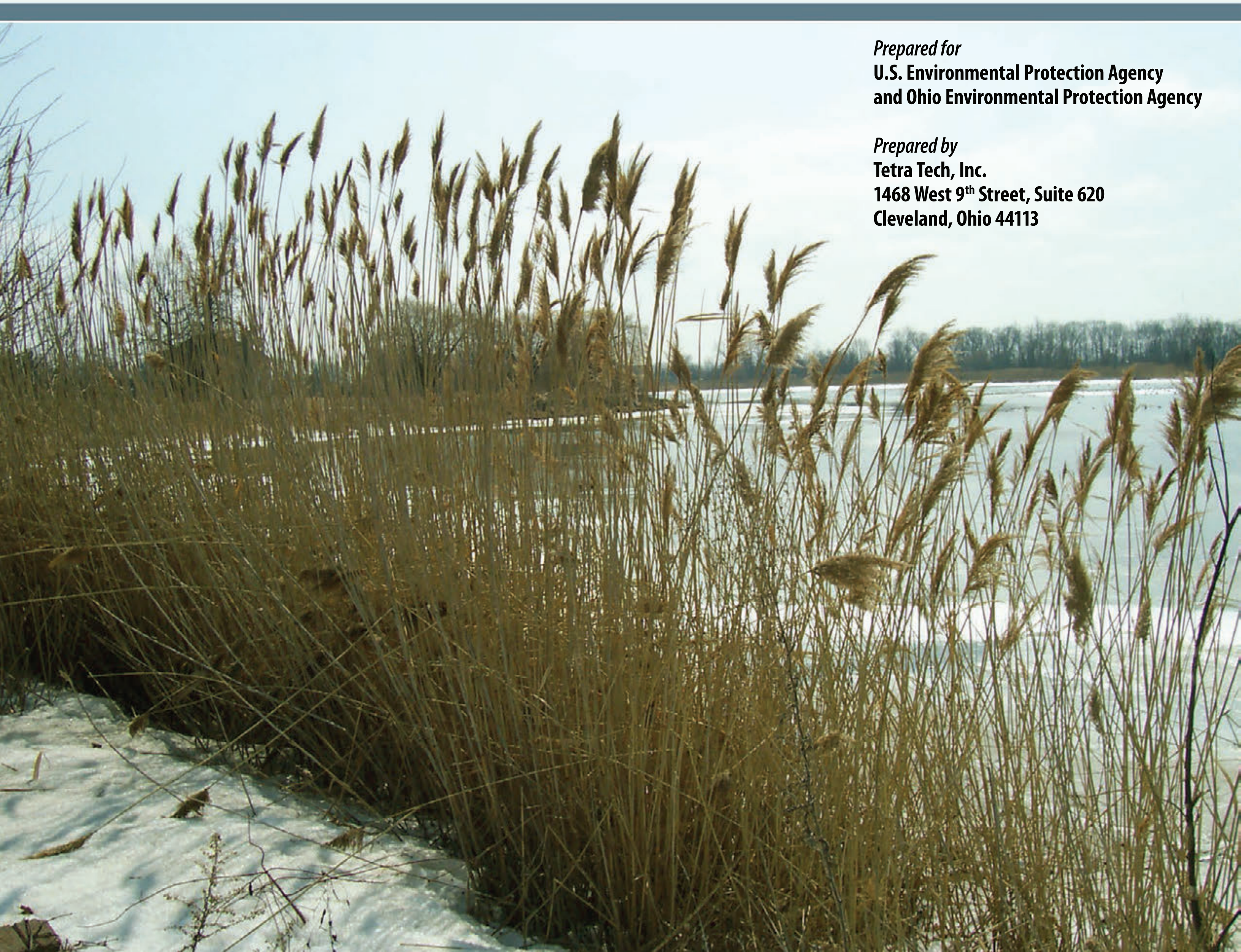


October 24, 2014

Halfway, Silver, and Shantee Creeks Analysis



Prepared for
U.S. Environmental Protection Agency
and Ohio Environmental Protection Agency

Prepared by
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Abbreviations and Acronyms

ALU	aquatic life use
AOC	area of concern
BUI	beneficial use impairment
BUSTR	Bureau of Underground Storage Tank Regulation (State Fire Marshal's Office)
DERR	Division of Environmental Response and Revitalization (Ohio EPA)
DSW	Division of Surface Water (Ohio EPA)
ESLS	Ecological Screening Levels for Sediment
FRS	Facility Registry System
HSSCA	Halfway, Silver, and Shantee Creeks Analysis
HU	hydrologic unit
HUC	hydrologic unit code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LUST	leaking underground storage tank
Michigan DEQ	Michigan Department of Environmental Quality
MIwb	Modified Index of well-being
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NWDO	Northwest District Office (Ohio EPA)
Ohio EPA	Ohio Environmental Protection Agency
OMZA	outside mixing zone average
OMZM	outside mixing zone maximum
PAH	polycyclic aromatic hydrocarbon [1]
PCB	polychlorinated biphenyl
POC	pollutant of concern
RCRA	Resource Conservation and Recovery Act
SRV	Sediment Reference Values
TMACOG	Toledo Metropolitan Area Council of Governments
Toledo DES	Toledo Division of Environmental Services (Department of Public Utilities)
U.S. EPA	U.S. Environmental Protection Agency
UST	underground storage tank
WQS	water quality standards

Units of Measure

mg/kg	milligram per kilogram
µg/kg	microgram per kilogram
µg/L	micrograms per liter

[1] Polycyclic aromatic hydrocarbons are also known as polynuclear aromatic hydrocarbons.

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The following agencies and contractors contributed to this project:

- Michigan Department of Environmental Quality
    - Remediation and Redevelopment Division
    - Water Resources Division
- Ohio Environmental Protection Agency
    - Division of Environmental Response and Revitalization
    - Division of Surface Water
- Tetra Tech, Inc.
- U.S. EPA, Region 5
    - Emergency Response Branch
    - Watersheds & Wetlands Branch
- Toledo Department of Utilities
    - Division of Engineering Services
    - Division of Environmental Services

Executive Summary

Halfway, Silver, and Shantee creeks are part of the Maumee Area of Concern (AOC) that is impaired for 10 of 14 beneficial uses (Ohio Environmental Protection Agency [Ohio EPA] 2014b). This project, entitled the Halfway, Silver, and Shantee Creeks Analysis (HSSCA), was funded by U.S. EPA Region 5 with the following three primary objectives: (1) investigate possible ongoing sources of contamination and locations of historical contamination, (2) delineate critical areas to be addressed by future activities, including remediation, and (3) research and report on the options to address the known toxic pollutants and critical areas using local input and expertise.

This document presents a summary of the results of the HSSCA. Data regarding environmental monitoring, regulated facilities, spills, and characteristics of the watershed were obtained from federal, state, and municipal regulatory agencies. These data were evaluated, within a framework of multi-scale spatial analyses, to develop a conceptual model that relates the pollutants of concern (POCs) to the POC sources and the fate and transport of the POCs through the environment.

Halfway Creek, which is mostly in undeveloped Michigan, is considerably less impacted by urban development than Silver and Shantee creeks. Fish and benthic macroinvertebrate communities' health are fair in Halfway Creek and habitat quality ranges from fair to good. Metals and PAHs were detected in a recent sediment sample, and nine polycyclic aromatic hydrocarbons (PAHs) exceeded Ohio-specific sediment reference values (SRVs). While metals were detected in water column samples in the 2000s and 2011, they did not exceed water quality standards (WQS) for the protection of aquatic life.

Much of Silver Creek is in Ohio. Its headwaters drain undeveloped southern Michigan and residential developments in the city of Toledo and Washington Township (Lucas County, OH). Silver Creek then flows through commercial areas in the city of Toledo and some industrial areas. Fish and benthic macroinvertebrate communities' health are poor in Silver Creek and habitat quality ranges from very poor to fair. Fish tissue results indicate that legacy polychlorinated biphenyls (PCBs; 2 cogeners) and pesticides (10 compounds) contaminate Silver Creek. Metals were detected in water column and sediment samples from the early 1990s and 2011; three metals exceeded Ohio-specific sediment SRVs. Six PAHs were detected in sediment above SRVs in 2011; chloroform was detected in the water column in 1994 but has not been detected since.

Shantee Creek is in Ohio and drains urban residential, commercial, and industrial areas in the city of Toledo and Washington Township in Lucas County. Fish community health is poor and benthic macroinvertebrate community health ranges from very poor to low-fair. Habitat quality in Shantee Creek ranges from very poor to poor. Fish community health is poor and benthic macroinvertebrate community health ranges from very poor to low-fair in Shantee Creek and habitat quality ranges from very poor to poor. Fish tissue results indicate that legacy PCBs (2 cogeners) and pesticides (9 compounds) contaminate Shantee Creek. Metals were detected in sediment samples from the early 1990s and metals, PCBs, and PAHs were detected in recent sediment samples. Four metals, ten PAHs, and two PCBs exceeded Ohio-specific SRVs. In the 1990s, three metals in the water column occasionally exceeded WQS for the protection of aquatic life, while no metals exceeded WQS in 2011 water column samples.1,1,1-trichloroethane was detected in the water column in 1992 but has not been detected since. The pesticides endrin, methoxychlor, and mirex were detected in the water column in 1992 and endrin exceeded the WQS.

The project area was delineated into subwatersheds for the multi-scale spatial analyses and critical areas were identified using the available environmental monitoring, facilities, and spills data. The critical areas represent locations that contain regulated facilities, had historic or recent spills and release, and have limited environmental monitoring data. Eleven critical areas were identified in the HSSCA project area along the following seven waterbodies:

- Halfway Creek (1)
- Jamieson Ditch (1), a tributary to Silver Creek
- Ketcham Ditch (1), a tributary to Silver Creek
- Shantee Creek (3)
- Silver Creek (3)
- Silver Creek Cutoff (1)
- Tifft Ditch (1), a tributary to Shantee Creek

Due to a lack of environmental monitoring data, the fate and transport of POCs from their sources to the waterbodies could not be thoroughly evaluated. To fully assess the fate and transport of POCs and to support remediation activities, additional data needs to be collected. Water column and sediment samples should be collected and evaluated for metals, PAHs, and PCBs. Additionally, fish and macroinvertebrate samples should be collected to evaluate aquatic community health and threats to public use of the waterbodies (i.e., chemical analysis of fish tissue). Such additional data will allow for an assessment of the fate and transport of POCs from their sources to the streams and will allow for stream segments to be evaluated for future remediation activities.

Collection of additional environmental monitoring data is recommended. The objective of this environmental monitoring is to identity in-stream areas of contamination. The results of this study identified areas of potential contamination (i.e., the critical areas) based upon limited existing water quality data, records and reports of regulated facilities, and spills reports. The recommended sampling will help determine if the areas of potential contamination are actually contaminated. It is expected that samples collected from the predominantly residential headwaters of the streams and ditches will not show contamination. If sample results do show contamination in specific critical areas, additional source assessment and sample collection may be necessary.

1 Introduction

Halfway, Silver, and Shantee creeks are part of the Maumee Area of Concern (AOC) that is impaired for 10 of 14 beneficial uses. The Halfway, Silver, and Shantee creeks watersheds are not supporting their aquatic life and human health designated uses due to priority inorganics and sedimentation/siltation (Ohio Environmental Protection Agency [Ohio EPA] 2014c). Before the impairments can be addressed through remediation and other activities, the causes and sources of the impairments need to be further assessed. The pollutants of concern (POCs) need to be identified, the point and nonpoint sources of the POCs need to be identified, and the fate and transport of the POCs through the watersheds need to be evaluated. Probable critical areas for future remediation activities also need to be identified and delineated. The objective of this report is to help the Maumee AOC community prioritize its future activities in the project area (Figure 1).

This summary report presents the results of the Halfway, Silver, and Shantee Creeks Analysis (HSSCA). The report begins with a watershed characterization (Section 2) and assessment of the existing water quality and stream condition (Section 3) to support the assessment of current and historical sources of POCs in the riparian corridor and upland areas (Section 4). The conceptual model and multi-scale analysis provide a framework for evaluating the sources and fate and transport of POCs in the HSSCA project area (Section 4). This framework is used on a subwatershed-scale to delineate and evaluate critical areas that are impacted by toxic pollution and urban stormwater (Section 5). The assumptions, limitations, and uncertainties of the analyses presented in this report are summarized in Section 6. Finally, the report concludes with recommendations for future potential activities to further characterize and address the POCs and their impacts upon the HSSCA project area and Maumee Bay and Lake Erie (Section 7).

Figure 1. Maumee AOC.

2 Watershed Characterization

This section briefly characterizes the HSSCA project area. Discussions of the sources of data are presented in Appendix A. Additional tables and figures that support the characterization the project area are presented in Appendix B. Refer to Hansen (1989) for a summary of the history of Lake Erie.

2.1 Project Setting

Halfway, Silver, and Shantee creeks are tributaries to North Maumee Bay in the greater Toledo area in the western basin of Lake Erie (Figure 2). Silver and Shantee creeks generally flow eastward through the city of Toledo and Sylvania and Washington townships of Lucas County in northwest Ohio. The Halfway Creek watershed is in Lenawee County and Bedford, Erie, and Whiteford townships in Monroe County in southeast Michigan; a portion of the watershed is also in the city of Toledo in Ohio. The HSSCA project area is composed of two 12-digit hydrologic units (HUs): *Shantee Creek* (hydrologic unit code [HUC] 04100001 03 01) and *Halfway Creek* (HUC 04100001 03 02). Due to re-routing of the streams, Shantee Creek now discharges to Silver Creek, which in turn, discharges to Halfway Creek; stream re-routing is further discussed in Section 2.2.

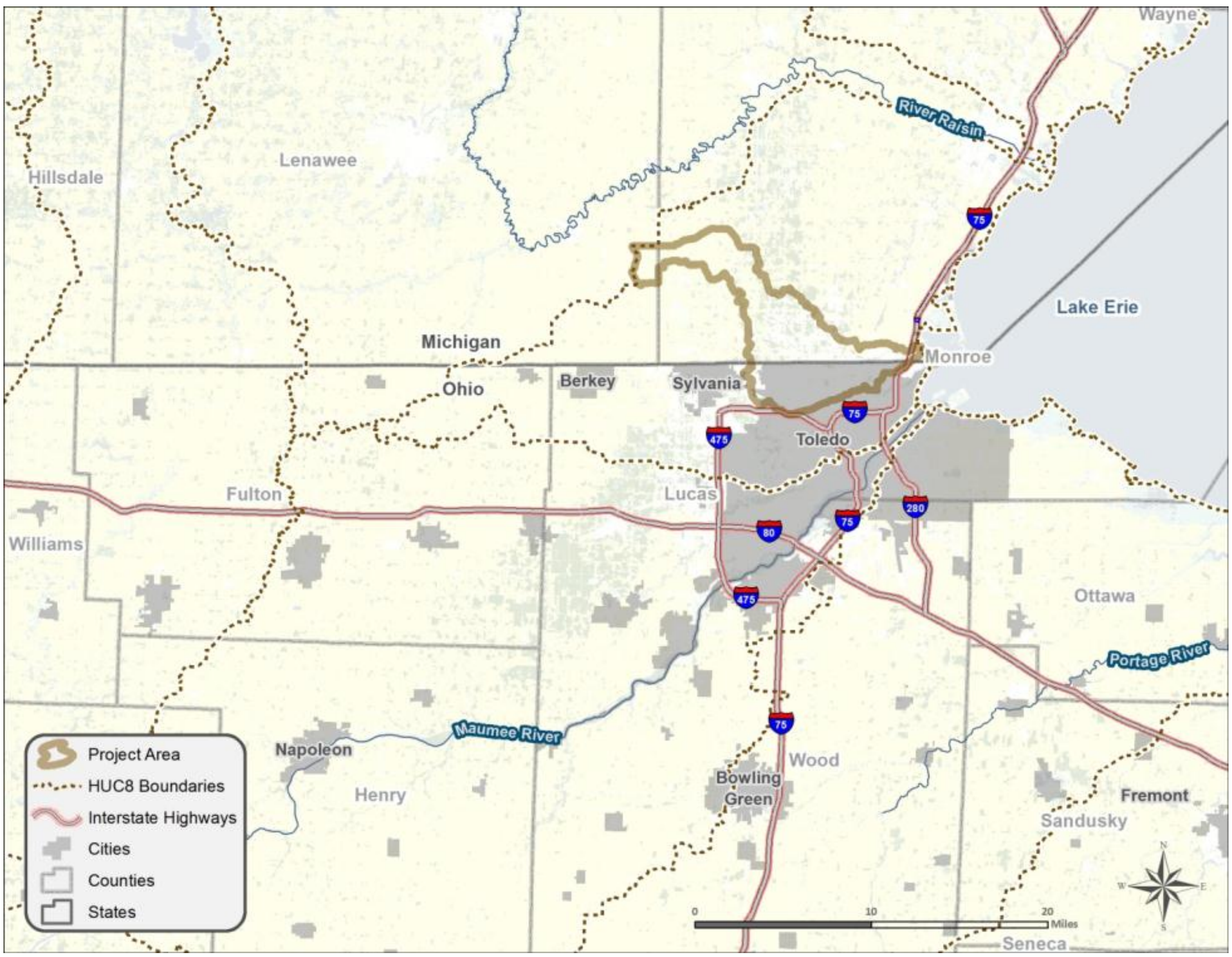


Figure 2. Northwest Ohio.

Halfway, Silver, and Shantee creeks have been channelized, culverted, piped, and re-routed during the development of Toledo and surrounding communities, with much of the work done to address flooding problems. For example, Shantee Creek was re-routed to discharge to Silver Creek and Silver Creek was re-routed such that its mouth on Halfway Creek was moved downstream from its previous location. In addition, small segments of the creeks have been re-routed for flood control and road construction. Altering these streams from their natural channels significantly affects the hydrology of the region and affects the water quality of the streams due to rapid delivery of pollutants into the streams.

The southern portion of the HSSCA project area is mostly in the city of Toledo, with small portions in Sylvania and Washington townships of Lucas County, Ohio (Figure 2). While the city of Toledo has a combined sewer system, no combined sewer overflow outfalls are in the HSSCA project area. The city of Toledo is also a Phase I municipal separate storm sewer system (MS4) and Sylvania and Washington townships are co-permittees of the *Lucas County and Others Small MS4*, which is a Phase II MS4. These watersheds and much of the Maumee AOC are characterized in the Toledo Metropolitan Area Council of Governments *TMACOG Areawide Water Quality Management Plan* (TMACOG 2013).

The HSSCA project area is within the Maumee AOC that was designated in 1985 by the International Joint Commission's Water Quality Board (Maumee RAP and Duck & Otter Creek Partnership, Inc. 2006). Numerous pollutants, including toxic substances and habitat alterations, are impairing 10 of the 14 beneficial uses of the Maumee AOC (Ohio EPA 2014b). The beneficial use impairments (BUIs) affect both human and wildlife populations:

- BUI 1 – Restrictions on Fish Consumption and Restrictions on Wildlife Consumption
- BUI 3 – Degradation of Fish Populations and Degradation of Wildlife Populations
- BUI 4 – Fish Tumors or Other Deformities
- BUI 6 – Degradation of Benthos
- BUI 7 – Restrictions on Dredging Activities
- BUI 8 – Eutrophication or Undesirable Algae
- BUI 10 – Beach Closings (Recreational Contact)
- BUI 11 – Degradation of Aesthetics
- BUI 12 – Added Costs to Agriculture or Industry
- BUI 14 – Loss of Fish Habitat and Loss of Wildlife Habitat.

The scope of the HSSCA is generally limited to toxic substances and is not intended to support the delisting of certain BUIs (e.g., BUI 7). Toxic substances released or spilled recently or historically within the HSSCA project area may be transported (or otherwise migrate) through surface waterways to Maumee Bay and Lake Erie. Thus, the HSSCA addresses the impacts of toxic substances on aquatic life that may support the delisting of certain BUIs (e.g., BUI 3).

2.2 Hydrography

The hydrography of the HSSCA project area is complex due to numerous anthropogenic activities. Streams were channelized, re-routed, culverted, and piped below grade. These activities have resulted in cutoff channels, some of which are hydrologically isolated from the original channels. However, some of these cutoff channels are hydrologically connected during peak flows associated with storm events.

During the course of the HSSCA, data and information about the anthropogenic activities that altered the hydrography and hydrology of the principal streams and ditches throughout the project area was obtained and evaluated. Using geographic information systems (GIS), a streams shapefile and watershed boundaries shapefile were created. Project specific shapefiles were needed because statewide and national GIS data were found to be in error for the project area. The streams shapefile was constructed using a streams and ditches shapefile and a storm sewer infrastructure shapefile provided by the city of Toledo's Department of Public Utilities Division of Engineering Services. For the Michigan portion of the HSSCA project area, streams were exported from the U.S. Geological Survey's (USGS) National Hydrography Dataset (NHD; USGS 2013). The streams shapefile is presented in Figure 3. Refer to Section A-3 of Appendix A for additional information regarding the GIS data.

