07	2.0	<	1.31	4.4
11/10/07	2.5	<	1.31	5.5
11/18/07	2.0	<	1.31	4.4
07/18/09	3.0	<	1.31	6.6
05/28/10	3.0	<	1.31	6.6
08/17/08	2.0	<	1.31	4.4
09/25/07	1.5	<	1.31	3.3
Average	4.0	<	2.14	12.2
				7.9

Data source: FRWC

Appendix D

Water Quality Standard Compliance

Water Quality Test Results vs. Water Quality Standards											
Location	Date	Ammonia Nitrogen		Dissolved Oxygen		Dissolved Solids		pH		Temperature	
		Result	WQS	Result	WQS	Result	WQS	Result	WQS	Result	WQS
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	SU	SU	°F	°F
Center Rd.	05/29/09			7.8	5.0	983	750	7.71	6.5-9.0	61.0	76
Center Rd.	07/01/09			6.2	5.0	696	750	7.44	6.5-9.0	60.4	85
Center Rd.	07/30/09			7.7	5.0	1,088	750	8.25	6.5-9.0	74.3	85
Center Rd.	08/17/09			6.1	5.0	583	750	6.77	6.5-9.0	70.5	85
Center Rd.	09/09/09			3.2	5.0	1,497	750	7.62	6.5-9.0	64.8	79
Center Rd.	03/29/10			13.4	5.0	968	750	7.80	6.5-9.0	45.0	50
Center Rd.	04/19/10			8.4	5.0	993	750	7.57	6.5-9.0	50.5	63
Center Rd.	05/19/10			9.0	5.0	814	750	7.90	6.5-9.0	61.0	76
Center Rd.	06/10/10			2.3	5.0	991	750	7.46	6.5-9.0	66.2	84
Center Rd.	07/20/10			3.8	5.0	1,305	750	8.23	6.5-9.0	76.5	85
Horigan Dr.	08/19/07			7.6	5.0	241	750	7.72	6.5-9.0	64.0	85
Horigan Dr.	08/25/07			7.3	5.0	278	750	7.69	6.5-9.0	72.0	85
Horigan Dr.	10/27/07			8.4	5.0	159	750	7.85	6.5-9.0	56.3	68
Horigan Dr.	11/03/07			11.9	5.0	702	750	8.30	6.5-9.0	49.5	55
Horigan Dr.	11/10/07			11.1	5.0	673	750	8.06	6.5-9.0	48.0	55
Horigan Dr.	11/18/07			14.7	5.0	817	750	8.32	6.5-9.0	42.3	55
Horigan Dr.	02/09/08					2820	750				
Horigan Dr.	02/17/08					1590	750				
Horigan Dr.	05/24/08			8.4	5.0	964	750	8.37	6.5-9.0	57.0	76
Horigan Dr.	05/31/08			7.8	5.0	1155	750	8.15	6.5-9.0	67.3	76
Horigan Dr.	06/08/08			6.3	5.0	293	750	7.89	6.5-9.0	73.0	84
Horigan Dr.	06/15/08			7.7	5.0	536	750	8.10	6.5-9.0	69.6	84
Horigan Dr.	07/04/08			8.7	5.0	413	750	8.22	6.5-9.0	64.6	85
Horigan Dr.	07/13/08			9.4	5.0	812	750	8.17	6.5-9.0	72.0	85
Horigan Dr.	08/10/08			8.4	5.0	466	750	8.07	6.5-9.0	63.1	85
Horigan Dr.	08/17/08			12.8	5.0	783	750	8.37	6.5-9.0	69.3	85
Horigan Dr.	06/12/09	0.06	0.210	8.8	5.0	618	750	8.25	6.5-9.0	62.1	84
Horigan Dr.	07/18/09	0.08	0.210	8.9	5.0	796	750	8.24	6.5-9.0	66.4	85
Horigan Dr.	08/30/09	0.06	0.210	9.2	5.0	520	750	7.64	6.5-9.0	60.6	85
Horigan Dr.	05/28/10	0.06	0.210	10.0	5.0	928	750	6.76	6.5-9.0	70.5	76
Horigan Dr.	06/20/10	0.03	0.210	10.6	5.0	802	750	8.13	6.5-9.0	72.1	84
Horigan Dr.	07/11/10	0.07	0.210	8.0	5.0	545	750	7.34	6.5-9.0	75.7	85
Horigan Dr.	08/16/10	0.03	0.210	9.1	5.0	526	750	8.15	6.5-9.0	73.4	85
Horigan Dr.	08/29/11	0.00	0.210	9.1	5.0	990	750	7.02	6.5-9.0	64.6	85
Horigan Dr.	09/10/11	0.00	0.210	15.3	5.0	903	750	6.99	6.5-9.0	68.5	79
Longway Blvd.	08/10/08	0.03	0.210	9.5	5.0	473	750	8.07	6.5-9.0	64.2	85
Longway Blvd.	08/17/08	0.03	0.210	20.5	5.0	773	750	8.81	6.5-9.0	78.8	85
Longway Blvd.	05/27/09	0.10	0.210	11.9	5.0	935	750	8.25	6.5-9.0	65.7	76