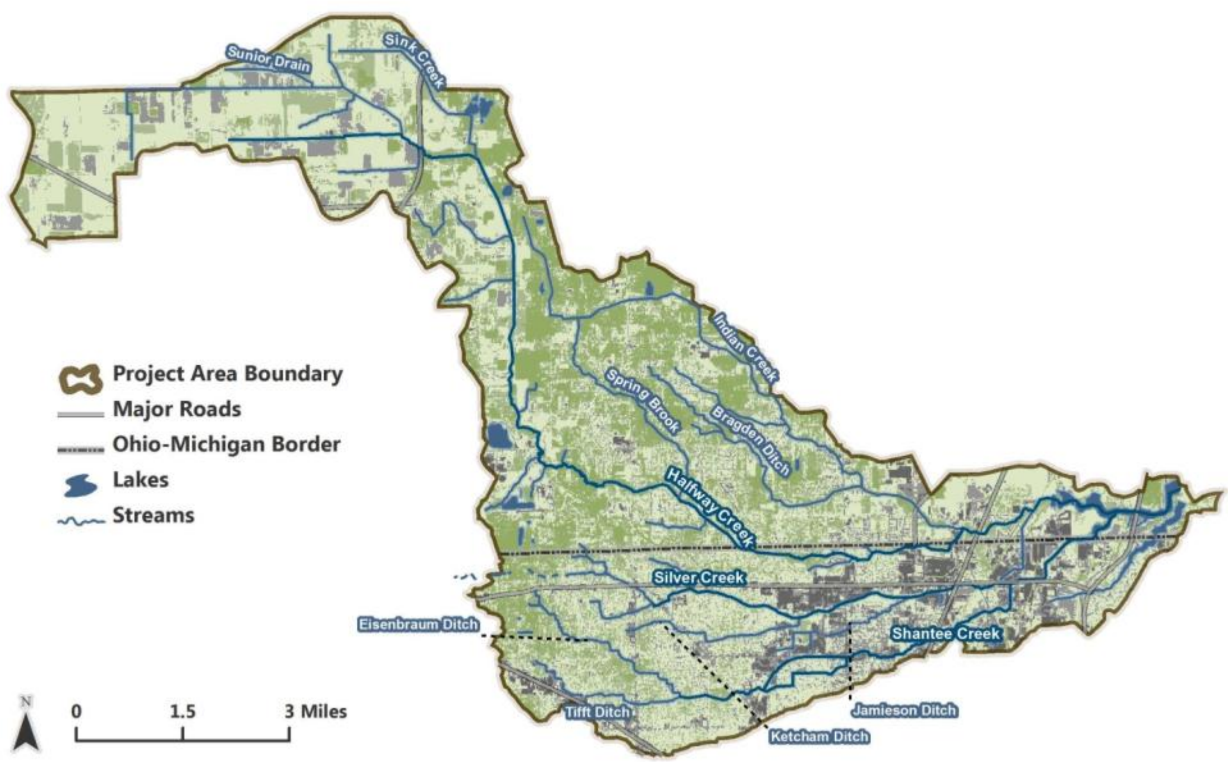


Figure 3. Streams and ditches hydrography in the HSSCA project area.

The watershed boundaries shapefile was developed using the NHD (USGS 2013). As of September 2013, the HSSCA project area is part of three 12-digit hydrologic units (HUs), as defined by USGS in the NHD (USGS 2013, Table 1). Shantee Creek Cutoff was recently removed from the Halfway Creek HU and placed in the Detwiler Ditch-Frontal Lake Erie HU.

Table 1. WAUs from the draft 2014 Integrated Report associated with the HSSCA project area

Hydrologic unit code	Name of hydrologic unit	Drainage area (square miles)	2009 streams with designated uses [a]

04100001 03 01	Shantee Creek	15.8	Silver Creek
			  Shantee Creek
			    Eisenbraum Ditch
			    Tifft Ditch
			  Ketcham Ditch

04100001 03 02	Halfway Creek	38.0	Halfway Creek
04100001 03 09	Detwiler Ditch-Frontal Lake Erie	1.7 [b] 6.7 [c]	Shantee Creek [b] (none) [c]

Notes
a. Stream designated uses were last updated in the year 2009 (Ohio EPA 2010a). Tributaries are represented by indentations.
b. This subwatershed is for the cutoff, lower segment of Shantee Creek; it is the smaller, northern subwatershed of this HU.
c. This subwatershed is for the frontal Lake Erie drainage between the Maumee and Ottawa rivers; it is the larger, southern subwatershed of this HU.

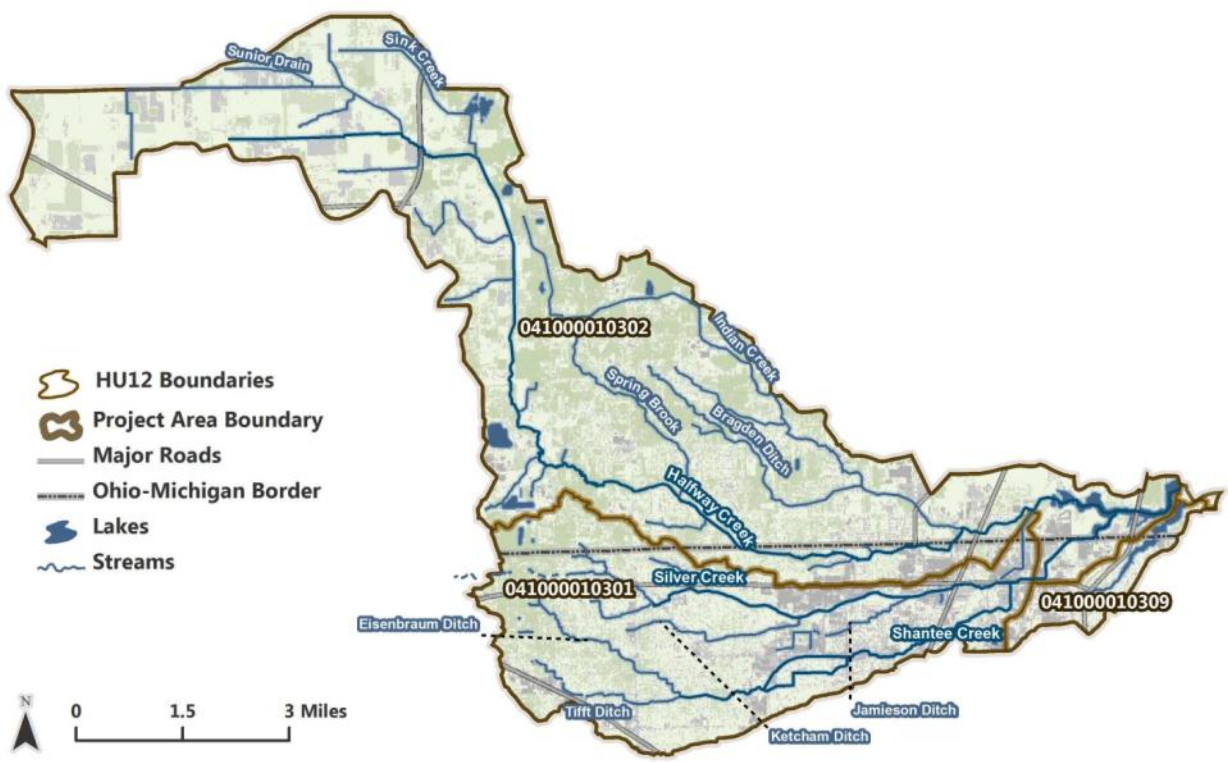


Figure 4. Hydrologic units in the HSSCA project area.

The following subsections summarize the tributaries to the principal streams in the HSSCA project area. The following four reports include additional information about the streams throughout the HSSCA project area:

- *Comprehensive Plan for Main Ditch Improvements* (Finkbeiner et al. 1971)
- *Gazetteer of Ohio Streams* (Childress 2001)
- *Master Plan for Storm Sewers in Old Washington Township, Reynolds Road Area, Byrne Road Area* (Finkbeiner et al. 1985)

- *Review of Comprehensive PLAN FOR MAIN Ditch Improvements - 1971 and Storm Drainage Study in Old Orchard. Southwest of Colony. Nopper Gardens, Beverly, West Toledo* (Finkbeiner et al. 1984)

Drainage areas and estimated 100-year recurrence interval peak flows for each tributary are presented in Table B-1 of Appendix B.

2.2.1 Halfway Creek

Halfway Creek generally flows southerly through Michigan east of the Lenawee County and Monroe County line, before flowing east back and forth across the Ohio-Michigan state line. According to the Ohio Stream Gazetteer, Halfway Creek (stream code 102) flows for 3.5 miles in Ohio, drains 18.6 square miles, and has falls 5.7 feet per mile (Childress 2001). Halfway Creek has 10 named tributaries (all in Michigan):

- **Indian Creek** flows southeast through mixed land use that is dominated by residential and forested lots. **Bragden Ditch** and **Salter Drain** are tributaries to Indian Creek that generally flow northwest to southeast.
- **Labadie Drain** flows southeast through rural, agricultural land in the northwest corner of the HSSCA project area. **McMeekian Drain** and **Sunior Drain** are tributaries to Labadie Drain.
- **Pomeroy Drain** generally flows westward through rural, agricultural land and through the Sand Wedge Golf Course.
- **Sink Creek** generally flows southeast through rural, agricultural areas and is a headwaters tributary to Halfway Creek.
- **Spring Brook** generally flows southeast then flows due south it the confluence with Halfway Creek. The subwatershed is mostly residential with one commercial industrial area and many wooded lots.
- **Swiss Garden Drain** flows west to east through mostly residential areas and is just south of the Michigan-Ohio state line.

2.2.2 Silver Creek

Silver Creek flows west to east and flows through both residential and commercial areas along the main roadways (Finkbeiner et al. 1971). The lower segment of Silver Creek, including the former mouth of Silver Creek on Halfway Creek, was cut off from the Silver Creek watershed when Silver Creek was re-routed along Alexis Road (circa early 1970s).

According to the Ohio Stream Gazetteer, Silver Creek (stream code 102.01) flows for 7.3 miles in Ohio, drains 6.22 square miles, and has falls 5.6 feet per mile (Childress 2001). Silver Creek has seven named tributaries that were described by Finkbeiner et al. (1971)(all in Ohio; small portions of the subwatersheds' headwaters are in Michigan):

- **Brock Ditch** flows northwest to southeast through mostly residential areas and some commercial areas along Secor and Alexis roads.
- **Jamieson Ditch** flows southwest to northeast through mostly residential areas with some commercial properties along major roadways. It discharges to Silver Creek.

- **Ketcham Ditch** flows west to east through residential developments. Its tributaries, **North Branch Ketcham Ditch** and **South Branch Ketcham Ditch** also flow west to east, through mostly residential areas with some commercial development along major roadways.
- **South Branch Silver Creek** flows west to east through mostly residential areas. The stream also flows through small commercial and industrial areas along Secor Road.
- **Wing Ditch** flows west to east through residential development.

USGS developed HEC-RAS models for the following streams to support FEMA flood insurance studies: Jamieson Ditch, Ketcham Ditch, North Ketcham Ditch, Silver Creek, South Branch Silver Creek, and Wing Ditch (Lucas County 2014).

2.2.3 Shantee Creek

The lower segment of Shantee Creek, including the mouth of Shantee Creek on North Maumee Bay, was cut off from the upstream watershed when Shantee Creek was re-routed into Silver Creek at Alexis Road and Enterprise Boulevard in the early 1970s. As of 2013, this lower cutoff segment is in the *Detwiler Ditch-Frontal Lake Erie* watershed (HUC 04100001 03 09)(all in Ohio).

According to the Ohio Stream Gazetteer, Shantee Creek (stream code 102.02) flows for 4.6 miles in Ohio, drains 10.92 square miles, and has falls 6.3 feet per mile (Childress 2001). Shantee Creek has seven named tributaries that were described by Finkbeiner et al. (1971):

- **Barnum Ditch** is about one-half residential and one-half commercial. Much of the stream is piped, with few open channel segments.
- **Eisenbraum Ditch** is a headwaters tributary to Shantee Creek and flows northwest to southeast through predominantly residential areas. **Ball Ditch**, **Eggman Ditch**, **Symington Ditch**, and **Webb Ditch** are small tributaries to Eisenbraum ditch in the residential areas that compose the western edge of the HSSCA project area.
- **Tifft Ditch flows** west to east through residential and commercial areas, with larger commercial areas along Monroe Street. Tifft Ditch is a headwaters tributary to Shantee Creek.

USGS developed HEC-RAS models for the following streams to support FEMA flood insurance studies: Barnum Ditch, Eisenbraum Ditch, Shantee Creek, and Tifft Ditch (Lucas County 2014).

2.3 Land Use and Land Cover

The HSSCA project area is dominated by developed land in the Ohio portion of the project area (Figure 5). In the Michigan portion of the HSSCA project area, rural and agricultural land uses dominate in the west, while the eastern potion is mixed between many land uses and land covers. The Ohio portion of the HSSCA project area is considerably more developed with much higher levels of impervious cover (Figure 6). Impervious cover in the Michigan portion of the HSSCA project area is generally limited to roads and buildings in the rural agricultural west and to small residential developments in the east.

The following three subsections present brief descriptions of the land use and land cover in the major waterways of the HSSCA project area: Halfway, Silver, and Shantee Creeks. For more specific land use and land cover information, refer to Appendix B. Areas and percentages presented herein and in Appendix B are based upon the subwatershed delineations discussed in Section 4.2, which are not exactly consistent with the boundaries of the 12-digit HUCs.

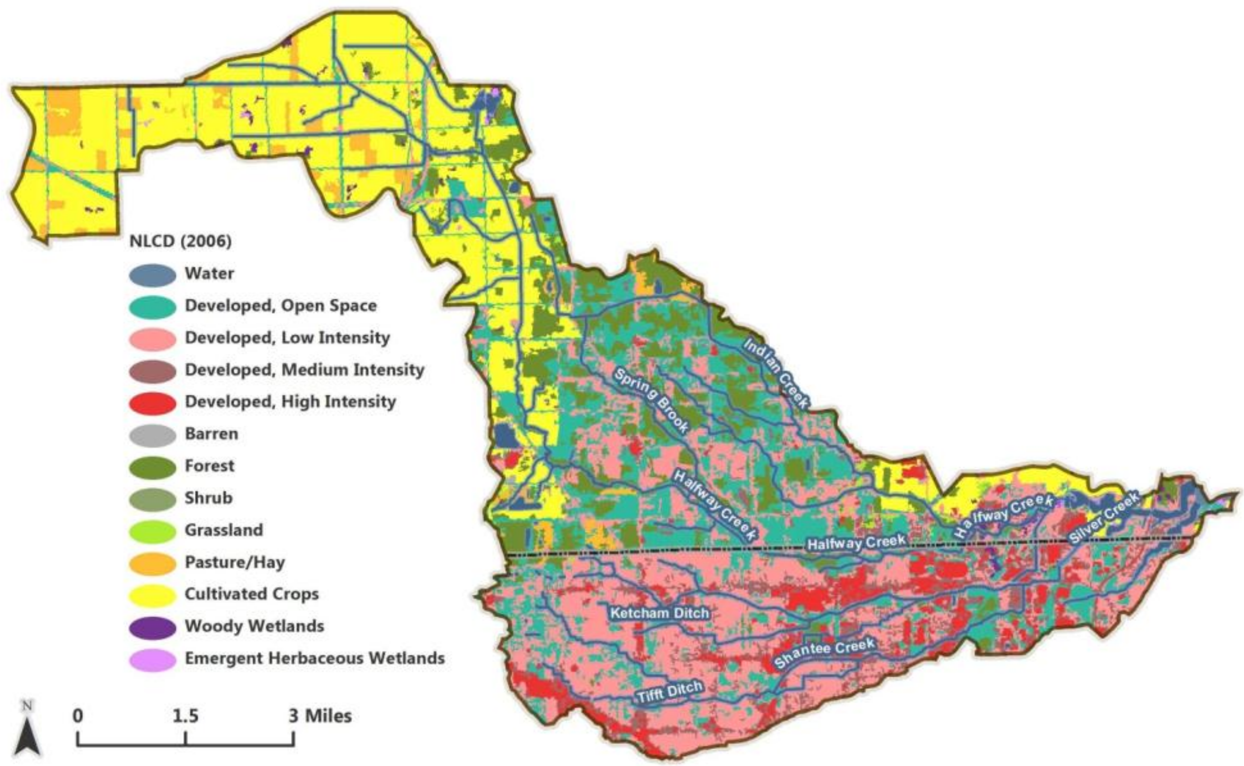


Figure 5. Land use and land cover in the HSSCA project area.

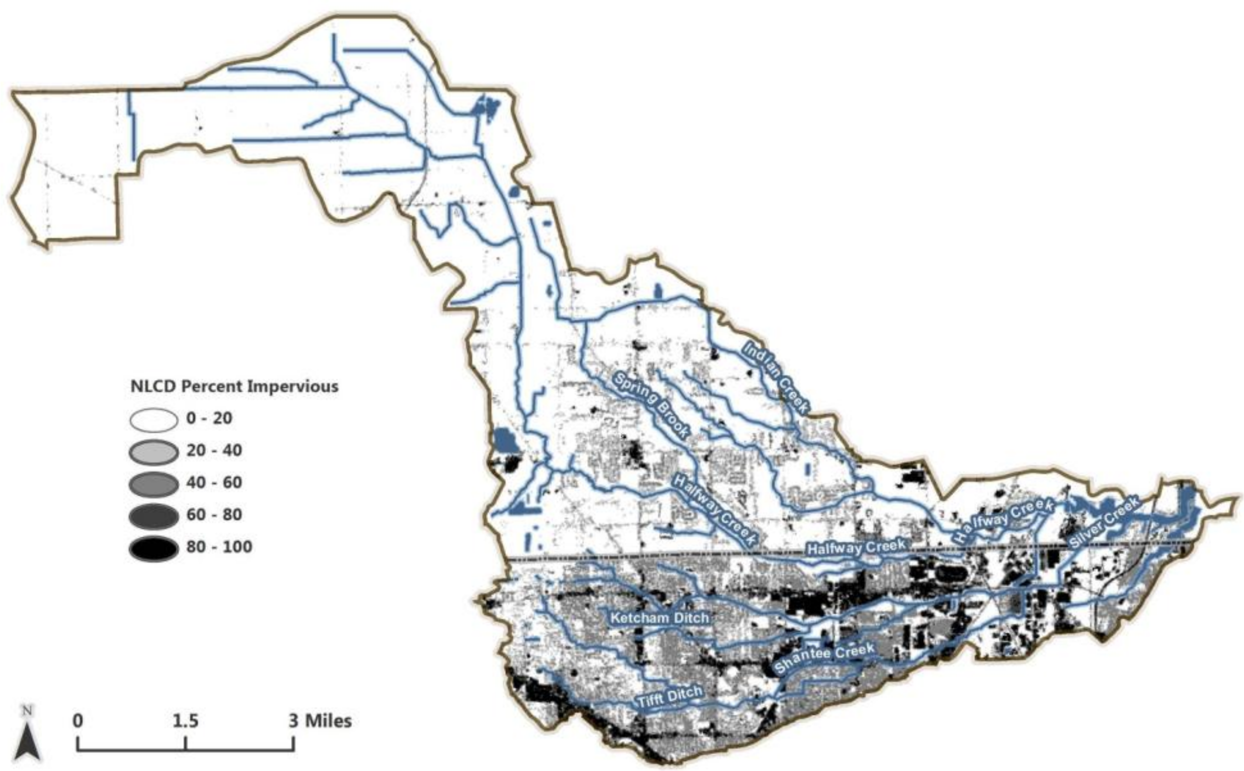


Figure 6. Percent impervious cover in the HSSCA project area.

2.3.1 Halfway Creek

The Halfway Creek HU (04100001 03 02) is mostly cultivated crops (36 percent), developed open space (21 percent), low-intensity developed land (16 percent), and deciduous forest (15 percent). Excluding Indian Creek, which is about a quarter of the HU, Halfway Creek is much more rural and has more cultivated crops (45 percent). Indian Creek is more developed (33 percent developed open space and 33 percent low-intensity developed) and more forested (30 percent).

2.3.2 Silver Creek

Silver Creek, excluding Shantee Creek and the Silver Creek Cutoff, is about half of the Shantee Creek HU (04100001 03 01). Silver Creek is dominated by developed land (92 percent) and has small amounts of deciduous forest (5 percent) and agriculture (cultivated crops, 2 percent; pasture/hay, 2 percent). The Silver Creek Cutoff subwatershed is almost exclusively developed land (98 percent) and woody wetlands (2 percent).

2.3.3 Shantee Creek

The Shantee Creek HU (04100001 03 01) is dominated by devolved land (93 percent), with low-intensity developed (45 percent) as the largest single land use. Shantee Creek (excluding the lower cutoff) is about half of the HU and is also dominated by developed land (96 percent). The Shantee Creek Cutoff subwatershed, which is part of the Detwiler Ditch-Frontal Lake Erie UU (04100001 03 09), is also dominate by developed land (91 percent). Low-intensity developed and developed open spaces are the largest land uses in both the Shantee Creek watershed (50 percent and 20 percent, respectively) and Shantee Creek Cutoff subwatershed (41 percent and 28 percent, respectively).

2.4 Geology and Soils

Northern Ohio along Lake Erie, including the HSSCA project area, was subjected to glaciation (Ohio EPA 2011a). The glacial advance and retreat had a significant influence on the topography, geology, and soils that developed in the region. In general, as glaciers advanced, existing rocks and soils were eroded repeatedly. These materials were re-deposited as sediments during several ice advance, melt, and retreat cycles. Such glacial materials were deposited as sands, gravels, silts, and clays; the melt water created large rivers, which carried and spread the deposited glacial materials throughout the region. Glacial deposits and associated land forms exerted a major effect that influences present day hydrology, soil types, and land cover.

2.4.1 Ecoregion Summary

The HSSCA project area is in the Huron/Erie Lake Plain (HELP) level III ecoregion #57 and is in the Maumee Lake Plains (#57a) and Oak Openings (#57b) level IV ecoregions (Woods et al. 2011). The general physiography, geology, and soils of the two corresponding level IV ecoregions are described in Table B-4 and Table B-5 in Appendix B; a map of these ecoregions is also in Appendix B.

2.4.2 Geology

The HSSCA project area is included within the study areas of numerous reports about the geology and hydrogeology of northwest Ohio and Lucas County (Baranoski 2013; Breen and Dumouchelle 1991; ODNR 1970; Shideler et al. 1996; Sprowls 2010). The HSSCA project is within the glaciated portion of Ohio and is underlain by limestone and dolomite aquifers.