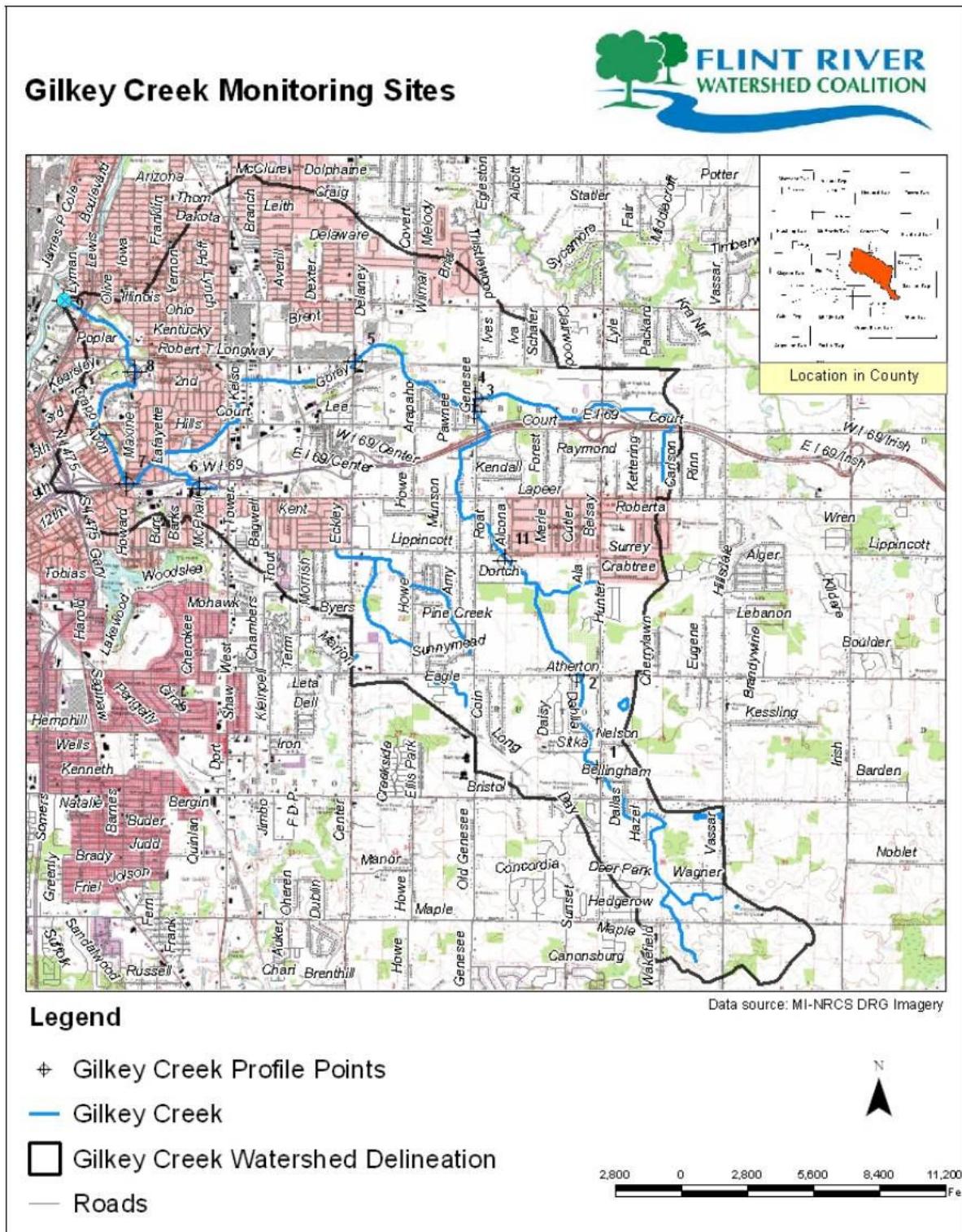
Water Quality Test Results vs. Water Quality Standards											
Location	Date	Ammonia Nitrogen		Dissolved Oxygen		Dissolved Solids		pH		Temperature	
		Result	WQS	Result	WQS	Result	WQS	Result	WQS	Result	WQS
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	SU	SU	°F	°F
Center Rd.	05/29/09			7.8	5.0	983	750	7.71	6.5-9.0	61.0	76
Center Rd.	07/01/09			6.2	5.0	696	750	7.44	6.5-9.0	60.4	85
Center Rd.	07/30/09			7.7	5.0	1,088	750	8.25	6.5-9.0	74.3	85
Center Rd.	08/17/09			6.1	5.0	583	750	6.77	6.5-9.0	70.5	85
Longway Blvd.	06/21/09	0.07	0.210	7.83	5.0	378	750	7.83	6.5-9.0	68.0	84
Longway Blvd.	07/03/09	0.05	0.210	9.39	5.0	558	750	7.69	6.5-9.0	66.7	85
Longway Blvd.	08/23/09	0.03	0.210	9.31	5.0	497	750	7.32	6.5-9.0	67.3	85
Longway Blvd.	09/15/09	0.01	0.210	OR	5.0	861	750	8.43	6.5-9.0	70.5	79
Longway Blvd.	05/23/10	0.02	0.210	13.1	5.0	653	750	7.90	6.5-9.0	67.3	76
Longway Blvd.	06/07/10	0.08	0.210	8.8	5.0	530	750	6.64	6.5-9.0	64.4	84
Longway Blvd.	07/13/10	0.09	0.210	8.4	5.0	398	750	7.99	6.5-9.0	72.1	85
Longway Blvd.	08/18/10	0.07	0.210	15.8	5.0	632	750	7.12	6.5-9.0	77.0	85