2.4.3 Soils

Soil surveys contain predictions of soil behavior and provide data related to different soil types, including the hydrologic soil groups (HSGs). HSG refers to the grouping of soils according to their runoff potential. Soil properties that influence HSGs include depth to seasonal high water table, infiltration rate and permeability after prolonged wetting, and depth to slow permeable layer. There are four HSGs: Groups A, B, C, and D (Appendix B, Table B-6).

Using the soil surveys for each county (NRCS 2013) and GIS, the HSG was analyzed using the *Soil Data Viewer* (NRCS 2011). Soils in the HSSCA project area are fairly evenly split between four of seven HSGs A (16 percent), B (19 percent), B/D (17 percent), and C/D (17 percent; Appendix B, Table B-7 and Figure B-3). The remaining three HSGs (A/D, C, D) were a combined16 percent of the project area, and HSGs were not reported for about 15 percent of the project area.

2.5 Climate

The climate of the Great Lakes region is determined primarily by westerly atmospheric circulation, the latitude, and the local modifying influence of nearby Lake Erie (Derecki 1976).

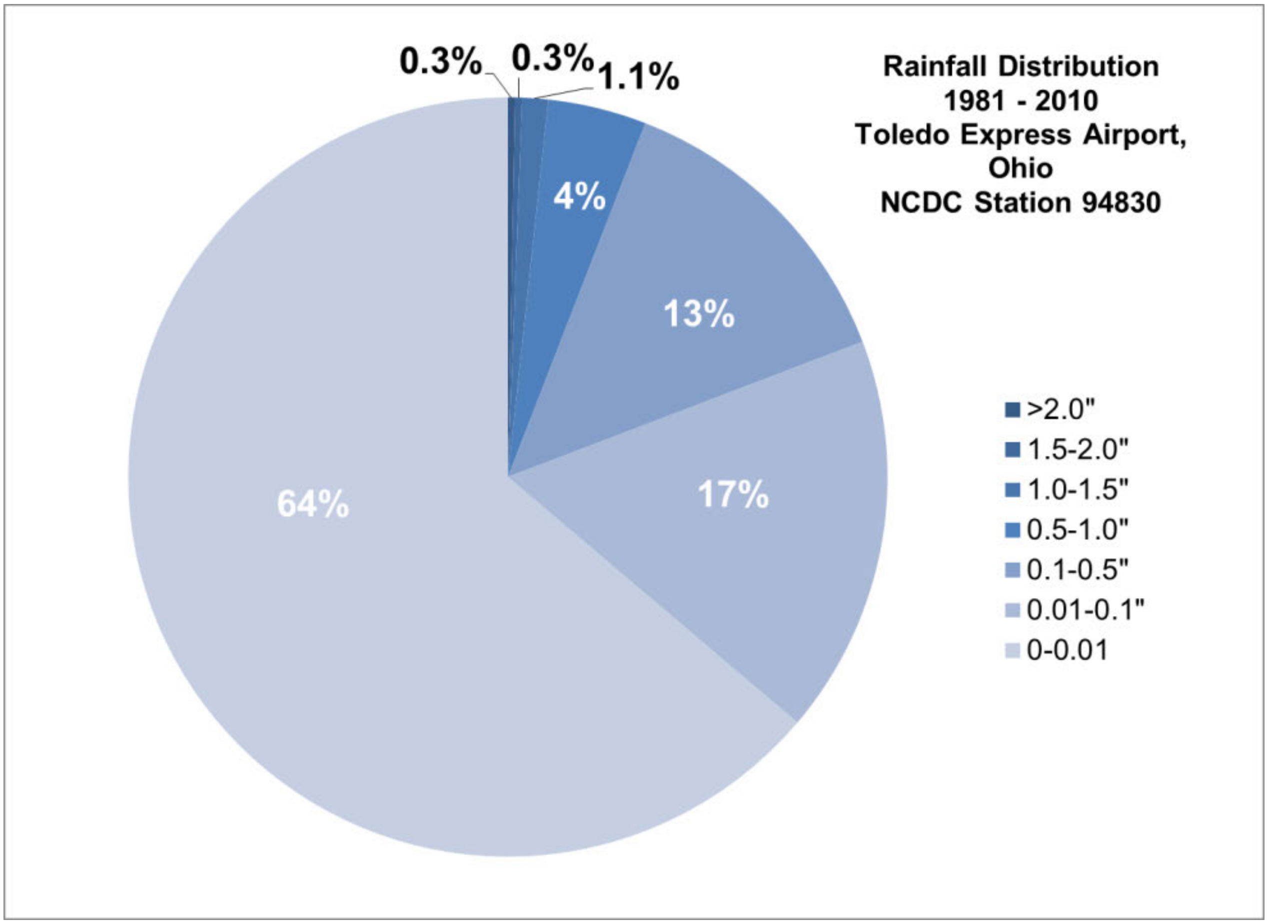
The climate of the Great Lakes basin is described as follows (U.S. EPA 1995 Chapter 2, Section 2):

> The weather in the Great Lakes basin is affected by three factors: air masses from other regions, the location of the basin within a large continental landmass, and the moderating influence of the lakes themselves. The prevailing movement of air is from the west. The characteristically changeable weather of the region is the result of alternating flows of warm, humid air from the Gulf of Mexico and cold, dry air from the Arctic.

These factors tend to increase humidity and can create lake effect precipitation during the cold fall and winter months. Despite that, the proximity to Lake Erie also moderates the local climate as the large waterbody acts as a heat sink or source, warming the air in cold months and cooling the air in the summer.

Weather data were obtained from the National Climactic Data Center (NCDC 2014): Toledo Express Airport (station 94830; 1955-2014). Daily minimum, average, and maximum temperatures from 1981 through 2010 were evaluated. The monthly average winter temperatures (December through February) were calculated to be 25.5 to 29.7 degrees Fahrenheit (°F) and the average monthly summer temperatures (June through August) were calculated to be 69.5 to 73.5 °F. From 1981 through 2010, normal annual precipitation at the Toledo Express was 34.2 inches (as water) with 37.6 inches as snowfall (Appendix B Table B-8 and Figure B-3).

Examination of precipitation patterns is a key part of watershed characterization. In particular, rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of stormwater upon streams. Figure 7 presents one method to assess rainfall intensity. The NCDC daily data show that 81 percent of precipitation events per year are less than 0.1 inch per day and that 2 percent are greater than 1 inch per day.



Note: Precipitation depths are in inches per day.

Figure 7. Precipitation intensity at the Toledo Express Airport (station 94830).

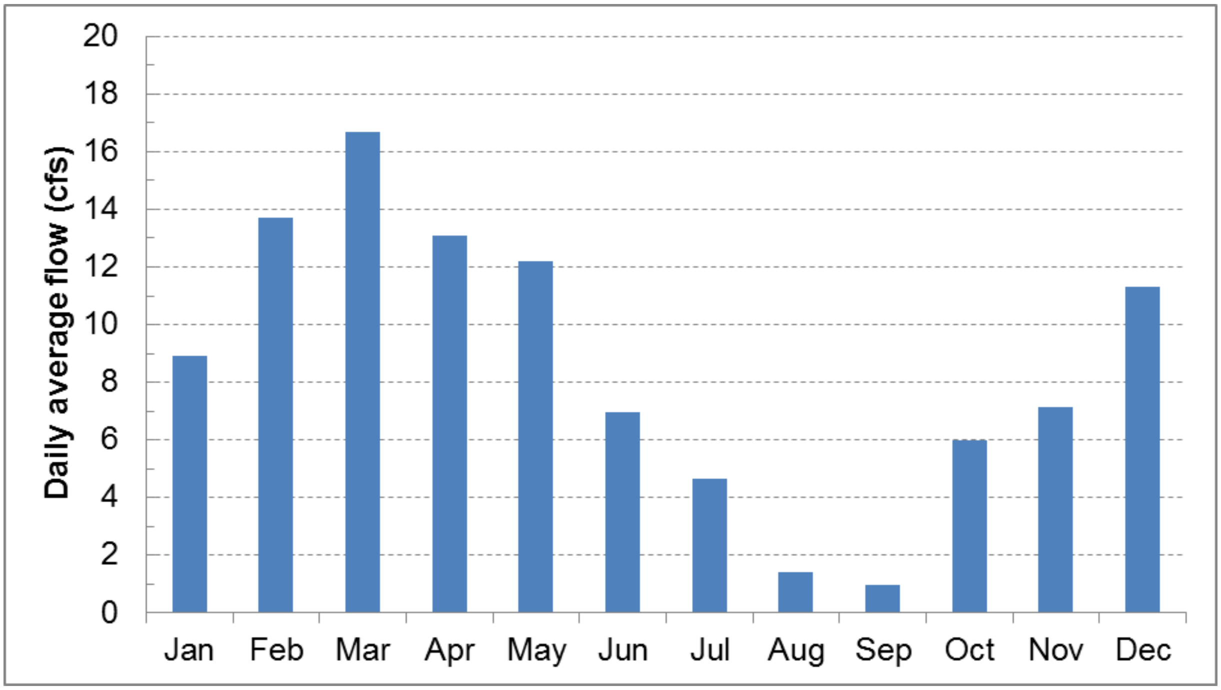
2.6 Hydrology

Hydrology plays an important role in evaluating water quality. In the HSSCA project area, hydrology is primarily driven by local climate conditions. This includes situations that often result in flashy flows, where the stream responds to and recovers from precipitation events relatively quickly.

The conversion of swamp land to agricultural land and then to urban development was helped by installing ditches and channelizing streams to improve drainage. Toledo also installed subsurface storm sewers, with the main lines generally running along major roads that discharge to the HSSCA project area streams. The drainage improvements also influence the hydrology, aquatic habitat, and water quality of area streams.

The lower segments of the Halfway Creek, Silver Creek, and Shantee Creek Cutoff, along with the small direct tributaries to Maumee Bay are lacustrine, which means that waters from the streams and Lake Erie mix within a freshwater estuary. These lacustuaries are slack water that can ebb and flow as lake seiches affect water levels; the lacustuaries are generally located between the farthest downstream riffle of the tributary and Lake Erie proper. All tributaries of lacustuaries are considered lacustuaries below the Lake Erie mean high water level. Anecdotal information regarding the extent of the lacustuaries is presented in Section A-5 of Appendix A.

USGS does not maintain any continuously recording gages on streams in the HSSCA project area. USGS's *StreamStats in Ohio* (Koltun et al. 2006) was used to estimate pertinent flow information for Silver Creek near Hagman Road. The mean annual flow was 6.43 cfs and Figure 8 presents the monthly average flows at this site. Additional results from *StreamStats in Ohio* are presented in Table B-9 of Appendix B.



Based upon: Koltun et al 2006

Figure 8. Daily average flow per month in Silver Creek near Hagman Road.

The groundwater hydrography and hydrology of the unconfined surficial sand aquifer and deeper carbonate aquifer underlying Lucas County is thoroughly documented by USGS (Breen and Dumouchelle 1991) and ODNR (1970). Both agencies have also developed potentiometric surface maps for Lucas County (Breen 1989; ODNR 2011a,b).

3 Water Quality Assessment

Halfway, Silver, and Shantee creeks are impaired by toxic pollution and to facilitate eventual remediation, the toxic pollution must be assessed. This section presents a synopsis of the available water quality data that are used to assess the toxic pollution. The identification of the POCs relied upon the available water quality data and spills reports. The section begins with a brief summary of the attainment statuses of Halfway, Silver, and Shantee creeks, continues with discussions of each type of water quality data, and concludes with a summary of these data.

The Clean Water Act and U.S. EPA regulations require that states assess waterways for attainment of state water quality standards. Ohio EPA and the Michigan Department of Environmental Quality (Michigan DEQ) each assessed their portions of the HSSCA project area and reported the results in their integrated reports (Ohio EPA 2014c; Michigan DEQ 2014). Generally, the agencies sampling has been driven by the need to assess aquatic community health and has not specifically been designed to investigate certain spills. In Ohio, the *Halfway Creek* and *Shantee Creek* watershed assessment units (equivalent to HUs) are not attaining their designated aquatic life uses (ALUs) and human health uses, and are on Ohio's 2014 Clean Water Act section 303(d) list. The ALU impairments for these two watershed assessment units are caused by priority organics (e.g., polycyclic aromatic hydrocarbons, polychlorinated biphenyls) and sedimentation/siltation from sediment re-suspension (contaminated sediments) and urban runoff/storm sewers (Ohio EPA 2014c). The human health use impairments are due to elevated levels of PCBs in historic fish tissue sampling in fish communities in the Ottawa River. The Michigan portion of the *Halfway Creek* HU is also not supporting its designated other indigenous aquatic life and wildlife use because of mercury in the water column (Michigan DEQ 2014).

3.1 Biological Communities

Ohio EPA and Michigan DEQ evaluated the aquatic biological communities through the collection of fish and macroinvertebrates. Both agencies use indices of biological community health to evaluate the quality and impairment status of the state waterways. Fish and macroinvertebrate community health index scores tended to be poor in Ohio and macroinvertebrate scores were better in Michigan. Michigan DEQ (2004, 2006) has reported on biological community health in the Halfway Creek watershed, and Ohio EPA is expected to issue a report for the Ottawa River basin that will include evaluations of the biological data collected in 2011 in the HSSCA project area.

3.1.1 Fish Community Health

Ohio EPA collected fish in Halfway, Silver, and Shantee creeks fifteen times during the following three years: 1992, 1993, and 2011. The agency calculated scores for the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb); refer to Section A-1.1 of Appendix A for fish indices scores and a map of fish sample sites.

The designated ALUs for the upper halves of both Shantee and Silver creeks are limited resources waters and the lower halves are designated modified warmwater habitat; large and diverse fish communities are not expected for these streams. Almost all of the IBI and MIwb scores from Shantee and Silver creeks indicate poor community health and the creeks are not meeting their biological criteria[2]. In 1992 and 1993, the five calculated IBI scores in Shantee Creek were 12 or 14, which is at or just above the minimum IBI score of 12 (i.e, very poor scores), and MIwb scores ranged from 1.071 to 2.571 (i.e., very

[2] The biological criteria for headwaters (<20 square miles) and wading size (20-100 square miles) streams in the Huron/Erie Lake Plain that are designated modified warmwater habitat due to channel modification are IBI scores of 20 (headwaters) and 22 (wading) and an MIwb score of 5.6 (wading).

poor scores; Table A-2 in Appendix A). IBI scores from 1992 and 1993 fish sampling in Silver Creek were also poor (n=5, range: 12-26); MIwb scores ranged from 0.547 to 4.330. In 2011, the Shantee Creek IBI scores were 12 and 24, while both Silver Creek sites yielded scores of 16.

Halfway Creek is designated warmwater habitat in Ohio and is meeting its biological criteria[3]. Halfway Creek was only sampled once in 2011 and the sample site is upstream of the mouths of Silver Creek and Silver Creek Cutoff, which drain the city of Toledo. The single 2011 sampling event yielded an IBI score of 36 and a MIwb score of 7.959, which indicates better fish community health than Shantee and Silver creeks.

3.1.2 Macroinvertebrate Community Health

Ohio EPA collected benthic macroinvertebrates in 1992, 1993, and 2011 in Halfway, Silver, and Shantee creeks and calculated the scores for the Invertebrate Community Index (ICI). Michigan DEQ collected benthic macroinvertebrates from Halfway and Indian creeks in 2000, 2005, and 2010 and calculated scores for Procedure #51 (Michigan DEQ 2004, 2006). Refer to Section A-1.1 of Appendix A for macroinvertebrate indices scores and a map of macroinvertebrate sample sites.

Narrative ICI scores were determined by Ohio EPA from macroinvertebrate samples collected in 1992 and 1993 from Shantee and Silver Creek; all the scores were poor. In 2011, the two Shantee Creek scores were very poor and low fair, while the two Silver Creek scores were still poor.

Michigan DEQ macroinvertebrate sampling yielded Procedure #51 scores of acceptable for Halfway and Indian creeks in 2000, 2005, and 2010. Ohio EPA determined a narrative ICI score of fair for Halfway Creek in 2011.

3.2 Habitat

Ohio EPA and Michigan DEQ evaluated stream habitat through the use of field work and indices. Generally, habitat in the Halfway Creek watershed was better than the habitat in the Silver and Shantee creeks' watersheds. QHEI scores for Silver Creek ranged from 18 to 43, which indicate very poor through fair habitat, and scores ranged from 20.5 to 28 in Shantee Creek, which indicate very poor through poor habitat. Typically, Silver and Shantee creeks had low substrate metric scores (range: 0 to 6.5 out of 20). Many of the habitat assessments showed heavy siltation and extensive embeddedness. In 1992 and 1993, both creeks had low channel morphology scores (range: 4 to 6 out of 20) due to recent channelization, little to no sinuosity, and poor development. In 2011, channels were recovered or recovering and sinuosity and development improved. QHEI scores from Ketcham and Tifft ditches, which are tributaries to Silver and Shantee creeks (respectively), were very poor. Ketcham and Tifft ditches scored very poorly on substrate (-2 and 0, respectively) and channel morphology (6 and 4, respectively) for the same reasons as Silver and Shantee creeks.

In 2011, the only year Ohio EPA evaluated habitat along Halfway Creek, the QHEI score was 50 and indicates fair habitat quality. Like Silver and Shantee creeks, Halfway Creek scored poorly in the substrate metric (4 out of 20 points) due, in part, to heavy siltation and extensive embeddedness. Unlike Silver and Shantee creek, Halfway Creek scored very well in the pool/glide and gradient metrics. Michigan DEQ found habitat to be fair to good along Halfway Creek and fair to marginal on Indian Creek, a tributary to Halfway Creek.

[3] The biological criteria for a wading size (20-100 square miles) stream in the Huron/Erie Lake Plain that is designated warmwater habitat are an IBI score of 32 and a MIwb score of 7.3 (Table 7-15 of *OAC-3745-1-07*).

Habitat index scores and a map are presented in Section A-1.2 of Appendix A. Additionally, Michigan DEQ (2004, 2006) has reported on habitat in the Halfway Creek watershed, and Ohio EPA is expected to issue a report for the Ottawa River basin that will include evaluations of the habitat data collected in 2011 in the HSSCA project area.

3.3 Groundwater Chemistry

USGS evaluated the hydrology and water quality of aquifers in Lucas, Sandusky, and Wood counties in 1991, including analyses of (1) the shallow sand aquifer in western Lucas County and (2) the carbonate aquifer in Silurian and Devonian bedrock that is within a regional groundwater system (Breen and Dumouchelle 1991). ODNR has also studied the carbonate aquifer (ODNR 1970). DRASTIC was used to evaluate the pollution potential of groundwater in Lucas County (Sprowls 2010), including in the glacial lake plain deposit dominated HSSCA project area.

USGS concluded that urban development has affected groundwater in the unconfined surficial sand aquifer that is underlain by a clay-rich drift and is recharged by precipitation (Breen and Dumouchelle 1991). USGS did not detect any VOCs in samples collected from the shallow surficial aquifer (Breen and Dumouchelle 1991, p. 72). Iron and manganese were detected at levels greater than 0.5 mg/L and 0.2 mg/L (respectively), which affect the aesthetic quality of the groundwater (Breen and Dumouchelle 1991, p.129).

3.4 Fish Tissue Chemistry

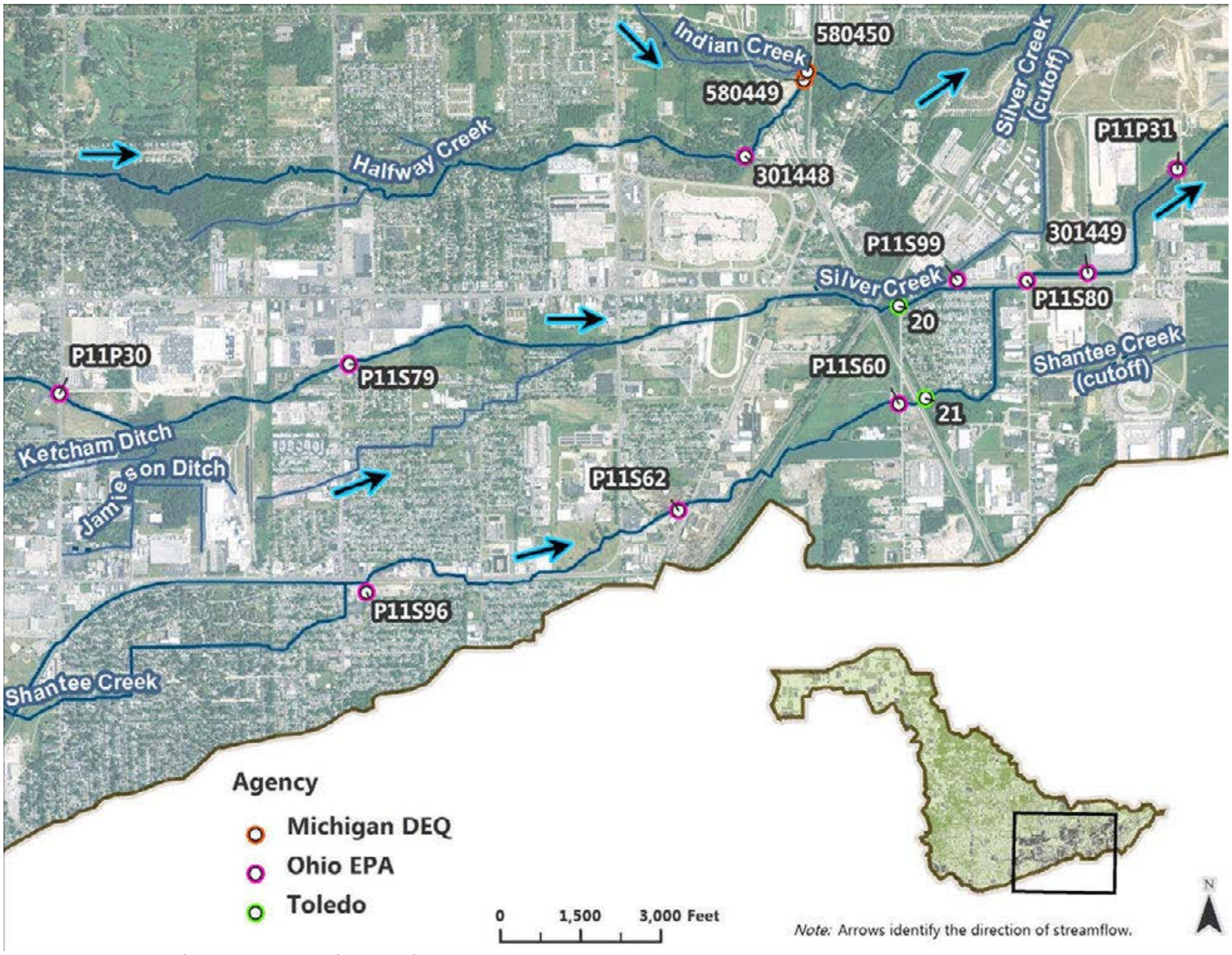
Ohio EPA collected fish from Shantee and Silver creeks in 1993 and evaluated the fish tissue for metals, PCBs, and pesticides (Section A-1.3 of Appendix A). Cadmium (0.03 µg/kg and 0.06 µg/kg), lead (1.23 µg/kg and 0.28 µg/kg), mercury (0.028 µg/kg and 0.014 µg/kg), and selenium (0.16 µg/kg and 0.44 µg/kg) were detected, while arsenic (<0.3 µg/kg) was not detected. Fish tissue samples were evaluated for seven PCB cogeners and two cogeners were detected (i.e., 1248 and 1260). Fish tissue samples were also evaluated for 24 pesticides and 10 pesticides were detected (i.e., aldrin, alphachlor, DDD, DDE, dieldrin, gammachlor, hepepoxide, cis-nonachlor, trans-nonachlor, and oxychlordane).