Longway Blvd.	09/05/10	0.03	0.210	13.7	5.0	451	750	6.44	6.5-9.0	71.6	79
Longway Blvd.	08/28/11	0.01	0.210	14.9	5.0	1017	750	6.98	6.5-9.0	74.1	85
Longway Blvd.	09/12/11	0.01	0.210	5.4	5.0	1050	750	6.92	6.5-9.0	69.4	79
Longway Blvd.	09/20/11			8.3	5.0	324	750	7.58	6.5-9.0	64.6	79
Longway Blvd.	10/05/11			13.5	5.0	808	750	7.38	6.5-9.0	61.0	68
Longway Blvd.	10/21/11			9.6	5.0	358	750	7.62	6.5-9.0	49.8	68
Longway Blvd.	11/02/11			14.1	5.0	1017	750	7.47	6.5-9.0	52.0	55
Longway Blvd.	11/12/11			13.6	5.0	681	750	7.73	6.5-9.0	49.5	55
Kearsley Park Blvd.	07/15/07	0.01	0.210	10.4	5.0	543	750	8.42	6.5-9.0	66.9	85
Kearsley Park Blvd.	07/21/07	0.06	0.210	7.8	5.0	361	750	8.22	6.5-9.0	73.9	85
Kearsley Park Blvd.	08/12/07	0.11	0.210	9.2	5.0	440	750	8.07	6.5-9.0	75.4	85
Kearsley Park Blvd.	08/18/07	0.04	0.210	12.2	5.0	608	750	8.55	6.5-9.0	70.0	85
Kearsley Park Blvd.	08/19/07	0.04	0.210	7.7	5.0	234	750	7.73	6.5-9.0	63.7	85
Kearsley Park Blvd.	08/25/07	0.12	0.210	7.4	5.0	280	750	7.65	6.5-9.0	73.2	85
Kearsley Park Blvd.	09/02/07	0.05	0.210	11.7	5.0	604	750	8.37	6.5-9.0	70.5	79
Kearsley Park Blvd.	09/15/07	0.03	0.210	9.3	5.0	480	750	8.12	6.5-9.0	55.4	79