3.5 Water Column Chemistry

Water column chemistry samples were collected by four agencies: Ohio EPA, Michigan DEQ, Toledo DES, and USGS. Many of the samples were evaluated for parameters outside the scope of the HSSCA (e.g., bacteria, nutrients). Samples that were evaluated for metals and organic compounds, including pesticides, are presented in this section.

3.5.1 Metals

Ohio EPA, Michigan DEQ and Toledo DES collected samples throughout the HSSCA project area and evaluated them for metals, including arsenic and lead (Figure 9; Table 2). Summary tables of metals results by waterbody are presented in Appendix C.



Note: Arrows identify the direction of streamflow.

Figure 9. Water column samples that were evaluated for metals.

Table 2. Water column chemistry samples evaluated for metals

Stream	RM	Site ID	Agency	Data year(s)	No. of samples	No. of metals analyzed [a]	No. of metals det. [b]
Shantee Creek (HUC 04100001 03 01)							
Shantee Creek	2.90[c]	P11S96	Ohio EPA	2011	5	11	5-8
	2.10[c]	P11S62	Ohio EPA	1987	1	8	4
	0.70	P11S60	Ohio EPA	1987, 1992, 1994, 2011	10	8-11	3-9
	0.61[d]	21	Toledo DES	1995-2013	93	2-10	1-5
	0.10	P11S80	Ohio EPA	1992, 1994	4	11	4-7
Silver Creek	4.70	P11P30	Ohio EPA	1977, 1994	2	6-10	2-5
	4.50	P11S79	Ohio EPA	1992, 1994, 2011	9	11	2-8
	2.52	20	Toledo DES	1995-2013	95	2-10	1-5
	2.30	P11S99	Ohio EPA	1994	2	11	3
	1.70	301449	Ohio EPA	2011	5	11	8-9
	1.05	P11P31	Ohio EPA	1976	1	10	3
Halfway Creek (HUC 04100001 03 02)							
Halfway Creek	5.10	301448	Ohio EPA	2011	5	11	3-6
	4.66[d]	580450	Michigan DEQ	2000, 2005	2	9-10	3
Indian Creek	0.15[e]	580449	Michigan DEQ	2000, 2005	2	9-10	2-3

Notes

Sample sites are listed by waterbody from headwaters to mouth as top to bottom.

a. The number of metals that the samples were analyzed for in one or more samples. A range indicates that different numbers of metals were evaluated for different samples. The following metals were analytes for various samples: aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and zinc.

b. The number of metals that were detected. A range indicates that different numbers of metals were detected in different samples.

c. The Ohio EPA rivermile (RM) displayed is the RM from the fish or macroinvertebrate sampling site that is closest, when plotted in GIS, to the water column sampling site. Often, Ohio EPA sites have multiple rivermiles (RMs) associated with them because the biological, habitat, and water quality sampling were performed at slightly different locations along the same segment.

d. Rivermiles (RMs) were approximated in GIS.

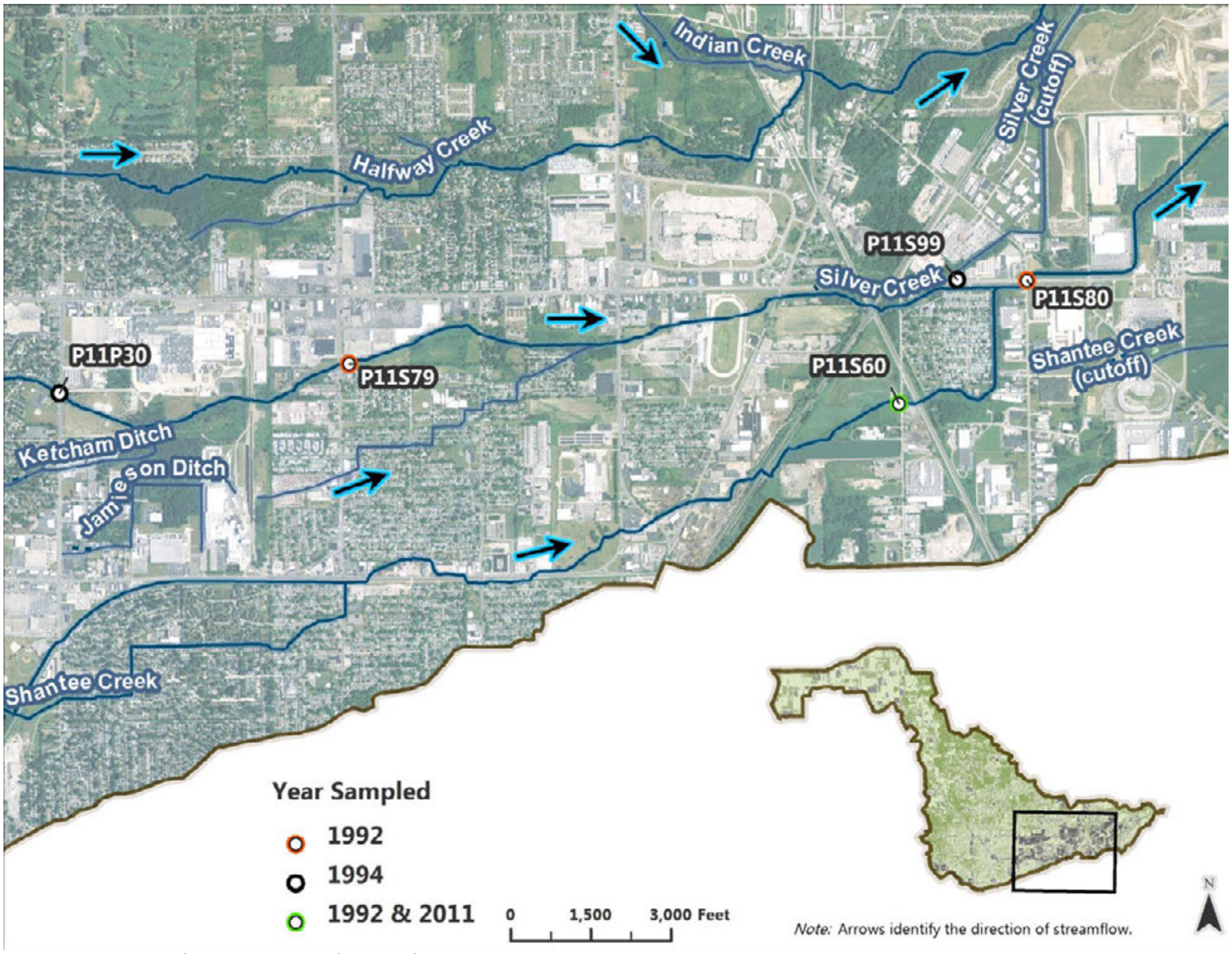
e. The geographic coordinates from Michigan DEQ (2004, 2006) do not plot in GIS on Indian Creek adjacent to the Bedford WWTP. The rivermile was selected using best professional judgment.

Aluminum, arsenic, copper, iron, lead, and zinc were regularly detected in Shantee and Silver creeks, while cadmium, chromium, manganese, mercury, and nickel were occasionally detected. Chromium, copper, lead, mercury (Silver Creek only) and zinc (Shantee Creek only) occasionally exceeded Ohio's outside mixing zone average (OMZA) and outside mixing zone maximum (OMZM) water quality standards (WQS) for the protection of aquatic life. No samples exceeded Ohio's WQS for agricultural uses and none of the streams are designated as public water supplies (i.e., drinking water WQS are inapplicable).

Far fewer water column samples were collected in Halfway and Indian creeks, as compared with Shantee and Silver creeks. In Halfway Creek within Ohio, aluminum, arsenic, copper, iron, manganese, nickel, and zinc were regularly detected. In Michigan, arsenic, copper, and zinc were detected in Halfway Creek In Indian Creek, arsenic, copper, and nickel were detected. No sample exceeded Ohio's aquatic life WQS and agricultural WQS nor did any sample exceed Michigan's WQS for human health or aquatic life.

3.5.2 Organic Compounds

Ohio EPA collected water column samples from Shantee Creek in 1992 and 2011 and from Silver Creek in 1994 and 2011 (Figure 10). These samples were evaluated for organic compounds; samples collected in 1992 and 1994 were evaluated for pesticides (Table 3).



Note: Arrows identify the direction of streamflow.

Figure 10. Water column samples that were evaluated for organic compounds.

Table 3. Water column chemistry samples evaluated for organic compounds

Stream	RM	Site ID	Agency	Data year	Organic constituents		Pesticides [a]	
					No. of parameters	No. of det. [b]	No. of parameters	No. of det. [b]
Shantee Creek	0.70	P11S60	Ohio EPA	1992	99	1	8	3
			Ohio EPA	2011	112	0	--	--
	0.10	P11S80	Ohio EPA	1992	99	0	8	2
Silver Creek	4.70	P11P30	Ohio EPA	1994 [c]	53 [d]	1 [e]	8	0
	4.50	P11S79	Ohio EPA	1992	99	0	--	--
	2.30	P11S99	Ohio EPA	1994 [c]	52-53	0	8	0

Notes
Sample sites are listed by waterbody from headwaters to mouth as top to bottom. Except as noted, each row represents one sample.
det. = detections; RM = river mile.
A double dash ("--") indicates that the samples were not evaluated for pesticides.
a. The pesticides are: Aldrin, Dieldrin, Endrin, Gamma-BHC (Lindane), Heptachlor, Heptachlor epoxide, Methoxychlor, and Mirex.
b. Number of parameters that were detected from the samples.
c. Two samples were collected at these sites in 1994.
d. Fifty-three organic constituents were evaluated in each of the two samples.
e. One organic constituent was detected in one sample and no organic constituents were detected in the other sample.

One petroleum hydrocarbon and three pesticides were detected in Shantee Creek in 1992 (Table 4). One PAH was detected in Silver Creek (Table 5).

Table 4. Water column organic compounds results for Shantee Creek

Constituent	WQS [a]		Shantee Creek		
			P11S60		P11S80
	OMZM	OMZA	9/1/1992	7/14/2011	9/1/1992
Petroleum Hydrocarbon					
1,1,1-trichloroethane	--	--	0.7	<0.50	<0.50
Pesticides					
Endrin	0.086	0.036	**0.05**	N	0.02
Methoxychlor	--	--	0.27	N	0.07
Mirex	--	--	0.10	N	<0.10

Notes
Results are reported in micrograms per liter.
A double dash ("--") indicates that no WQS were promulgated for the constituent indicated.
N = samples were not evaluated for the constituent indicated; OMZA = outside mixing zone average; OMZM = outside mixing zone maximum; WQS = water quality standards.
Shaded orange cells indicate results greater than the reporting or detection limit.
Bolded red value exceeds the OMZA WQS.
a. Ohio water quality standards for organic compounds (as total) for the protection of aquatic life (Table 7-1 of *OAC-3745-01-07*).

Table 5. Water column organic compounds results for Silver Creek

Pollutant of concern	WQS		P11P30	P11S79	P11S99
			1994	1992	1994
	OMZM	OMZA	n=2	n=1	n=2
Chloroform	--	--	0.7, NS	<0.5	<0.5, NS

Notes
Results are reported in micrograms per liter.
A double dash ("--") indicates that no WQS were promulgated for the constituent indicated.
Shaded orange cells indicate results greater than the reporting or detection limit.

3.6 Sediment Chemistry

Ohio EPA is the only entity that collected sediment samples. Two samples each were collected from Shantee Creek and Silver Creek on October 22, 1992, and one sample each was collected from Shantee, Silver, and Halfway creeks on August 30, 2011 (Table 6 and Figure 11). Table 6 presents the number of metals and organic constituents that were evaluated in the laboratory for each sample that Ohio EPA collected. Refer to Section A-1.4 of Appendix A for a brief discussion of Ohio EPA's sediment chemistry sampling efforts. The following two subsections present synopses of Ohio EPA's two sediment sampling efforts.

Table 6. Sediment chemistry samples

				Metals		Organic constituents	
Stream	RM	Site ID	Data year	No. of parameters	No. of detections	No. of parameters	No. of detections
Shantee Creek (HUC 04100001 03 01)							
Shantee Creek	0.70	P11S60	1992	11	10	--	--
			2011	9	9	93	12
	0.10	P11S80	1992	11	10	--	--
Silver Creek	4.50	P11S79	1992	11	10	--	--
	1.10	301449	2011	8	8	93	6
	1.00	P11S78	1992	11	10	--	--
Halfway Creek (HUC 04100001 03 02)							
Halfway Creek	5.10	301448	2011	8	8	93	10

Note: HUC = hydrologic unit code; RM = rivermile.

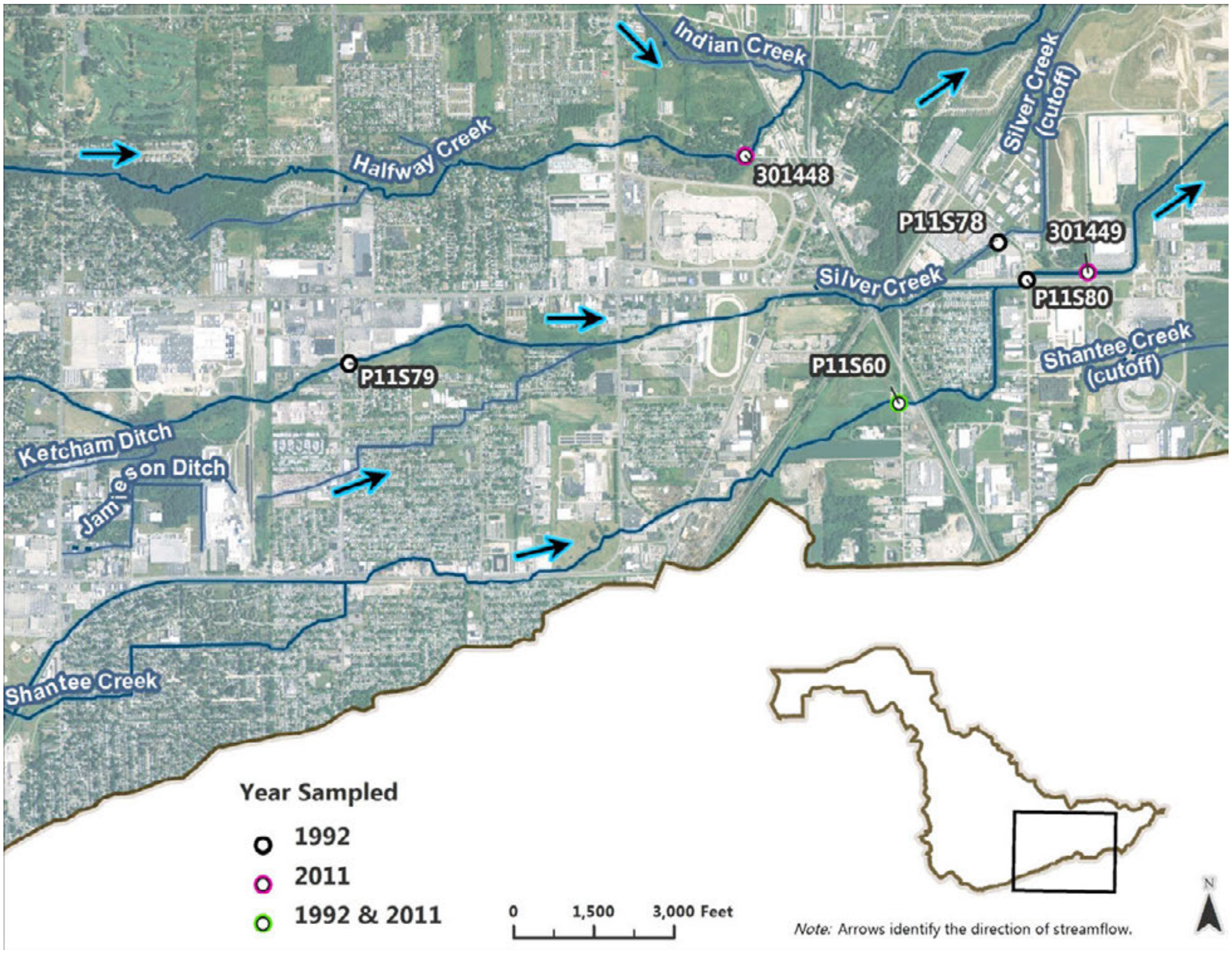


Figure 11. Sediment samples that were evaluated for metals, PAHs, or PCBs.

3.6.1 Sediment Metals Results (October 22, 1992)

Ohio EPA collected sediment samples from Shantee and Silver creeks on October 22, 1992 and evaluated the samples for eleven metals concentrations. Results of seven of the metals were compared with Ohio EPA Sediment Reference Values (SRVs; Ohio EPA 2008), which were designed for the protection of ecological resources, and some samples exceeded the SRVs for four metals: cadmium, copper, lead, and zinc (Table 7).

Table 7. Sediment metals results (October 22, 1992)

	Target		Shantee Creek		Silver Creek	
Constituent	Value	Source [a]	P11S60	P11S80	P11S79	P11S78
Aluminum			5,630	11,200	6,100	6,640
Arsenic			6.67	7.44	4.74	6.71
Cadmium	0.96	SRV (HELP)	**1.53**	0.52	**3.14**	**2.40**
Chromium	51	SRV (HELP)	28.9	22.7	16.7	29.5
Copper	42	SRV (HELP)	**75.1**	27.3	10.3	38.5
Iron			13,700	17,900	11,200	14,500
Lead	47	SRV (state)	**60.3**	**63.2**	37	**84.8**
Mercury [b]	0.59	SRV (state)	0.19	0.05	0.03	0.07
Nickel	36	SRV (HELP)	30.6	26.4	13	23.4
Selenium			<0.80	<0.74	<0.66	<0.81
Zinc	190	SRV (HELP)	**355**	128	85.5	**346**

Notes
Results are reported in milligrams of constituent per kilogram of sediment, except as noted.
Shaded orange cells indicate results greater than the reporting or detection limit.
Bolded red indicates a result value that exceeds the target value.
a. SRV (HELP) = Sediment Reference Value for the Huron/Erie Lake Plain level III ecoregion (Ohio EPA 2008).
SRV (state) = statewide Sediment Reference Value (Ohio EPA 2008).
b. Mercury results are reported in micrograms of mercury per kilogram of sediment.

3.6.2 Sediment Metals, PAHs, and PCBs Results (August 30, 2011)

Ohio EPA collected one sample each from Shantee, Silver, and Halfway creeks on August 30, 2011 and evaluated the samples for nine metals and 93 organic constituents. Results of seven of the metals were compared with Ohio EPA SRVs. Similar to the samples collected on October 22, 1992, some samples exceeded the SRVs for the same four metals: cadmium, copper, lead, and zinc (Table 8).

Twelve organic constituents were detected in one or more samples (Table 8). All 12 detected organic constituents were compared with U.S. EPA Ecological Screening Levels for Sediments (ESLSs; U.S. EPA 2003). Five organic constituents were detected in all three samples and exceeded their respective ESLSs: benzo[a]anthracene, chrysene, fluoroanthene, phenanthrene, and pyrene. Two PCB cogeners (i.e., 1242, 1260) were detected at concentrations exceeding the ESLS.

Table 8. Sediment metals, PAHs, and PCBs results (August 30, 2011)

Constituent	Target Value	Target Source [a]	Shantee Creek P11S60 [b]	Silver Creek 301449	Halfway Creek 301448
Organic constituents (mg/kg)					
2-Methylnaphthalene	0.0202	ESLS	<0.68	**18.40**	<0.69
Benz[a]anthracene	0.108	ESLS	**1.87**	**0.63**	**1.81**
Benzo[a]pyrene	0.150	ESLS	**2.32**	<0.60	**2.31**
Benzo[b]fluoranthene	10.40	ESLS	2.81	<0.60	2.69
Benzo[g,h,i]perylene	0.170	ESLS	**1.83**	<0.60	**1.87**
Benzo[k]fluoranthene	0.240	ESLS	**2.10**	<0.60	**2.11**
bis(2-Ethylhexyl)phthalate	0.182	ESLS	**1.73**	<0.60	<0.69
Chrysene	0.166	ESLS	**3.09**	**0.84**	**3.03**
Fluoranthene	0.423	ESLS	**6.13**	**1.65**	**6.21**
Ideno(1,2,3-cd)pyrene	0.200	ESLS	**1.77**	<0.60	**1.71**
Phenanthrene	0.204	ESLS	**2.46**	**7.06**	**1.87**
Pyrene	0.195	ESLS	**4.47**	**1.65**	**4.63**
Polychlorinated biphenyls (µg/kg)					
PCB-1242	59.8	ESLS [c]	**184**	<29	<34
PCB-1260	59.8	ESLS [c]	**129**	<29	<34
Metals (mg/kg, except as noted)					
Cadmium	0.96	SRV (HELP)	**1.43**	**0.781**	**0.565**
Chromium	51	SRV (HELP)	30.3	15	10.2
Copper	42	SRV (HELP)	**51.1**	16.6	14.6
Lead	47	SRV (state)	**67.9**	17.2	23.3
Mercury [d]	0.59	SRV (state)	--	--	0.059
Nickel	36	SRV (HELP)	21.5	19.5	9.27
Zinc	190	SRV (HELP)	**253**	77.4	83.3

Notes
mg/kg = milligram per kilogram; µg/kg = microgram per kilogram
Shaded orange cells indicate results greater than the reporting or detection limit.
Bolded red indicates a result value that exceeds the target value.
a. ESLS = Ecological Screening Levels for Sediments (U.S. EPA 2003).
SRV (HELP) = Sediment Reference Value for the Huron/Erie Lake Plain level III ecoregion (Ohio EPA 2008).
SRV (state) = statewide Sediment Reference Value (Ohio EPA 2008).
b. A strong petroleum odor and visible sheen were observed during sediment sampling.
c. ESLS is for all PCBs.
d. Mercury results are reported in micrograms of mercury per kilogram of sediment.

3.7 Summary

This section provides a brief summary of water quality by stream.

3.7.1 Halfway Creek

Fish and benthic macroinvertebrate communities' health are fair in Halfway Creek. Habitat quality ranges from fair to good. Metals and PAHs were detected in a recent sediment sample, and nine PAHs exceeded Ohio-specific reference values. Metals were detected in water column samples collected in the 2000s and 2011 but did not exceed WQS for the protection of aquatic life.

3.7.2 Silver Creek

Fish and benthic macroinvertebrate communities' health are poor in Silver Creek. Habitat quality ranges from very poor to fair. Fish tissue results indicate that legacy PCBs (2 cogeners) and pesticides (10 compounds) contaminate Silver Creek. Metals were detected in sediment samples from the early 1990s, and cadmium, lead, and zinc exceeded Ohio-specific reference values. Similarly, metals and PAHs were detected in a recent sediment sample, and six PAHs exceeded Ohio-specific reference values. Metals were detected in water column samples collected in the early 1990s and 2011. Chloroform was detected in the water column in 1994 but has not been detected since.

3.7.3 Shantee Creek

Fish community health is poor and benthic macroinvertebrate community health ranges from very poor to low-fair in Shantee Creek. Habitat quality ranges from very poor to poor. Fish tissue results indicate that legacy PCBs (2 cogeners) and pesticides (9 compounds) contaminate Shantee Creek. Metals were detected in sediment samples from the early 1990s, and cadmium, lead, and zinc exceeded Ohio-specific reference values. Similarly, metals, PCBs, and PAHs were detected in a recent sediment sample, and cadmium, copper, lead, zinc, ten PAHs, and two PCBs exceeded Ohio-specific reference values. Metals were detected in water column samples collected in the early 1990s and copper, lead, and zinc occasionally exceeded WQS for the protection of aquatic life. Metals detected in samples collected in 2011 did not exceed WQS. 1,1,1-trichloroethane was detected in the water column in 1992 but has not been detected since. The pesticides endrin, methoxychlor, and mirex were detected in the water column in 1992 and endrin exceeded the WQS.

4 Source Assessment

The objective of the source assessment is to identify the POCs that presently or historically impacted the HSSCA project area and identify the potential point and nonpoint sources that did discharge, could discharge, or could have discharged the POCs to the environment. The source assessment included evaluations of sources both in the riparian corridor and in upland areas throughout the watersheds.

The section begins with an overview of the available data, continues with an evaluation of the POCs, and concludes with summaries of the sources within the HSSCA project area. The data inventory that supported the source assessment is presented in Appendix A.

4.1 Available Datasets

Information and data were collected from multiple sources to support the HSSCA. These data were typically obtained directly from state and municipal government agencies or through publically available websites maintained by federal government agencies. An inventory of available data with discussions of data acquisition is presented in Appendix A and a brief summary of the data inventory and acquisition is presented here.

4.1.1 Facilities Data

Facility databases are maintained by Ohio EPA, Michigan DEQ, and U.S. EPA. The following datasets of facilities information were obtained:

- Facility Registry System (FRS; U.S. EPA)
- National Pollutant Discharge Elimination System (NPDES)
    - Discharge monitoring reports effluent data (Ohio EPA, Michigan DEQ, U.S. EPA)
    - NPDES permits (Ohio EPA, Michigan DEQ)
    - Regulated MS4 and industrial stormwater (Ohio EPA, Michigan DEQ).
- Resource Conservation and Recovery Act Information database (RCRAInfo; U.S. EPA)
- Superfund (U.S. EPA)
- Toxic Release Inventory (TRI; U.S. EPA)
- Toxic Substance Control Act Inventory (TSCA; U.S. EPA)

Refer to Appendix A's Section A-2 for more in-depth discussions of these datasets.

4.1.2 Spills and Releases Data

Spills reports and lists of spills were obtained directly from Ohio EPA, Michigan DEQ, and Toledo DES; data were also downloaded from publicly available websites maintained by U.S. EPA.

- Spills reports (Michigan DEQ, Ohio EPA, Toledo DES, and U.S. EPA)
- Volunteer Action Program (VAP; Ohio EPA)
- 201 Sites (Michigan DEQ)

Spills reports datasets tended to be for larger geographic areas and were initially screened to locate only those spills reports in the HSSCA project area. Spills reports were also screened for the media of the spill (e.g., water, air): spills and releases to streams, ditches, and sewers were retained for further evaluation, while spills reports for releases to the air or that were fully contained on-site were not further evaluated. Additionally, many spills reports were not pertinent to this study since the released material did not migrate to surface waterways[4]. Spills reports regarding the discharge of sanitary wastewater to storm sewers or surface waterways are not discussed herein as the scope of this report is limited to toxic pollutants. Refer to Appendix A's Section A-2 for discussions of obtaining spills reports from the federal, state, and municipal agencies.

4.1.3 Georeferenced Spatial Data

GIS data are available from numerous federal, state, and municipal entities; refer to Appendix A's Section A-3 for discussions of the available, georeferenced data. Georeferenced spatial datasets were also available in Flex Viewer, which is online, interactive mapping software used for interagency response to environmental threats (U.S. EPA 2014). Generally, georeferenced spatial data are organized into four categories: physical; political; facilities, infrastructure, and spills; and important resources.

Physical georeferenced spatial data include aerial imagery, ecoregions, elevations, geology, land use and land cover, and surface and groundwater hydrography and hydrology. These data characterize the watersheds in the HSSCA project area.

Shapefiles for state, county, township, and city boundaries were obtained from websites maintained by state and county agencies. Parcels and ownership shapefiles were obtained from Lucas County.

Spatial data characterize the locations that spills and releases of POCs did or could occur. Facilities georeferenced spatial data include the locations of facilities records from various databases (e.g., underground storage tanks). Infrastructure data include pipelines, roads, and sewers. Spills spatial data present the known locations of spills or releases of POCs, including areas or facilities that have since been remediated (e.g., VAP projects). Many of these datasets were available in Flex Viewer.

Ecological and physical GIS data characterize important resources that may need protection. These datasets include the locations of various species and managed or protected areas. Many of these datasets are available in the Inland Sensitivity Atlas and Flex Viewer.

4.1.4 Non-Georeferenced Spatial Data

Non-georeferenced spatial data are electronic files containing maps and site plans that cannot be used within GIS. The maps include quadrangles, geology maps, maps of the Ohio Department of Transportation's municipal separate storm sewer systems, and potentiometric surface maps. The engineering plans were provided by the city of Toledo's Department of Public Utilities' Division of Engineering Services. Additional information on these maps is presented in Appendix A's Section A-4.

4.1.5 Project Area Studies

The HSSCA project area is included within many regional studies from such agencies as Ohio EPA, ODNR, TMACOG, and USGS. Local stormwater management studies include portions of the HSSCA project area as do other local studies (e.g., scrapyard study [Tetra Tech 2013]). Section A-5 of Appendix A presents the available previous studies.

[4] For example, a complaint was filed with Toledo DES for a leaking chocolate ice-cream tank and Toledo DES determined that the spilled ice-cream was discharged to sanitary sewers (i.e., no violation occurred; Toledo 2014b).

4.2 Subwatershed Delineation

The identification of sources of POCs, fate and transport, and critical area identification and delineation were performed within the framework of a multi-scale spatial analysis. Each of the 12-digit HUs was delineated into smaller subwatersheds with a focus upon named streams in Ohio. Six spatial datasets were used to delineate subwatersheds within the 12-digit HUs:

- Aerial imagery
  - GoogleEarth™ (Google Inc. 2013)
  - National Agricultural Imagery Program (NRCS 2013)
- Elevation and slope (from a digital elevation model; NRCS 2013)
- Hydrography
  - NHD high (USGS 2013)
  - Streams and ditches (Toledo 2014a)
- Storm sewers (Toledo 2014a)

These datasets are further discussed in Section A-3 of Appendix A.

Forty-one subwatersheds were delineated that ranged in size from 52 acres to 4,397 acres (Figure 12; Table 9). Since critical areas were to be identified and delineated within the Maumee AOC, which has a northern boundary of the Ohio-Michigan state line, subwatersheds in Ohio were at a finer scale (52 acres to 1,245 acres; average of 448 acres) than subwatersheds in Michigan (380 acres to 4,397 acres; average of 1,704 acres)[5]. Refer to Appendix D for tables of the subwatersheds with descriptions of hydrography, downstream subwatersheds, drainage areas, land use distribution, and percentages of impervious cover and canopy cover.

[5] For the purpose of this sentence, subwatersheds that crossed the state border were assigned to the state in which a larger portion of the subwatershed resides in.

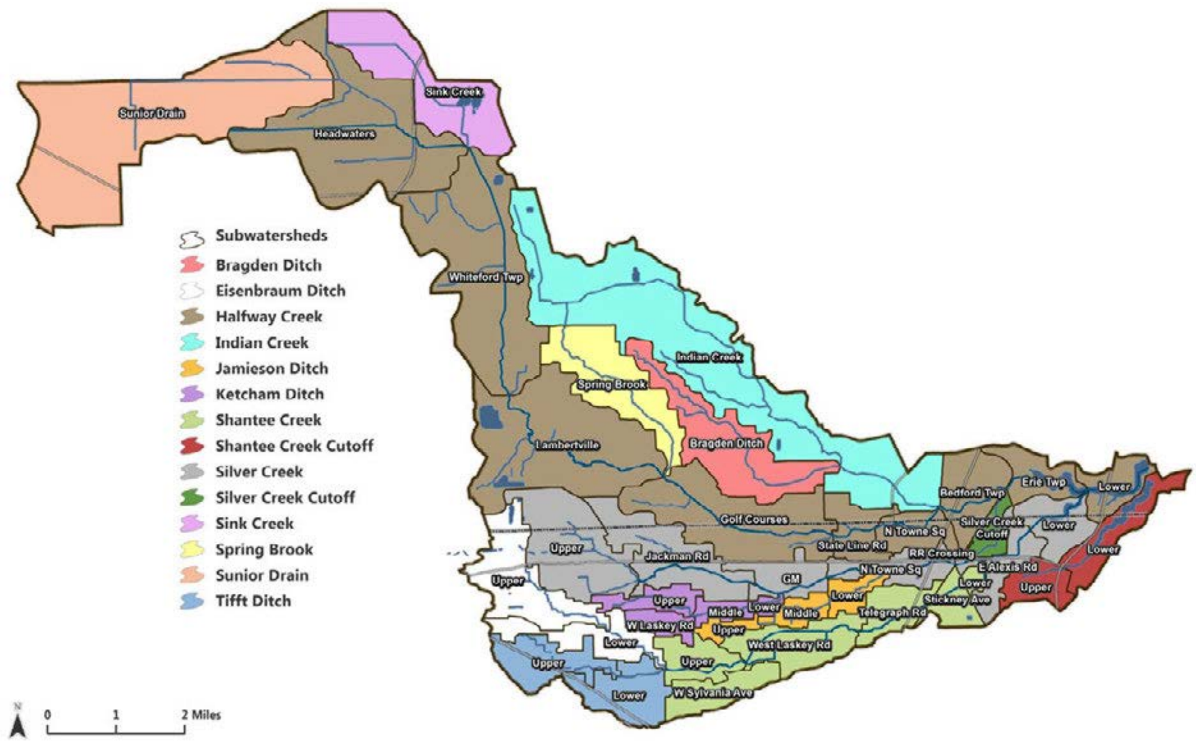


Figure 12. Delineated subwatersheds of the HSSCA project area.

Table 9. Summary of the delineated subwatersheds in the HSSCA project area

Subwatershed name	Hydrography description
Shantee Creek (HUC 04100001 03 01)	
Tifft Ditch (upper)	Tifft Ditch from headwaters to Franklin Park Mall
Tifft Ditch (lower)	Tifft Ditch from Franklin Park Mall to mouth on Shantee Creek
Eisenbraum Ditch (upper)	Eisenbraum Ditch from headwaters to West Laskey Road
Eisenbraum Ditch (lower)	Eisenbraum Ditch from West Laskey Road to mouth on Shantee Creek
Shantee Creek (upper)	Shantee Creek from the confluence of Tifft Ditch and Eisenbraum Ditch to split west of Jackman Road (along railroad lines adjacent to Bowman Park)
Shantee Creek (West Sylvania Avenue)	South of Shantee Creek along southern HSSCA boundary
Shantee Creek (West Laskey Road)	Shantee Creek from split west of Jackman Road to Bennett Park
Shantee Creek (Telegraph Road)	Shantee Creek from Bennet Park to railroad
Shantee Creek (Stickney Avenue)	Shantee Creek between railroad lines
Shantee Creek (lower)	Shantee Creek from railroad to mouth on Silver Creek
Silver Creek (upper)	North and South branches of Silver Creek
Silver Creek (Jackman Road)	Confluence of North and South branches of Silver Creek to Jackman Road

Subwatershed name	Hydrography description
Ketcham Ditch (upper)	Ketcham Ditch headwaters to Wernerts Field
Ketcham Ditch (West Laskey Road)	Storm sewer drainage to Ketcham Ditch at Wernerts Field
Ketcham Ditch (middle)	Ketcham Ditch from Wernerts Field to Jackman Road
Ketcham Ditch (lower)	Ketcham Ditch from Jackman Road to mouth on Silver Creek
Silver Creek (General Motors)	Silver Creek from Jackman Road to Lewis Avenue
Jamieson Ditch (upper)	Jamieson Ditch from headwaters to Jackman Road
Jamieson Ditch (middle)	Jamieson Ditch from Jackman Road to Lewis Avenue
Jamieson Ditch (lower)	Jamieson Ditch from Lewis Avenue to the mouth on Silver Creek
Silver Creek (North Towne Square)	Silver Creek from Lewis Avenue to Enterprise Boulevard
Silver Creek (RR crossing)	Silver Creek from railroad intersection to Raintree Parkway
Silver Creek Cutoff	Silver Creek cutoff from East Alexis Road to mouth on Halfway Creek
Silver Creek (lower)	Silver Creek from Raintree Parkway to the mouth on Halfway Creek
Halfway Creek (HUC 04100001 03 02)	
Sunior Drain	Sunior Drain and other agricultural ditches
Sink Creek	Sink Creek
Halfway Creek (headwaters)	Halfway Creek headwater to confluence with Sink Creek, Labadie Drain, & McMeekian Drain
Halfway Creek (Whiteford Township)	Halfway Creek from Sink Creek to Clegg Road
Halfway Creek (Lambertville)	Halfway Creek from Clegg Road to North Ridgewood Lane
Spring Brook	Spring Brook
Halfway Creek (golf courses)	Halfway Creek from North Ridgewood Lane to Lewis Avenue
Halfway Creek (State Line Road)	Halfway Creek from Lewis Avenue to motor home park
Halfway Creek (North Towne Square)	Halfway Creek from motor home park to Indian Creek
Bragden Ditch	Bragden Ditch
Indian Creek	Indian Creek excluding Bragden Ditch
Halfway Creek (Bedford Township)	Halfway Creek from Indian Creek to Silver Creek cutoff
Halfway Creek (Erie Township)	Halfway Creek from Silver Creek cutoff to Silver Creek
Halfway Creek (lower)	Halfway Creek from Silver Creek to mouth on North Maumee Bay
Detwiler Ditch-Frontal Lake Erie (HUC 04100001 03 09)	
Shantee Creek Cutoff (upper)	Shantee Creek cutoff from the racetrack to East Alexis Road
Shantee Creek Cutoff (lower)	Shantee Creek cutoff from East Alexis Road to mouth on North Maumee Bay

Notes
HUC = hydrologic unit code.
Shaded orange subwatersheds are critical areas and are further discussed in Section 5.

4.3 Pollutants of Concern

POCs were identified using environmental data and spills reports for the HSSCA project area. Sediment, water, and fish tissue chemistry data were evaluated to determine which constituents were detected. Spills reports were reviewed to determine what pollutants have been spilled, released, or otherwise discharged into the HSSCA project area. The magnitude and frequency of spills was also considered. The spill reports often identified generic classes of chemicals (e.g., fuel oil, gasoline, solvent); however, some spills reports identify specific chemicals (e.g., mercury).

The identified POCs include many substances that are categorized into three groups: PAHs, PCBs, and metals. The general characteristics of the three categories of POCs are well-documented. U.S. EPA Region 5 presents summaries of these and other toxic pollutants on their ecological toxicity website (U.S. EPA 2011) and environmental chemistry textbooks provide general information; for example, Eby (2004) and Spiro and Stigliani (2003).

4.3.1 Environmental Data

PAHs, PCBs, and metals were detected in water column, fish tissue, and sediment samples collected by Ohio EPA. Table 10 presents the POCs detected during environmental monitoring. Additionally, pesticides were detected in water column and fish tissue samples collected in 1992 and 1993 (Table 10).

Michigan DEQ and Toledo DES only evaluated their samples for metals. Arsenic, copper, nickel and zinc were detected in Michigan; in contrast to the Ohio EPA samples shown in Table 10, none of these metals were detected at levels that exceeded the Michigan WQS. Toledo DES results are similar to Ohio EPA results shown in Table 10, except that cadmium was once detected above Ohio's WQS and mercury was occasionally detected above Ohio's WQS.

Table 10. Metals, PAHs, and PCB detected in environmental samples collected by Ohio EPA

POC	Water column		Fish tissue	Sediment	
	Detected [a]	WQS [b]	Detected [a]	Detected [a]	SRV [b]
Metals					
Arsenic	**Detected**	Less than	ND	--	--
Cadmium	**Detected**	Less than	**Detected**	**Detected**	**Exceed**
Chromium	**Detected**	Less than	--	**Detected**	Less than
Copper	**Detected**	**Exceed**	--	**Detected**	**Exceed**
Lead	**Detected**	**Exceed**	**Detected**	**Detected**	**Exceed**
Mercury	**Detected**	Less than	**Detected**	**Detected**	Less than
Nickel	**Detected**	Less than	--	**Detected**	Less than
Selenium	ND	n/a	**Detected**	ND	n/a
Zinc	**Detected**	**Exceed**	--	**Detected**	**Exceed**
Polycyclic Aromatic Hydrocarbons					
2-Methylnaphthalene	--	--	--	**Detected**	**Exceed**
1,1,1-Trichloroethane	**Detected**	Less than	--	--	n/a
Benz[a]anthracene	ND	n/a	--	**Detected**	**Exceed**
Benzo[a]pyrene	ND	n/a	--	**Detected**	**Exceed**
Benzo[b]fluoranthene	ND	n/a	--	**Detected**	**Exceed**
Benzo[g,h,i]perylene	ND	n/a	--	**Detected**	**Exceed**
Benzo[k]fluoranthene	ND	n/a	--	**Detected**	**Exceed**
bis(2-Ethylhexyl)phthalate	ND	n/a	--	**Detected**	**Exceed**
Chloroform	**Detected**	--	--	--	n/a
Chrysene	ND	n/a	--	**Detected**	**Exceed**
Fluoranthene	ND	n/a	--	**Detected**	**Exceed**
Indeno(1,2,3-cd)pyrene	ND	n/a	--	**Detected**	**Exceed**
Phenanthrene	ND	n/a	--	**Detected**	**Exceed**
Pyrene	ND	n/a	--	**Detected**	**Exceed**
Polychlorinated Biphenyls					
PCB 1242	--	--	ND	**Detected**	**Exceed**
PCB 1248	--	--	**Detected**	ND	n/a
PCB 1260	--	--	**Detected**	**Detected**	**Exceed**
Pesticides					
Aldrin	ND	--	**Detected**	--	n/a
gamma-BHC (Lindane)	ND	--	ND	--	n/a
4,4'-DDD	--	n/a	**Detected**	--	n/a
4,4'-DDE	--	n/a	**Detected**	--	n/a
Dieldrin	ND	--	**Detected**	--	n/a
Endrin	**Detected**	**Exceed**	ND	--	n/a
Hexachlorobenzene	--	n/a	**Detected**	--	n/a
Methoxychlor	**Detected**	--	ND	--	n/a
Mirex	**Detected**	--	ND	--	n/a

Notes
Constituents that were never detected in any media are excluded from this table.
a. The constituent in the specified media was either detected in one or more samples ("**Detected**") or was not detected in any sample ("ND"). A double dash ("--") indicates that the sample was not analyzed for the specified constituent.
b. The detected constituent in the specified media was (1) at a concentration above ("**Exceed**") or always below ("Less than") the water quality standard (WQS) or Ohio-specific sediment reference value (SRV; Ohio EPA 2008). A double dash ("--") indicates that the specified constituent has no WQS or SRV, and an "n/a" indicates that the constituent was not detected and the evaluation of the WQS or SRV is not applicable.