Kearsley Park Blvd.	09/25/07	0.04	0.210	10.6	5.0	781	750	8.45	6.5-9.0	72.1	79
Kearsley Park Blvd.	10/07/07	0.04	0.210	8.79	5.0	544	750	8.15	6.5-9.0	69.3	68
Kearsley Park Blvd.	10/13/07	0.02	0.210	14.5	5.0	540	750	8.76	6.5-9.0	59.4	68
Kearsley Park Blvd.	10/27/07	0.00	0.210	8.6	5.0	149	750	7.86	6.5-9.0	55.8	68
Kearsley Park Blvd.	11/03/07	0.04	0.210	12.8	5.0	636	750	8.30	6.5-9.0	52.7	55
Kearsley Park Blvd.	11/10/07	0.05	0.210	12.3	5.0	586	750	8.15	6.5-9.0	48.6	55
Kearsley Park Blvd.	11/18/07	0.04	0.210	17.0	5.0	605	750	8.38	6.5-9.0	47.8	55
Kearsley Park Blvd.	05/24/08	0.27	0.210	10.3	5.0	720	750	8.21	6.5-9.0	64.6	76
Kearsley Park Blvd.	05/31/08	0.16	0.210	11.0	5.0	948	750	8.15	6.5-9.0	73.6	76
Kearsley Park Blvd.	06/08/08	0.15	0.210	6.5	5.0	294	750	7.89	6.5-9.0	73.6	84
Kearsley Park Blvd.	06/15/08	0.13	0.210	8.8	5.0	484	750	8.20	6.5-9.0	72.3	84
Kearsley Park Blvd.	07/04/08	0.06	0.210	10.2	5.0	409	750	8.39	6.5-9.0	70.0	85
Kearsley Park Blvd.	07/13/08	0.00	0.210	12.9	5.0	545	750	8.37	6.5-9.0	74.8	85
Kearsley Park Blvd.	08/10/08	0.02	0.210	9.9	5.0	440	750	8.29	6.5-9.0	66.0	85
Kearsley Park Blvd.	08/17/08	0.02	0.210	11.1	5.0	657	750	8.54	6.5-9.0	73.9	85