4.3.2 Spills Reports

Most spills reports pertinent to the HSSCA identified generalized POCs. Often, a spill was reported to be of "gasoline", "diesel fuel", or some type of oil (e.g., "hydraulic oil", "waste oil", "weathered oil"). Some spills were also only identified as a sheen of oil or petroleum. In some cases, specific spilled materials were identified; for example, "mercury" or "cyanide".

4.4 Sources of Pollution

Sources of POCs were identified as the POCs themselves were identified. Generally, the sources of POCs were urban stormwater and spills. Non-stormwater NPDES permittees are authorized to discharge low levels of some POCs but are not considered a significant contributor because their discharges are controlled by permits. Spills and releases, which are illegal discharges of POCs that migrate to surface waterways, are the most significant sources of POCs. Urban stormwater runoff also contributes POC loads to surface waterways when runoff, following precipitation events, carries pollutants deposited on impervious surfaces to the storm sewer infrastructure or directly to a stream.

4.4.1 Regulated Facilities

Facilities that discharge to the environment are permitted by federal and state government agencies. U.S. EPA, Ohio EPA, and Michigan DEQ permit facilities and entities to discharge to surface waters through the NPDES Program. These agencies maintain databases of these facilities and databases of the monitoring data required of the facilities in the NPDES permits. Section A-2.2 of Appendix A presents the NPDES-permitted facilities throughout the HSSCA project area; this section is summarized in Table 11.

Table 11. Summary of NPDES-permitted facilities in the HSSCA project area

National Pollutant Discharge Elimination System	Number of permitees
Individual Permits	**12**
Industrial stormwater	3
Industrial stormwater (terminated)	2
Municipal Separate Storm Sewer System (Phase I)	1
Non-stormwater	6
General Permits	**39**
Construction stormwater	n/a
Industrial stormwater	20
Industrial stormwater with no exposure	14
Industrial stormwater associated with marinas	0
Municipal Separate Storm Sewer System (Phase II)	5

Note: n/a represents "not available".

Most regulated facilities in the HSSCA project area, which are industrial or commercial, are not permitted to discharge to water of the United States. Such facilities may contain toxic materials, and thus, there is a potential for an unpermitted release of toxic materials to the environment. Records for some programs (e.g., Superfund) do represent releases to the environment. Section A-2 of Appendix A presents the regulated facilities throughout the HSSCA project area; this section is summarized in Table 12.

Table 12. Summary of regulated facilities in the HSSCA project area

Program	Number of records
Federal Registry System	488
National Pollutant Discharge Elimination System	51
Part 201 sites [a]	5
Resource Conservation and Recovery Act	266
Superfund	5
Toxic Release Inventory	11
Underground storage tanks [a]	318
Underground storage tanks (leaking) [a]	223
Volunteer Action Program [a]	1

Notes
Some facilities are regulated under multiple programs.
a: These programs are solely administered by state regulatory agencies.

4.4.2 Spills and Releases

Facilities with the potential for unpermitted discharges to the environment are regulated by federal and state government agencies. Facilities that discharge to municipal treatment systems are regulated by municipal government agencies; if such facilities violate the terms of their permitted discharges (i.e., pre-treatment), then the discharges are considered to be spills or releases.

Spills and releases have occurred throughout the HSSCA project area. Federal, state, and municipal government regulatory agencies respond to spills, with federal and state response for larger spills or spills with more toxic or hazardous materials. Toledo DES responds to citizen complaints of spills, which often include materials not pertinent to the HSSCA (e.g., garbage dumping into streams, dye testing sewers, suspended solids from water or sewer pipeline construction).

Since the mid-1990s over 300 spills were documented (Table 14), excluding pre-treatment violations. Spill reports from prior to the mid-1990s were either destroyed (per record retention policy) or are otherwise unavailable for review. Many spill reports lack georeferenced spatial data or were in hardcopy format. Refer to Section 6.1.2 and 6.4.2 for discussions of the assumptions, uncertainties, and limitations with the spills datasets.

Table 13. Summary of spill reports in the HSSCA project area

Agency	Number of spill reports
U.S. EPA Region 5	6
Ohio EPA DERR	129
Michigan DEQ	9
Toledo DES	>200

Notes
Michigan DEQ = Michigan Department of Environmental Quality; Ohio EPA DERR = Ohio Environmental Protection Agency Division of Emergency Response and Revitalization; Toledo DES = Toledo Department of Public Utilities Division of Environmental Services; U.S. EPA = U.S. Environmental Protection Agency.
Some facilities are regulated under multiple programs.

4.5 Fate and Transport

Contaminate fate and transport describes "how the chemical contaminants might move through, or be transformed physically, chemically, and biologically in the environment" including the chemical contaminants interactions with plants and animals (U.S. EPA 1997, 2011). All chemical constituents in the environment are affected by biotic and abiotic factors. The POCs identified in the HSSCA are chemical contaminants that have entered the HSSCA project area that were, are, or will be affected by physical, chemical, and biological processes. Refer to U.S. EPA (1997, 2011) for additional information regarding typical physical, chemical, and biological processes that affect chemical contaminants.

A simple conceptual model may be used to help inform an understanding of sources and pathways that may contribute toxic pollutants to project area streams. Toxic pollution may affect human health and important ecological resources through many exposure pathways. For example, humans may be exposed to toxic POCs through dermal contact with soils contaminated from a spill; similarly, fish may be exposed to POCs through direct contact with surface water contaminated by a upland spill that migrated to surface waters. Limited environmental monitoring data are available to assess the fate and transport of toxic pollutants through the HSSCA project area. Without such data, it is also difficult to assess the pathways that may affect human or ecological health.

An evaluation of spills reports generally found that the spilled materials entered the streams from public or private storm sewers. At industrial properties, a spill typically migrated to on-site drainage structures that either discharged directly to a stream or ditch or discharged to public storm sewers. Spills at commercial and industrial facilities also migrated over impervious surfaces to public storm sewers, notably when a vehicle was the source of the spill, with POCs migrating along roadways.

Spill reports often documented the migration of spilled materials to storm sewers and surface waterways. Environmental monitoring data collected during the investigations and remediation activities were not available for review. Descriptions of the investigations did show that POCs migrated through storm sewers and down the streams, especially during and after precipitation events. As would be expected, larger volumes of liquid POCs migrated faster and farther downstream. Environmental data are not available to assess the impact of the streams upon Lake Erie or to determine if the POCs can move upstream within the lacustuary.

Figure 13 below conceptually summarizes the sources of POCs in the HSSCA project area. In Figure 13, the sources of POCs are represented as spills and releases (e.g., pipeline spill), urban stormwater (e.g., industrial stormwater), and non-stormwater point sources (e.g., wastewater treatment plant).

Note: Locations of sources on this figure do not correspond to actual locations of sources.

Figure 13. Conceptual representation of the sources of POCs in the HSSCA project area.

5 Critical Areas

Eleven of the 41 subwatersheds were identified as critical areas in the Ohio portion of the HSSCA project area (Figure 14). Critical areas are defined as areas with a large number or concentration of facilities or spills records. Due to a lack of environmental data, stream water quality and health could not be characterized nor could areas for future potential remediation be delineated. Instead, the critical areas were identified based upon areas with concentrations of facilities and spills records that may have been affected by historic or recent spills. Future environmental sampling will be necessary for each critical area to characterize stream water quality and health and to support future delineation of areas for remediation activities.

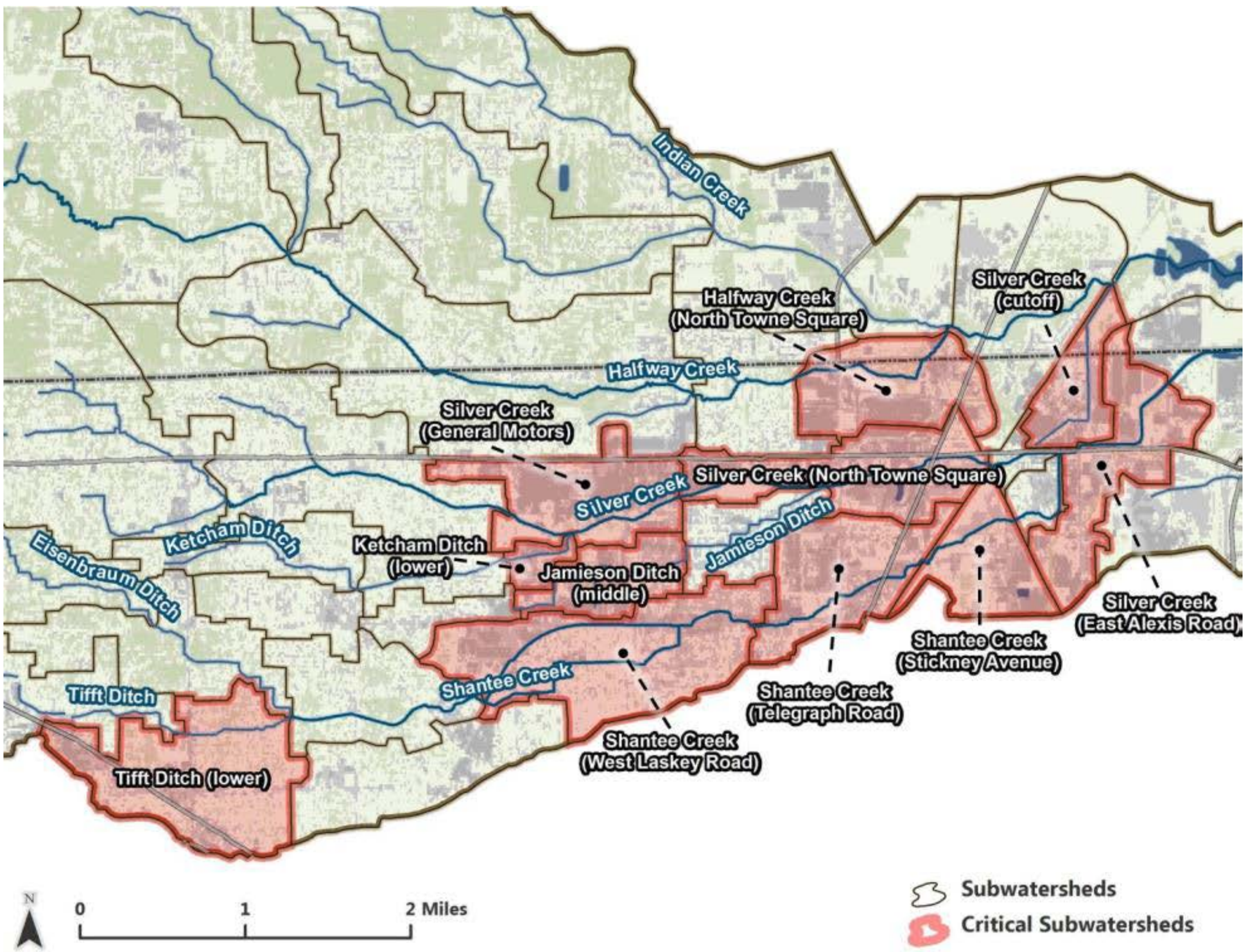


Figure 14. Critical areas in the HSSCA project area.

The remainder of this section presents evaluations of each of the 11 critical areas. In each subsection, one critical area subwatershed is discussed and the available water quality, facilities, and spills data are summarized. Unless otherwise noted, the spills described in this section are summaries of the spills reports from U.S. EPA (2014a), Ohio EPA (2014a,d) and Toledo (2014b). As previously discussed, spill reports are not discussed herein if the spill was not to surface waterways or storm sewers or was not of a POC (e.g., sanitary wastewater); Toledo DES investigated many such spills (Toledo 2014b). For additional information regarding water quality, facilities, and spills, refer to the data inventory in Appendix A.

Each subsection includes a discussion of historic and recent spills and includes a table that summarizes the spills within the critical area subwatershed. The *Importance of Spills* field in these tables provides a simple qualitative rank for each spill. The ranks are summarized in Table 14. The qualitative rank assignment for each spill was best professional judgment based upon review of the available spills report(s).

Table 14. Qualitative rankings of the importance of spills

Rank	Description
♦	The spill was fully contained and did not migrate to storm sewers or surface waterbodies *or* the spilled material was not a POC (e.g., the spill was untreated sanitary sewage).
♦♦	The spill was partially or mostly contained and a small volume migrated to surface waterbodies that was partially or mostly recovered.
♦♦♦	The spill was partially or mostly contained and (1) a small volume migrated to surface waterbodies that was not recovered *or* (2) a large volume migrated to surface waterbodies that was partially or mostly recovered *or* (3) the spilled substance was very toxic, migrated to surface waterbodies and was partially mostly recovered.
♦♦♦♦	The spill was not contained or partially contained and (1) a large volume migrated to surface waterbodies that was only partially or mostly not recovered *or* (2) the spilled substance was very toxic, migrated to surface waterbodies, and was mostly not recovered. *or* (3) the spill, regardless of volume or recovery, migrated a long distance and migrated across the Ohio-Michigan state boundary.
♦♦♦♦♦	The spill qualifies at rank #3 or #4 and (1) resulted in a fish kill or deaths of other wildlife *or* (2) directly threatened nearby residential developments *or* (3) required in extensive remediation efforts.

Recommendations for future environmental sampling are included in a *Summary and Recommendations* subsection at the end of each critical area section. The objective of the recommended sampling is to locate areas of contamination. More extensive sampling may be required for certain future remediation activities (e.g., sediment removal). Summary tables of recommended sampling, including costs, and maps of potential sample sites are present at the end of each section and compiled in Appendix E. For the recommended sampling to locate areas of contamination, Table E-1 of Appendix E table includes a ranked prioritization of sampling efforts, identifies the environmental media to be sampled, presents the types of parameters that samples should be evaluated for, and estimated labor and laboratory costs. Sampling and laboratory analytical methods are discussed in Section 7.1, which includes summaries of all recommended environmental sampling.

Generalized unit costs are summarized in Table 15; these generalized unit costs are estimated labor and laboratory costs of biological, water column, and sediment sampling. These estimates are intended to provide a rough approximation of costs for potential follow up sampling efforts in the HSSC watershed. Actual labor and laboratory costs are expected to deviate from these estimates.

Laboratory unit costs were estimated using prices for methods with reporting limits at or below the standards and targets for the POCs; methods with reporting limits above various targets may be suitable if the objective of future sampling is to determine only the presence of, and not to quantify, specific POCs. As presented herein, the total cost to perform all recommended sampling, excluding other direct costs (e.g., travel, lodging, equipment), is $45,225.

Table 15. Generalized unit costs for future recommended sampling

Sample	Labor costs per site [a]	Laboratory costs per site [b]
Biology		
Fish sampling to evaluate the IBI and MIwb	$900	--
Macroinvertebrate sampling to evaluate the ICI	$400	$500
Habitat monitoring to evaluate the QHEI	$100	--
Fish sampling to evaluate tissue	$200	$1,500
Water Column		
Measurement of field parameters	$25	--
Measurement of flow	$100	--
Collection of water column samples for analysis of metals and organic constituents	$50	$625 [c]
Sediment		
Collection of sediment samples for analysis of metals and organic constituents	$50	$400 [d]
Collection of sediment samples for analysis of polychlorinated biphenyls		$200 [d]

Notes

Costs reported in this table are estimated labor and laboratory costs of biological, water column, and sediment sampling. These estimates are intended to provide a rough approximation of costs for potential follow up sampling efforts in the HSSC project area. Actual labor and laboratory costs are expected to deviate from these estimates

a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1 of the main report.

c. Laboratory costs for water column samples were based upon methods with reporting limits at or below WQS.

d. Laboratory costs for sediment samples were based upon methods with reporting limits at or below Ohio-specific SRVs for metals (Ohio EPA 2008) and U.S. EPA Region 5 Ecological Screen Levels for Sediment (U.S. EPA 2003).

5.1 Tifft Ditch (Lower)

USTs, LUSTs, and spills are in the vicinity of the intersection of Secor Road, West Sylvania Avenue and Monroe Street in the Tifft Ditch (lower) subwatershed (Figure 15; Appendix D). This critical area is along the lower segments of Tifft Ditch at the southern boundary of the HSSCA project area. The Tifft Ditch (lower) subwatershed is 628 acres, is about 92 percent developed land (excluding open developed land) , and is 51 percent impervious cover (Appendix D). The land use is predominantly commercial along the major roadways and is surrounded by residential areas, many of which have neither curbs nor gutters.

5.1.1 Water Quality

Tifft Ditch at Secor Road (P11S97) is an Ohio EPA sample site. QHEI was assessed at this site in 1993 with a score of 21, which is very poor for a headwaters size stream. No fish, macroinvertebrate, water column, or sediment samples were collected at this site. The site is a primary headwaters stream and too small to evaluated fish and macroinvertebrate community health.

5.1.2 Facilities

Facilities in this critical area are regulated by BUSTR and RCRA. No facilities regulated through the following programs are in this critical area: NPDES, Superfund, TSCA, and TRI. Nineteen UST records for 15 locations and 18 LUSTs records at 14 locations are in this critical area (Figure 15). Nineteen facilities regulated by RCRA are in this critical area; many of the RCRA facilities along Monroe Street and Secor Road were associated with UST records. None of the RCRA records are at the same locations as U.S. EPA Region 5 or Ohio EPA DERR spills reports. USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

5.1.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and U.S. EPA Region 5. All 18 LUSTs records are inactive; nine records are for the closure of a regulated UST and nine records are for the suspected contamination from a UST. BUSTR determined that no further action was necessary for 17 of the LUSTs records. A release was disproved for a single LUST record, which was a suspected contamination source. With no proven releases, LUSTs should not be a source of POCs in this critical area.

Five spill reports in Ohio EPA DERR's spills database[6] and one spill report from U.S. EPA Region 5 are for locations in this critical area (Figure 15). The five spill events occurred between 1995 and 2010 (Table 16).

[6] While spill report 2003-3354 plots in GIS near the intersection of Secor Road and West Sylvania Avenue, the street address plots in Toledo to the south in the Ottawa River watershed. This spill report is assumed to be outside of the HSSCA project area and is not further discussed.

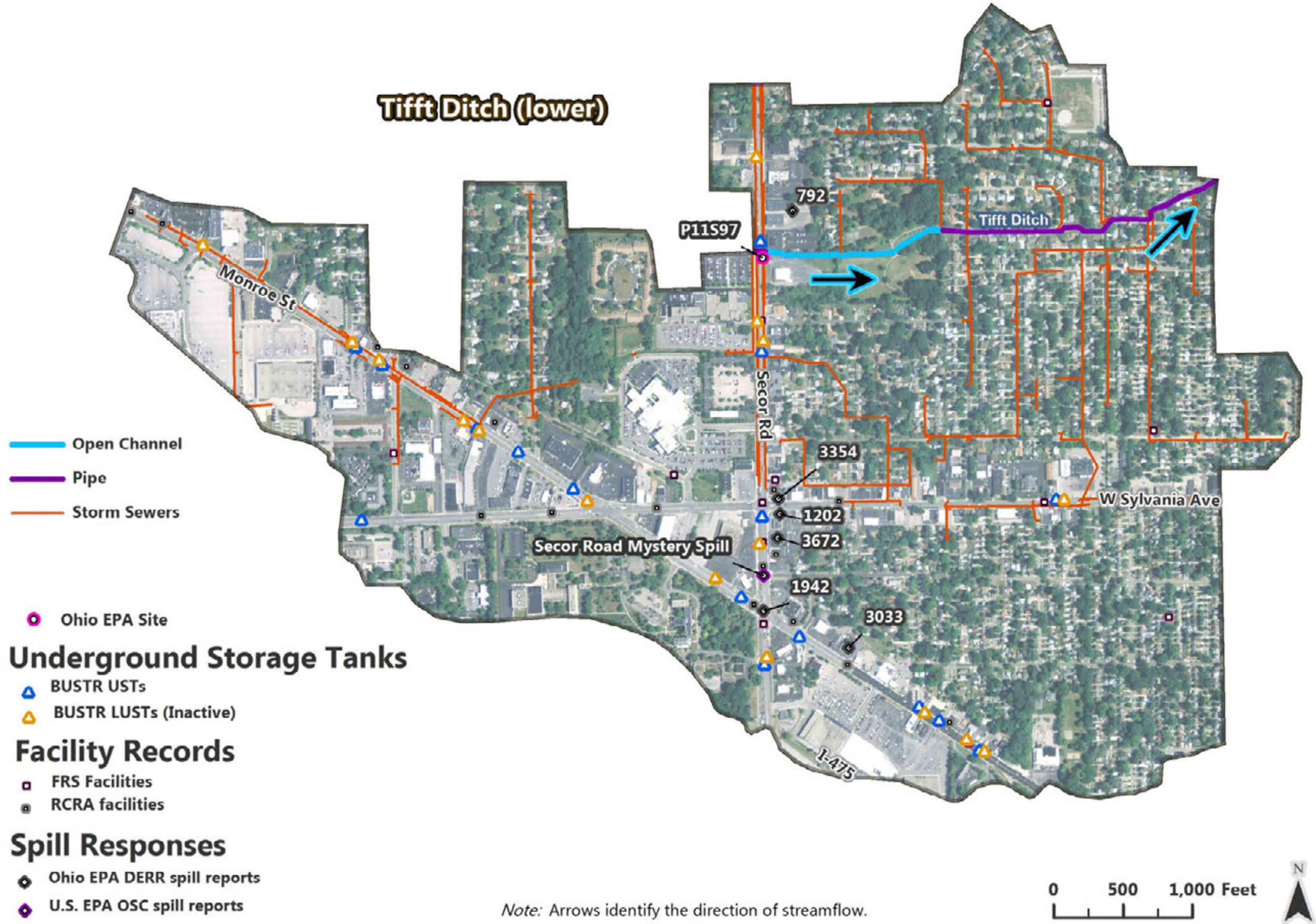


Figure 15. Tifft Ditch (lower): Secor Road, West Sylvania Avenue, and Monroe Street.

Table 16. Spills in the critical area: Tifft Ditch (lower)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1995-3672	9/28/1995	gasoline	*unknown*	*none reported*	♦
DERR	1997-1942	5/20/1997	gasoline Banner product mixture [b]	20 *unknown* 400	storm sewers	♦♦♦
DERR	2003-3033	8/6/2003	diesel fuel	10	storm sewers [c]	♦♦
DERR	2005-0792	2/8/2005	mercury	*unknown*	*none reported*	♦
DERR	2010-1202	5/6/2010	*unknown petroleum*	50	storm sewer catch basin [c]	♦♦♦
R5	E10522	5/13/2010	*weathered gasoline*	unknown	storm sewers [c]	♦♦♦

Notes
DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization. R5 = U.S. EPA Region 5.
a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. Dithane of fungicide mixture.
c. Spill reports identify the eventual receiving waterbody to be the Ottawa River. While these site locations are within the 12-digit HUCs that define the HSSCA project area, stormwater may be piped across the watershed boundary to the Ottawa River.

Spills 1995-3672 and 2005-0792 were not reported to affect waterways, and thus, are not further evaluated herein. Additionally, no further information regarding spill 1997-1942 is available[7]; therefore, this spill is not further evaluated. Spill 2003-3033 occurred when an employee at Toledo Radiator cleaned out a 300 gallon diesel fuel tank and the wash water was discharged on-site (instead of placement into a drum); the wash water with residual diesel fuel drained into Toledo's storm sewer system. The spill report identified the receiving waterbody as the Ottawa River to the south; a storm sewer shapefile shows the site drains adjacent to storm sewer main lines under Secor Road that appear to run north. The discrepancy between the spill report and the available GIS should be resolved prior to future remediation activities.

A single spill identified as 2010-1202 and E10522 was an historic spill of gasoline that migrated to Toledo's storm sewer system. The spill was discovered by Toledo DES during a road construction project. Refer to Section A-2.5.1.4 of Appendix A for further information. While the spill is within the *Shantee Creek* 12-digit HUC (04100001 03 01), the spill reports state that the storm sewers drain to the Ottawa River.

5.1.4 Summary and Recommendations

The Tifft Ditch (lower) critical area contains USTs regulated by BUSTR and facilities regulated by RCRA. Analysis of LUST records and spills reports found that LUSTs are not releasing POCs. An evaluation of spills reports shows that minor spills have occurred that entered storm sewers and potentially the Ottawa River. Potential exists for future spills in this critical area due to the number of USTs and RCRA facilities and because historic spills have occurred.

Due to a lack of environmental data from Tifft Ditch, it is recommended that water column and sediment samples be collected to evaluate potential contamination. Sample types and estimated costs are in Table 17 and site location information is in Table E-1 of Appendix E. Tifft Ditch is primary headwaters habitat, and thus, too small to evaluate aquatic community health with the IBI, MIwb, and ICI. Water column and sediment samples should be collected at Secor Road in Tifft Ditch (lower) and sediment samples should be collected at Tallmadge Road in Tifft Ditch (upper) to evaluate potential impacts of spills that migrated

[7] The narrative of the spill report, provided by Ohio EPA (2014a), indicates that an error occurred during a past migration of data from one database to another and that the data did not transfer to the new spills database.

to Tifft Ditch through storm sewers. Lower priority sampling is recommended at multiple locations along Tifft Ditch that drain residential areas to determine how urban residential stormwater may affect Tifft Ditch. Considerable portions of Tifft Ditch are piped underground within residential areas, which limit sampling to a few segments of open channel (Figure 16; Figure E-2 of Appendix E). Adjacent Eisenbraum Ditch should also be sampled, during the same timeframe as the Tifft Ditch sampling, to compare with Tifft Ditch, since Eisenbraum Ditch is predominantly residential. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample these three subwatersheds is $2,425 (Table 17).

Table 17. Sample Recommendations for Tifft and Eisenbraum ditches

Samples	Tifft Ditch (upper)				Tifft Ditch (lower)	ED (lower)
Site ID	TD-1	TD-2	TD-3	TD-4	P11S97	ED-1
Water						
Field Par.	X	X	X	X	X	X
Flow	--	--	--	--	X	X
Met. & Org.	--	--	--	--	X	--
Sediment						
Met. & Org.	X	--	--	--	X	X
PCBs	--	--	--	--	X	--
Costs						
Labor [a]	$75	$25	$25	$25	$225	$175
Laboratory [b]	$400	--	--	--	$1,225	$400
Total	**$525**	**$25**	**$25**	**$25**	**$1,300**	**$525**

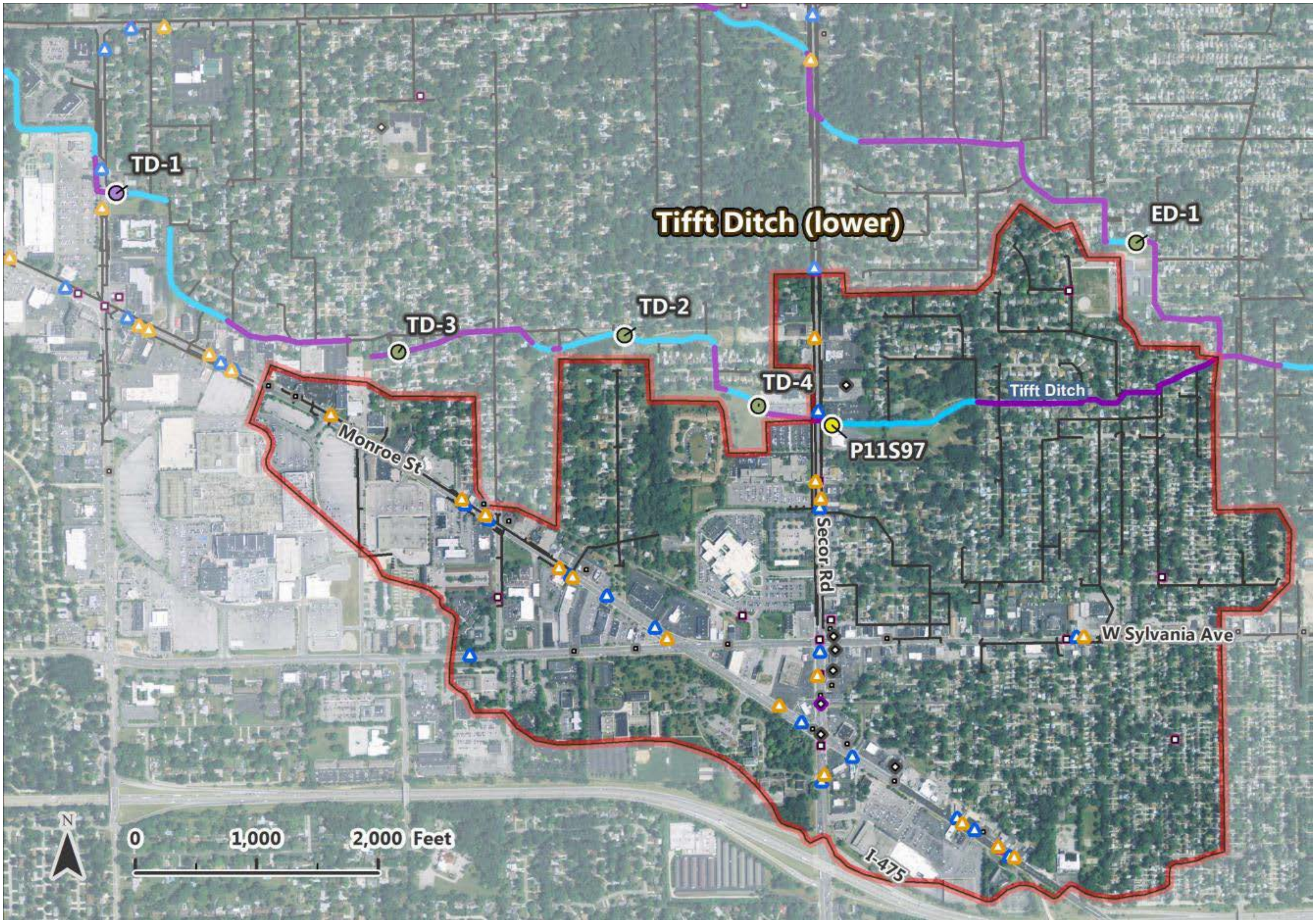
Notes

Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.

ED = Eisenbraum Ditch; Field Par. = field parameters; Met. & Org. = metals and organic constituents; PCBs = polychlorinated biphenyls; TD = Tifft Ditch.

a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 15 and is also shown on Figure E-1 in Appendix E.

Figure 16. Recommended sample locations along Tifft Ditch and on Eisenbraum Ditch.

During the HSSCA, a few habitat restoration opportunities were identified during field visits and GIS analyses. While a comprehensive analysis was not performed, the cursory results are presented herein for consideration as future activities. Any restoration activities would need to consider the city of Toledo and Lucas County's stormwater management objectives with Tifft Ditch and activities that may affect restoration (e.g., use of heavy equipment to remove large woody debris to maintain an open stormwater channel).

Along Tifft Ditch, there are isolated locations in commercial or mixed use areas that have potential for habitat restoration. Much of Tifft Ditch is channelized or routed underground through pipes. Typically, when Tifft Ditch is an open channel, there is not sufficient area along the banks in residential developments to restore a natural meander. However, Tifft Ditch east of Secor Road (Figure 17) is one segment where the banks are not held in place by riprap where there may be room to restore some meander and plant natural vegetation. Additionally, in Foxglove Meadow Park, which is surrounded by residential developments, there is sufficient room adjacent to Tifft Ditch to restore natural meander, plant native vegetation, and restore habitat (Figure 18).

Figure 17. Tifft Ditch at Secor Road (facing east, downstream).

Figure 18. Tifft Ditch at Foxglove Meadow Park (facing east, downstream).

5.2 Shantee Creek (West Laskey Road)

USTs, LUSTs, regulated facilities (NPDES, RCRA, and Superfund) and spills are along West Laskey Road in the Shantee Creek watershed (Figure 19; Appendix D). This critical area is along Shantee Creek near the southern boundary of the HSSCA project area. The Shantee Creek (West Laskey Road) subwatershed is 732 acres, is about 92 percent developed land (excluding open developed land), and is 49 percent impervious cover (Appendix D). The land use is predominantly commercial and industrial along West Laskey Road (between Jackman and Bennett roads). The critical area is surrounded by residential areas, except to the north in the Jamieson Ditch subwatershed that contains commercial and industrial land. Many of the commercial and industrial properties on the north side of West Laskey Road between Jackman and Bennett roads drain to both Shantee Creek and Jamieson Ditch; in cases where the majority of a facility's area drains to Jamieson Ditch, the facility is discussed with Jamieson Ditch in Section 0.

5.2.1 Water Quality

Shantee Creek Diversion at Lewis Avenue (P11S96) is the only Ohio EPA sample site in this critical area. Shantee Creek is a limited resources water along this segment. Between five and eight metals (of 11 total metals) per sample were detected in water column samples collected in 2011. Aluminum, arsenic, copper, iron, lead, manganese, nickel, and zinc were detected in one or more sample but were never detected above WQS. Cadmium, chromium, and selenium were never detected.

Fish and benthic macroinvertebrates were collected in 1993 and 2011. The IBI scores were 12, which is the lowest possible score, and the MIwb scores were 0.563 and 2.002. These scores indicate poor fish community health. Ohio EPA also found the macroinvertebrate community health to be poor in 1993 and very poor in 2011. QHEI scores were 22 in 1993 and 29 in 2011; these scores indicate very poor habitat for a headwaters-size stream.

5.2.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, Superfund, and TRI. Fourteen UST records for 10 locations, 14 LUSTs records at 11 locations, and 15 facilities regulated by RCRA are in this critical area (Figure 19). RCRA records are associated with many of the properties regulated under additional authorities (e.g., BUSTR, NPDES). USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Ohio EPA has issued general NPDES permit coverage for stormwater associated with industrial activities for two properties along West Laskey Road. One of the facilities is Al's Polishing and Plating (1615 West Laskey Road; 2GR00265), which was investigated as part of the Shantee Creek Emergency Response (as discussed later in this section) and was required to clean out contaminated sediments in their stormwater pipes. The other permittee is Transrail North America (1200 West Laskey Road; 2GR01862) that also is regulated through RCRA. As with any facilities permitted to discharge stormwater offsite, these facilities are potential sources of future spills.

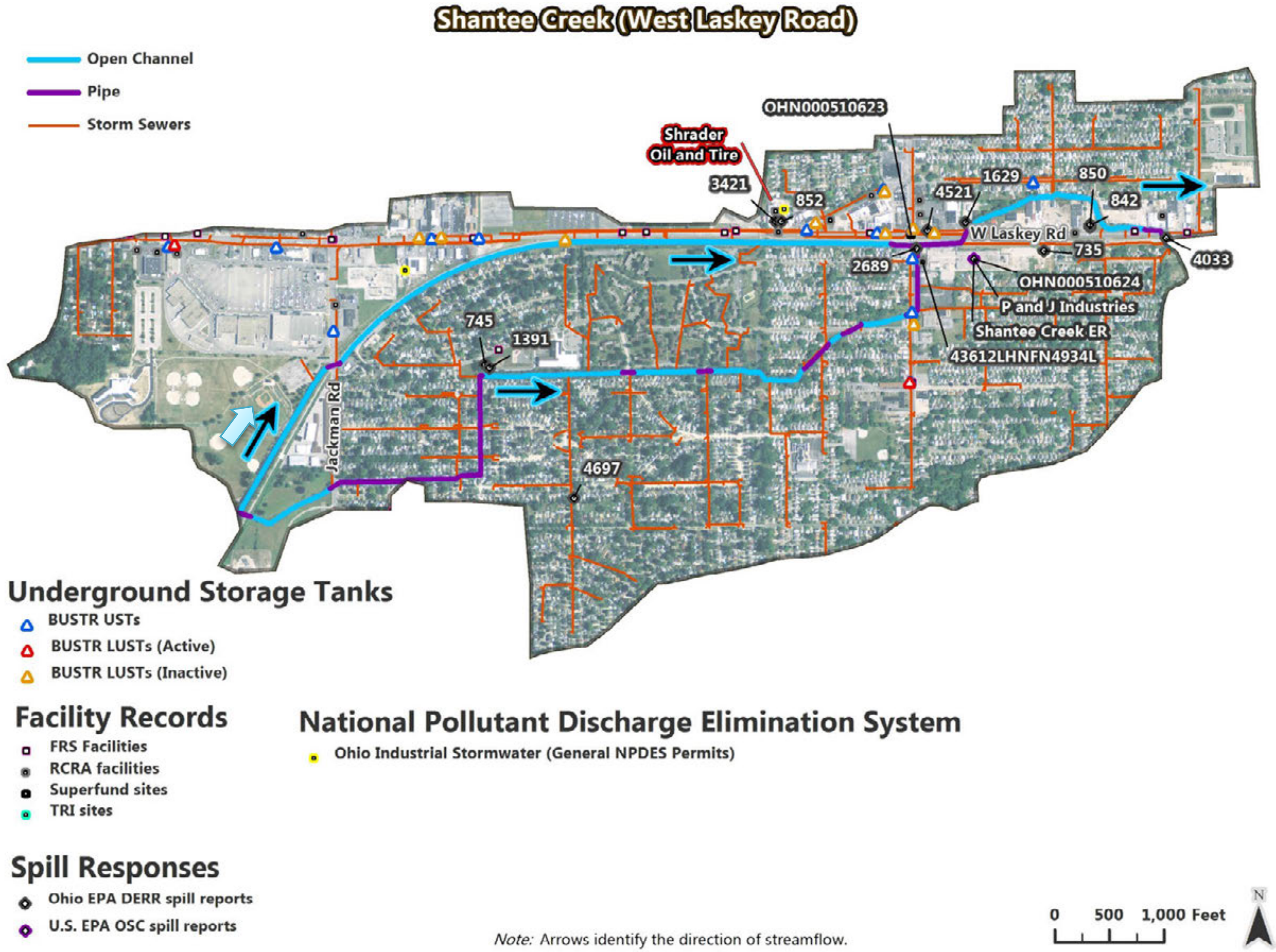


Figure 19. Shantee Creek (West Laskey Road).

Two Superfund sites are in this critical area: P&J Industries (OHN000510623) and Shantee Creek Emergency Response (OHN000510624). An orange discoloration of Shantee Creek and dead fish were reported to Toledo DES on August 15, 2011 and were due to a cyanide spill. During the investigation, conducted by U.S. EPA with Ohio EPA DERR and Toledo DES, the source of the spill was determined to be an industrial property: Al's Polishing and Plating (1615 West Laskey Road). Another industrial property, P&J Industries, was also investigated and found to be in violation of hazardous materials storage requirements. Refer to Section A-2.5 and Section A-2.6 of Appendix A for discussions of the available information in the spills reports and Superfund files, respectively. As spills or hazardous materials storage requirements were violated, there is potential for future spills and releases.

One facility is on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A): P&J Industries (43612LHNFN4934L). They are listed for 13 materials between 1987 and 2011, including organic compounds, PAHs, and metals.

5.2.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and U.S. EPA Region 5. All ten LUST records are inactive. Seven of the inactive LUST records are for the closure of a regulated UST and three records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for nine records and a release was disproved for the last LUST record. With no proven releases, LUSTs should not be a source of POCs in this critical area.

Twelve spills reports in Ohio EPA DERR's spills database[8] and two spill reports from U.S. EPA Region 5 are for locations in this critical area (Figure 19). The 12 spills occurred between 1997 and 2013 (Table 18).

[8] Spill report 2013-0850 plots in GIS within this critical area. However, the spilled material is identified as pollen; this spill report will not be further discussed.

Table 18. Spills in the critical area: Shantee Creek (West Laskey Road)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1997-3421	8/20/1997	soil [b]	--	*none affected*	♦
DERR	2000-4033	10/24/2000	diesel fuel	*unknown*	Shantee Creek	♦♦
DERR	2001-4521	11/29/2001	oil	*unknown*	Shantee Creek [c]	♦♦
DERR	2001-4697	12/13/2001	gasoline	*unknown*	sanitary sewers	♦
DERR	2004-0735	2/24/2004	yellow material	*unknown*	Shantee Creek	♦♦♦
DERR	2005-1391	3/26/2005	sewage	*unknown*	Shantee Creek [d]	♦
DERR	2007-1629	4/26/2007	gasoline	*unknown*	Shantee Creek	♦♦
DERR	2008-0745	2/28/2008	sewage	*unknown*	Shantee Creek [d]	♦
DERR	2011-2689	8/16/2011	*unknown*	*unknown*	Shantee Creek	♦♦♦♦♦
R5	C567	8/17/2011	cyanide			
R5	C568 [e]	8/26/2011	*none*	--	*none affected*	♦
DERR	2012-0852	4/9/2012	oil	130	Shantee Creek	♦♦♦
DERR	2013-0842	4/18/2013	white material	*unknown*	Shantee Creek	♦♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization. R5 = U.S. EPA Region 5.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. The spill report identifies the spilled product as "contaminated soil from oil spillage".
c. Spill report 2001-4521 reports the receiving waterbody as Silver Creek. The spill address and geographic coordinates plot near each other in GIS and the facility appears to drain to Shantee Creek.
d. Discharged to Shantee Creek via storm sewers.
e. The P&J Industries spill investigation was part of the Shantee Creek Emergency Response. P&J Industries was found to have hazardous materials in violation of storage requirements. No pollutant was released into the environment.

P&J Industries and Shantee Creek Emergency Response are spills that were responded to by U.S. EPA Region 5, Ohio EPA DERR, and Toledo DES. These two sites are plotted on Figure 19 at the same location because they were part of the same emergency response. Cyanide was spilled at an industrial facility in August 2011 that resulted in orange discoloration of Shantee Creek and a fish kill. During the investigation, U.S. EPA Region 5 also identified hazardous materials that were stored in violation of storage requirements at P&J Industries. These spill sites became Superfund sites. Refer to Section A-2.5 and Section A-2.6 of Appendix A for discussion of the available spills reports and Superfund documents, respectively. Additionally, P&J Industries was the site of another spill 7.5 years earlier (2004-0735) when a yellow material leaked from temporarily stored waste, entered the storm sewers, and was discharged to Shantee Creek; Ohio EPA DERR and Toledo DES responded, the spill was contained, and eventually cleaned up. The source of a fish kill in Shantee Creek upstream of Raintree Village in 2012 was never identified; however, soluble yellow material was observed in the stream at the former P&J Industries facility (refer to Section 5.4.3 for a discussion of the fish kill).

Ohio EPA DERR and Toledo DES investigated spills that resulted in oil sheens (2007-1629) and discolorations of Shantee Creek (2013-0842) that dissipated on their own and were not remediated. In other cases, the spills were larger and clean-up efforts were undertaken. Ohio EPA DERR and Toledo DES investigated an oil sheen on Shantee Creek (spill 2001-4521) that was a spill of diesel fuel from a saddle tank of a truck owned by Conway Trucking, which was involved in an automobile accident. An additional oil sheen in Shantee Creek (2012-0852) was investigated by both agencies and U.S. EPA that came from Shrader Oil and Tire when oil was released into an on-site drain and bypassed their oil-water separator, which may have been overwhelmed. Shrader Oil and Tire was investigated for multiple stormwater management and containment issues and did not have a Spill Prevention, Control, and Countermeasure plan[9].