Water Quality Test Results vs. Water Quality Standards											
Location	Date	Ammonia Nitrogen		Dissolved Oxygen		Dissolved Solids		pH		Temperature	
		Result	WQS	Result	WQS	Result	WQS	Result	WQS	Result	WQS
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	SU	SU	°F	°F
Center Rd.	05/29/09			7.8	5.0	983	750	7.71	6.5-9.0	61.0	76
Center Rd.	07/01/09			6.2	5.0	696	750	7.44	6.5-9.0	60.4	85
Center Rd.	07/30/09			7.7	5.0	1,088	750	8.25	6.5-9.0	74.3	85
Center Rd.	08/17/09			6.1	5.0	583	750	6.77	6.5-9.0	70.5	85
Kearsley Park Blvd.	06/12/09	0.03	0.210	10.3	5.0	635	750	8.39	6.5-9.0	70.3	84
Kearsley Park Blvd.	07/18/09	0.04	0.210	14.1	5.0	791	750	8.36	6.5-9.0	75.2	85
Kearsley Park Blvd.	08/30/09	0.02	0.210	13.0	5.0	536	750	8.06	6.5-9.0	64.2	85
Kearsley Park Blvd.	05/28/10	0.05	0.210	13.6	5.0	949	750	8.26	6.5-9.0	80.1	76
Kearsley Park Blvd.	06/20/10	0.00	0.210	16.9	5.0	781	750	8.79	6.5-9.0	80.1	84
Kearsley Park Blvd.	07/11/10	0.01	0.210	13.7	5.0	571	750	8.15	6.5-9.0	82.2	85
Kearsley Park Blvd.	08/16/10	0.05	0.210	12.4	5.0	644	750	7.24	6.5-9.0	76.3	85
Kearsley Park Blvd.	08/29/11	0.00	0.210	13.7	5.0	992	750	7.25	6.5-9.0	68.0	85
Kearsley Park Blvd.	09/10/11	0.00	0.210	14.0	5.0	858	750	7.19	6.5-9.0	75.4	79
Chavez Blvd.	05/29/09			9.5	5.0	686	750	16.5	6.5-9.0	61.7	76
Chavez Blvd.	07/01/09			6.6	5.0	595	750	15.9	6.5-9.0	60.6	85
Chavez Blvd.	07/30/09			7.9	5.0	589	750	24.6	6.5-9.0	76.3	85
Chavez Blvd.	08/17/09			4.5	5.0	692	750	22.1	6.5-9.0	71.8	85
Chavez Blvd.	09/09/09			6.2	5.0	193	750	19.8	6.5-9.0	67.6	79
Chavez Blvd.	03/29/10			11.3	5.0	922	750	7.2	6.5-9.0	45.0	50
Chavez Blvd.	04/19/10			10.6	5.0	1,118	750	10.1	6.5-9.0	50.2	63
Chavez Blvd.	05/19/10			11.6	5.0	975	750	17.9	6.5-9.0	64.2	76
Chavez Blvd.	06/10/10			6.3	5.0	935	750	18.4	6.5-9.0	65.1	84
Chavez Blvd.	07/20/10			7.0	5.0	426	750	24.1	6.5-9.0	75.4	85
Average		0.05		10		702		8.9		65.9	

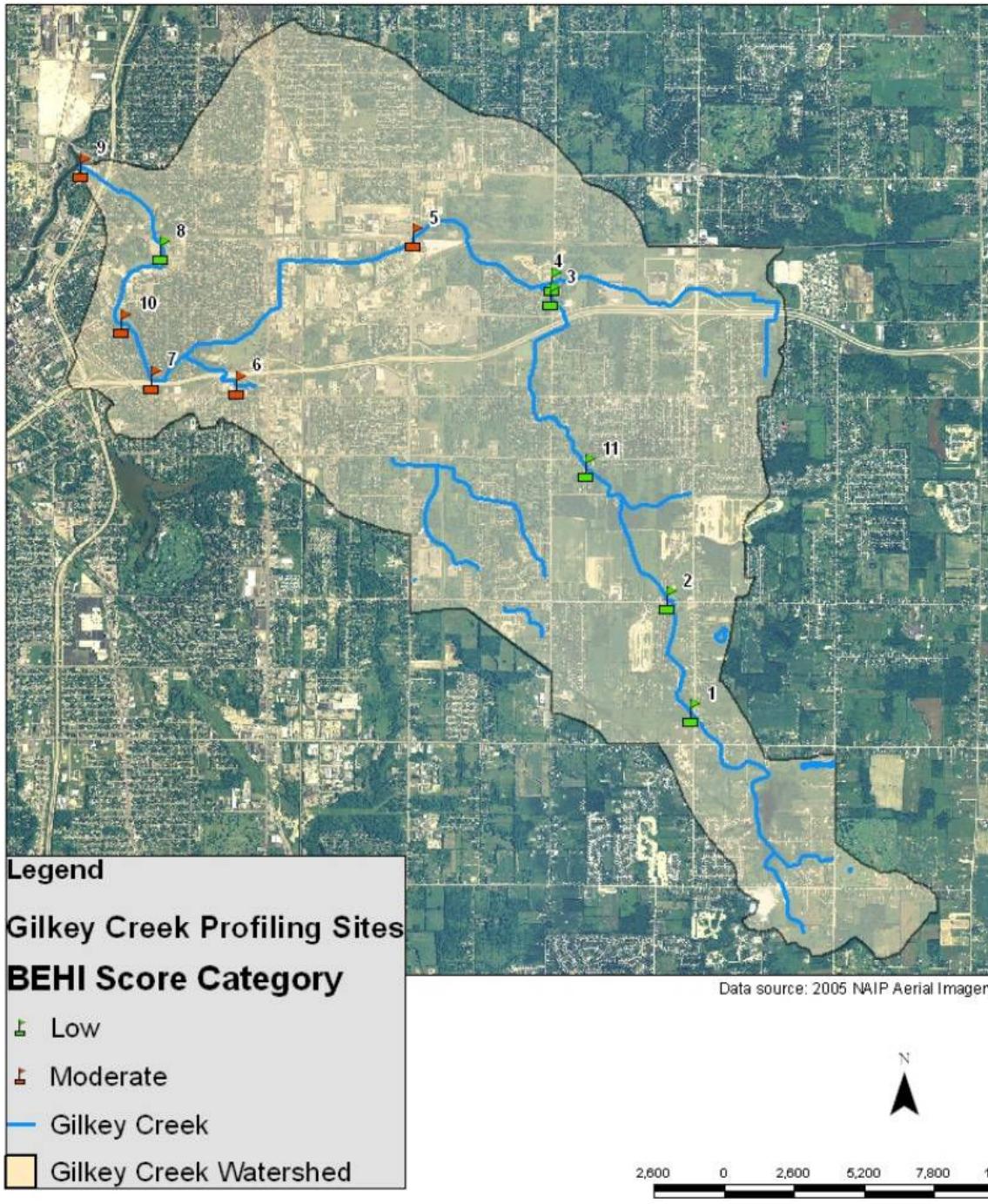
Data source: FRWC and WPC

Appendix E

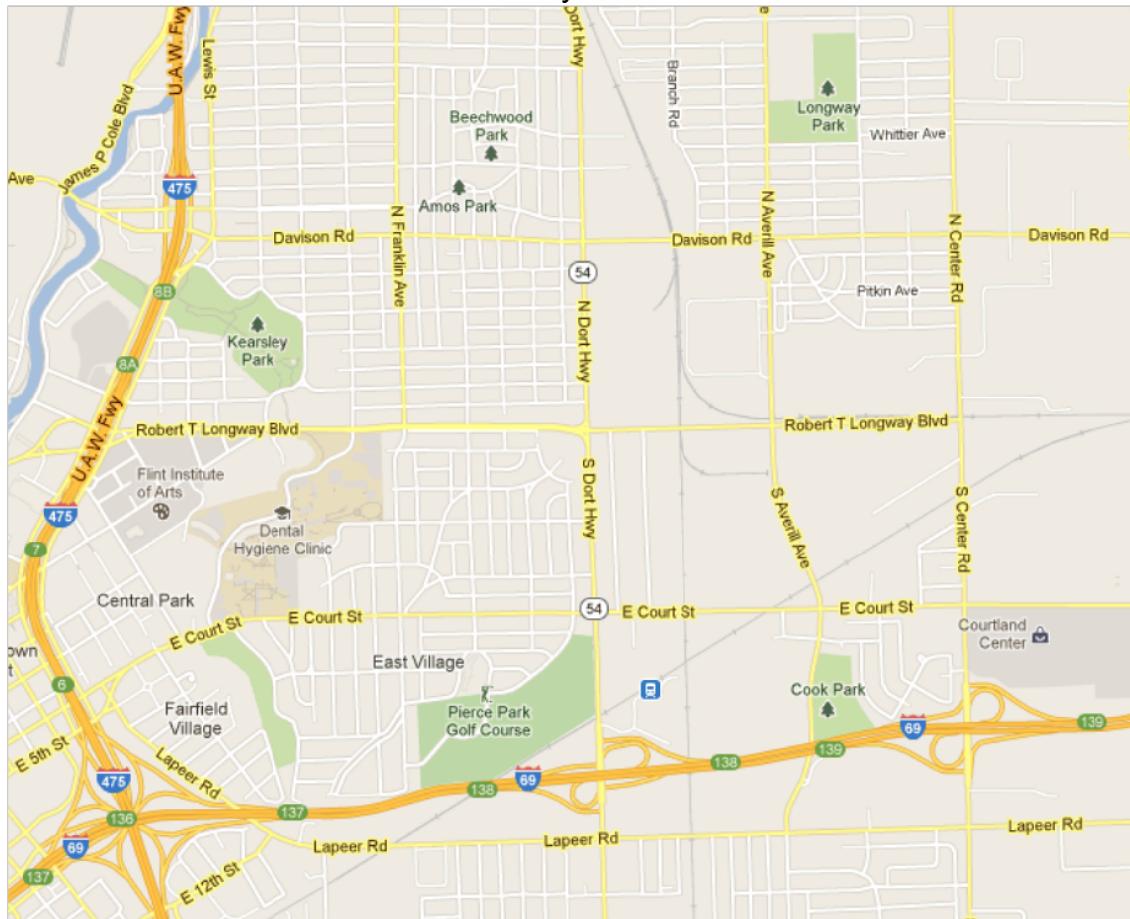
Maps



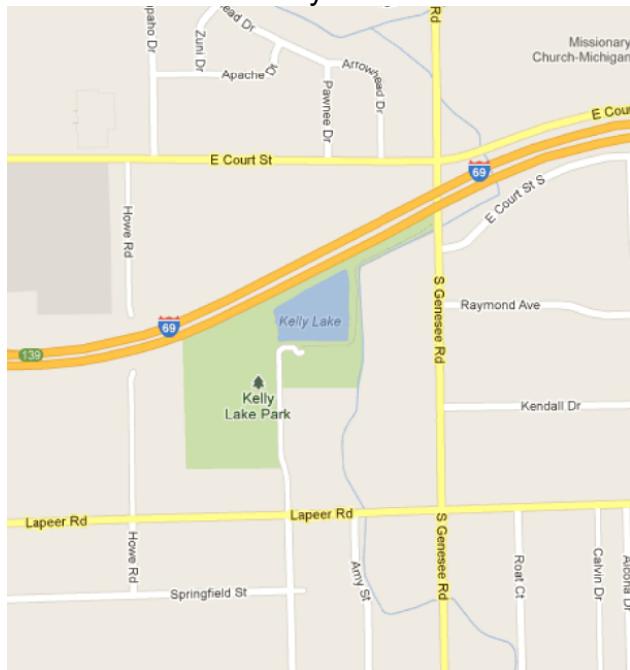
Gilkey Creek BEHI Results



Parks in the Gilkey Creek Watershed



Parks in the Gilkey Creek Watershed



Soil Contamination Sites near Gilkey Creek



Legend: pink dots represent leaking underground storage tank sites and brown squares indicate other soil contamination sites.

Source: DEQ Environmental Mapper tool