[9] Ohio EPA took an enforcement action against Shrader Oil and Tire, which was required to pay a fine. Additionally, Shrader Oil and Tire was required to take down their existing tanks, and then install a containment system and construct a building around the replacement tanks.

A pinhole size leak was identified in a BP pipeline that transported high sulfur diesel fuel (2000-2043). Ohio EPA DERR and Toledo DES investigated. BP hired a contractor to contain the oil sheen in Shantee Creek and clean up the stream; most of the oil sheen was contained and removed.

Spills involving Toledo's sanitary sewer lines (2001-4697) or sanitary waste discharged to storm sewers (2005-1391 and 2008-0745) are not further discussed as toxic substances were not discharged to surface waterways.

5.2.4 Summary and Recommendations

The West Laskey Road critical area in the Shantee Creek watershed contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, Superfund, and TRI. Analysis of LUST records and spills reports found that LUSTs are not releasing POCs. An evaluation of spills reports shows that major and minor spills have occurred that entered storm sewers and Shantee Creek. Potential exists for future spills in this critical area due to the numbers of USTs and NPDES, RCRA, Superfund, and TRI facilities and because historic and recent spills have occurred. Additionally, a few properties are regulated under multiple programs and spills have occurred at these properties.

Due to a lack of environmental data from the segment of Shantee Creek that runs along West Laskey Road, it is recommended that extensive sampling be performed to locate potential contamination. Sample types and estimated costs are in Table 19 and site location information is in Table E-1 of Appendix E. The Shantee Creek (upper) subwatershed is not anticipated to contribute significant contamination; measurements of field parameters are recommended to evaluate urban residential and commercial stormwater. Aquatic community health and habitat should be assessed at the upstream boundary of the Shantee Creek (West Laskey Road) critical area subwatershed (Figure E-3 in Appendix E); these results can serve as a baseline to be compared with downstream results at sites impacted by spills and releases. Field measurements and flow should be monitored when Shantee Creek is split into two segments to evaluate the hydrography of the *artificial braiding* of the creek and to assess urban residential stormwater; this sampling is of a lower priority. High priority sediment sampling at the downstream terminus of Shantee Creek in this critical area will allow for an assessment of the Superfund sites and certain industrial properties along West Laskey Road (Figure 20; Figure E-3 in Appendix E).

This sampling will also assist with the assessment of sources in the next downstream subwatershed: Shantee Creek (Telegraph Road). Thus, it is recommended to sample these subwatersheds during the same timeframe. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample these three subwatersheds is $10,150 (Table 19 and Table 21 [Section 5.3.4]).

There is limited potential for habitat restoration along Shantee Creek in this critical area. Shantee Creek is split into two channels with one channel following a railroad right-of-way and the other channel flowing through or under (through pipes) residential developments. In this critical area, Shantee Creek is a channelized stormwater conveyance that has insufficient adjacent land to restore a natural meander or to plant native vegetation. While there may be very isolated restoration opportunities along Shantee Creek in this critical area, resources should be devoted to other subwatersheds in the HSSCA project area with better restoration opportunities.

Table 19. Sample recommendations for Shantee Creek (upper and West Laskey Road)

Samples	Shantee Creek (upper)		Shantee Creek (West Laskey Road)					
Site ID	ShC-1	ShC-2	ShC-3	ShC-4	ShC-5	ShC-6	ShC-7	ShC-8
Biology								
IBI & MIwb	--	--	X	--	--	--	--	--
ICI	--	--	X	--	--	--	--	--
QHEI	--	--	X	--	--	--	--	--
Water Column								
Field Par.	X	X	X	X	X	X	X	X
Flow			X	X	X	--	--	--
Met. & Org.	--	--	X	--	--	--	--	--
Sediment								
Met. & Org.	--	--	X	--	--	X	X	X
PCBs	--	--	X	--	--	--	--	--
Cost								
Labor [a]	$25	$25	$1,625	$125	$125	$75	$75	$75
Laboratory [b]	--	--	$1,725	--	--	$400	$400	$400
Total	**$25**	**$25**	**$3,350**	**$125**	**$125**	**$475**	**$475**	**$475**

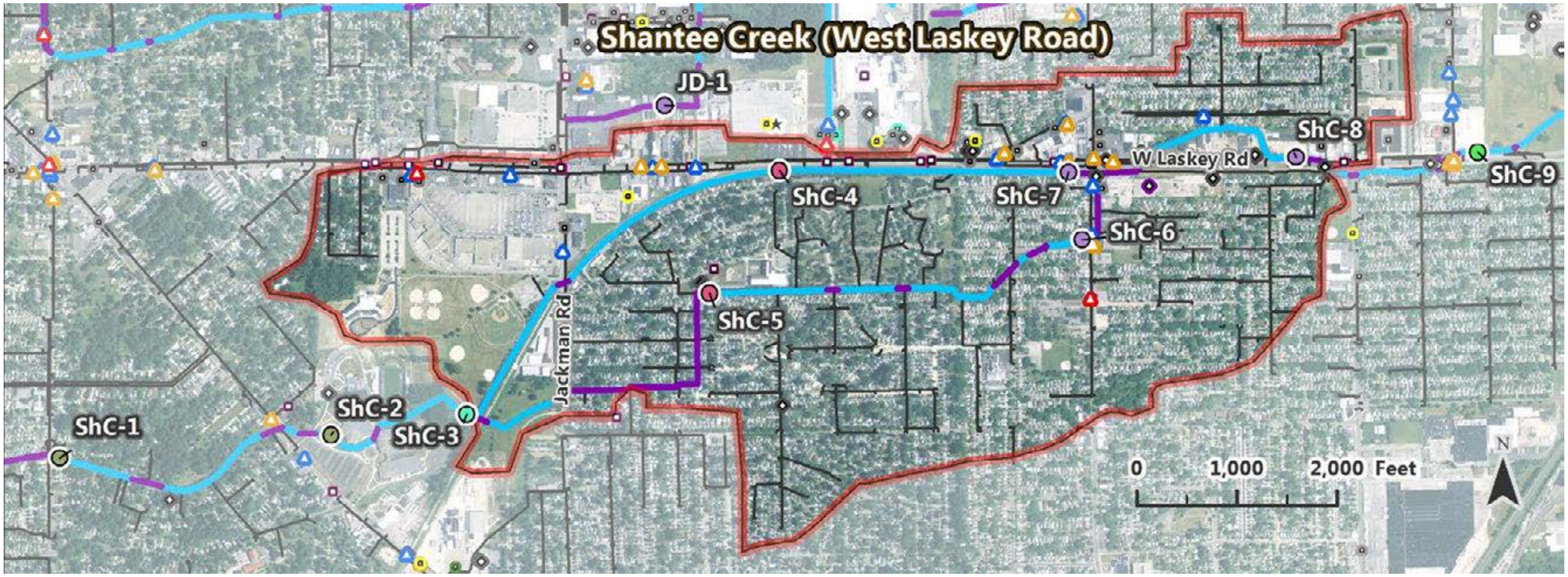
Notes

Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.

Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index; ShC = Shantee Creek.

a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 19 and is also shown on Figure E-1 in Appendix E.

Figure 20. Recommended sample locations along Shantee Creek in and upstream of the West Laskey Road critical area.

5.3 Shantee Creek (Telegraph Road)

USTs, LUSTs, regulated facilities (NPDES, RCRA, and TRI), and spills are along Telegraph Road, North Detroit Avenue, and West Laskey Road in the Shantee Creek watershed (Figure 21; Appendix D). This area is in the lower segments of Shantee Creek upstream of the early 1970s re-route to Silver Creek. The Shantee Creek (Telegraph Road) subwatershed is 408 acres, is 84 percent developed land (excluding open developed land), and is 53 percent impervious cover. The southern border of this critical area is the southern boundary of the HSSCA project area. The land use is predominantly industrial. Residential developments are adjacent to the critical area to the north, west, and south.

5.3.1 Water Quality

Shantee Creek Diversion at Detroit Avenue (P11S62) is the only Ohio EPA sample site in this critical area. Shantee Creek is designated modified warmwater habitat (due to channelization) along this segment. One sample was collected from the water column at site P11S62 in 1987. Arsenic, iron, lead, and zinc were detected well below WQSs. Cadmium, chromium, copper, and nickel were not detected.

Fish were collected in 1993 and benthic macroinvertebrates were collected in 1992. The IBI scores was 14, which is just above the lowest possible score (12), and the MIwb scores was 1.710. These scores indicate poor fish community health. Ohio EPA also found the macroinvertebrate community health to be poor in 1992. The QHEI score was 20.5 in 1993, which indicates very poor habitat for a headwaters-size stream.

5.3.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, and Superfund. Twelve UST records for eleven locations and five LUSTs records at nine locations are in this critical area (Figure 21). Nineteen facilities regulated by RCRA are in this critical area. Some RCRA records are associated with many of the properties regulated under additional authorities (e.g., BUSTR, NPDES) and some are associated with spill reports. USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Five properties have general NPDES permit coverage for stormwater associated with industrial activities (Figure 21):

- Maumee Valley Fabricators, Inc (4801 Bennett Road; 2GR01585)
- OmniSource Corporation (5130 North Detroit Avenue; 2GR01674)
- OmniSource Corporation (5270 North Detroit Avenue; 2GR00504)
- Resource Reclamation Toledo LLC (5400 North Detroit Avenue; 2GR1584)
- Toledo Molding & Die's Laskey Plant (4 East Laskey Road; 2GR00171).

As with any facility permitted to discharge stormwater offsite, these facilities are potential sources of future spills. One facility was previously designated no exposure: Resource Reclamation Toledo LLC (5400 North Detroit Avenue; 2GRN00119). A property that has no exposure coverage should not have discharged stormwater offsite.

Three facilities are on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A):

- Doehler-Jarvis Toledo Inc. (43612DHLRJ5400N) for eight materials between 1987 and 1998, including organic compounds and metals.
- New Mather Metals Inc (43612NWMTH5270N) for manganese between 1998 and 2010.

- Safety-Kleen Systems (43612SFTYK5148T) for four materials between 2001 and 2012, including lead and PAHs.

Three scrapyards were identified in this critical area from a study of scrapyards and salvage facilities funded by a Great Lakes Restoration Initiative grant that was awarded to the city of Toledo (Tetra Tech 2013). Rada and Sons (4 East Laskey Road) is a salvage facility that was inspected during the study and later implemented some of the recommended best management practices (BMPs). OmniSource Corporation (5130 North Detroit Avenue) operates scrapyards on multiple properties along North Detroit Avenue. OmniSource treats stormwater in oil-water separators and installed a berm along Shantee Creek.

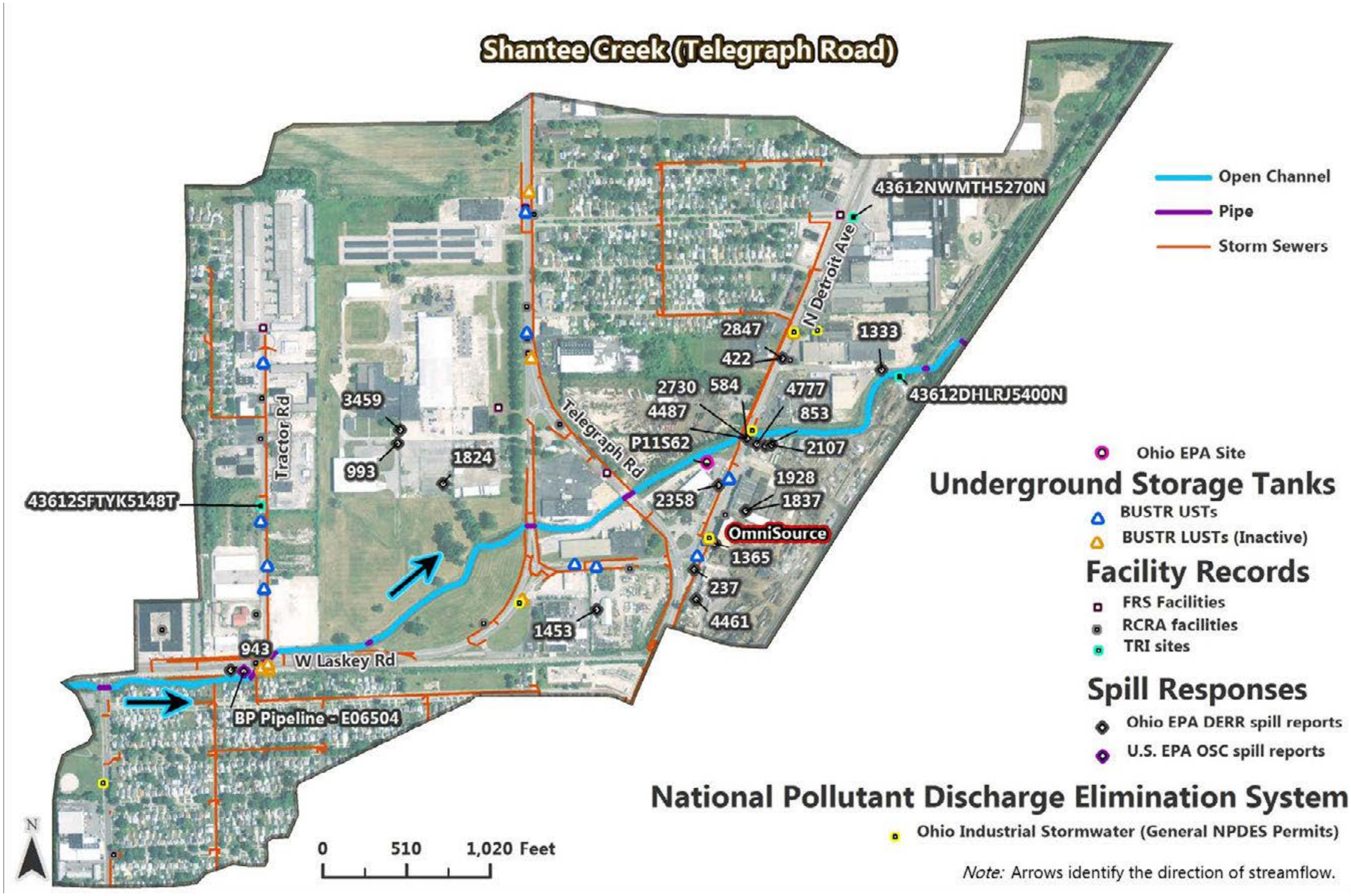


Figure 21. Shantee Creek (Telegraph Road): Telegraph Road, North Detroit Avenue, and West Laskey Road.

5.3.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and U.S. EPA Region 5. All nine LUSTs records are inactive. Five records are for the closure of a regulated UST and four records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for eight of the LUST records. One record's status is disproval of a suspected release. With no proven releases, LUSTs should not be a source of POCs in this critical area.

Twenty-one spills reports in Ohio EPA DERR's spills database[10] and two spill reports from U.S. EPA Region 5 are for locations in this critical area (Figure 19). The 21 spills occurred between 1997 and 2013.

Table 20. Spills in the critical area: Shantee Creek (Telegraph Road)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1995-0422	2/3/1995	hydraulic fluid	300	Shantee Creek	♦♦♦
DERR	1995-1453	4/19/1995	*unknown*	*unknown*	Shantee Creek	n/a[b]
DERR	1997-0237	1/22/1997	hydraulic oil	50	Shantee Creek [c]	♦♦
DERR	1997-0993	3/13/1997	*unknown*	*unknown*	*none reported*	♦
DERR	1997-4461	11/11/1997	lube oil residue	*unknown*	*none reported*	♦
DERR	1999-1365	4/16/1999	hydraulic oil	100	Shantee Creek [c]	♦♦♦
DERR	2001-1837	5/23/2001	oil	*unknown*	Shantee Creek [c]	♦♦
DERR	2001-1928	5/30/2001	residual oil & metal shavings residue	*unknown*	Shantee Creek [d]	♦♦
DERR	2002-0584	2/21/2002	residual black sludge	*unknown*	Shantee Creek [c]	♦♦
DERR	2002-2730	7/9/2002	*oil sheen*	--	Shantee Creek	♦♦
DERR	2002-2732	7/10/2002	cutting oil	*unknown*	Shantee Creek [c,e]	♦♦
DERR	2002-4487	11/22/2002	oil waste from scrap piles	500	Shantee Creek	♦♦♦
DERR	2006-0943	3/23/2006	gasoline	13,000	Shantee Creek	♦♦♦♦♦
R5	E060504					
DERR	2007-0853	3/6/2007	diesel fuel	500	Shantee Creek	♦♦♦
DERR	2007-2107	5/31/2007	*light sheen*	--	Shantee Creek	♦♦
DERR	2008-1824	4/19/2008	*oil sheen*	--	Shantee Creek	♦♦
DERR	2008-4777	12/27/2008	diesel fuel	500	Shantee Creek [c]	♦♦♦
DERR	2009-2358	8/9/2009	fire runoff	*unknown*	Shantee Creek [c]	♦♦♦
DERR	2009-3459	12/10/2009	transformer oil	50	Shantee Creek [c]	♦♦♦
DERR	2010-1333	5/18/2010	hydraulic fluid	1,200	Shantee Creek	♦♦♦♦
DERR	2010-2847	10/13/2010	orange material	*unknown*	Shantee Creek	♦♦♦♦♦

Notes
DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization; n/a = not available.
a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. Spill report 1995-1543 is not available for review.
c. Discharged to Shantee Creek via storm sewers.
d. Spill report 2001-1928 reports the receiving waterbody as a tributary to the Ottawa River.
e. Spill report 2002-2732 may be in error. The facility address is not consistent with the geographic coordinates. The address plots within this critical area, which drains to Shantee Creek.

[10] Spill report 2013-0850 plots in GIS within this critical area. However, the spilled material is identified as pollen; this spill report will not be further discussed. Spill report 2004-2964 plots in GIS within this critical area. However, the street address plots south of this critical area and outside of the HSSCA project area. The spill is assumed to be outside of the HSSCA project area and is not further discussed.

The largest, most significant spill in this critical area is the BP pipeline leak that began on March 23, 2006. Toledo DES identified a few wildlife deaths (two turtles, a duck, and a muskrat; spill 0158/06 Toledo 2014b). BP conducted a two month spill investigation, clean-up, and remediation that multiple federal, state, and local agencies participated in. A summary of the spill is presented in Section A-2.5.1.2 of Appendix A. Approximately 5.5 years earlier and about 850 feet west, a pinhole-size leak was found in a BP pipeline that released diesel fuel into Shantee Creek, resulting in a sheen (spill 2000-4033, which is discussed in Section 0).

Fourteen spills occurred at OmniSource between 1995 and 2010 and all but one spill migrated to storm sewers and Shantee Creek. The sources of the spills varied considerably from issues with the oil-water separators and private storm sewers (1995-1365, 1997-2037, 2001-1928, 2002-0584), to scrap axles and oily parts (2002-4487), to tanker trucks (2007-0853 and 2008-4777) and a fire (2009-3459). Sources on the OmniSource property were not explicitly identified in some spill reports (2001-1837, 2002-2730, and 2007-2107). Some of OmniSource's spills did not migrate to storm sewers or surface waters (1997-4461) and one spill of hydraulic fluid migrated from OmniSource to Shantee Creek then to Silver and Halfway creeks and migrated into Michigan (2010-1333). Finally, some spills were believed to originate from both OmniSource and New Mather Metal spills (2002-2732 and 2007-2107).

Two spills occurred at NTA Graphic. An illegal dumping of waste solvent by a trespasser on the NTA Graphic property was investigated by Ohio EPA DERR, Toledo DES, and the Toledo police (1997-0993). A weather event knocked down a pole with transformers and one of the transformers leaked oil from its downed-location in a truck bay of NTA Graphic; the transformer oil migrated to storm sewers and then Shantee Creek (2009-3459). The transformer oil did not contain PCBs and was cleaned up by a contractor.

The source of an oil sheen in Shantee Creek was not identified (2008-1824) nor was the source of a fish kill associated with orange-discolored water in Shantee Creek (2010-2847) identified. Hydraulic oil spilled from a truck when a line broke (1995-0422); no additional information is available.

5.3.4 Summary and Recommendations

The Telegraph Road critical area in the Shantee Creek watershed contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, and TRI. Analysis of LUST records and spills reports found that LUSTs are not releasing POCs. An evaluation of spills reports shows that major and minor spills have occurred that entered storm sewers and Shantee Creek. Potential exists for future spills in this critical area due to the numbers of USTs and NPDES, RCRA, and TRI facilities and because historic and recent spills have occurred. Additionally, a few properties are regulated under multiple programs and spills have occurred at these properties. Multiple spills have occurred at OmniSource and other locations.

Due to a lack of environmental data from this segment of Shantee Creek, the considerable number of spills and spilled volume, and the occurrence of a fish kill, it is recommended that extensive sampling be performed to evaluate potential contamination of Shantee Creek. Multiple sites should be sampled along this segment, and high priority future sample sites should bracket the OmniSource and New Mather Metals properties along with the outlets for storm sewers that drain Telegraph and Tractor roads (Figure 23; Figure E-4 of Appendix E). Aquatic community health and habitat should be assessed below the industrial properties, near the downstream terminus of the Shantee Creek (Telegraph Road) critical area subwatershed. Sampling of the Telegraph Road critical area should be coupled with the sampling associated with the West Laskey Road critical area. Sample types and estimated costs are in Table 21 and site location information is in Table E-1 of Appendix E. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample Shantee Creek's upper, West Laskey Road, and Telegraph Road subwatersheds are $10,150.

Table 21. Sample recommendations for Shantee Creek (Telegraph Road)

Samples	Shantee Creek (Telegraph Road)			
Site ID	ShC-9	P11S62	ShC-10	ShC-11
Biology				
IBI & MIwb	--	--	--	X
ICI	--	--	--	X
QHEI	--	--	--	X
Water				
Field Par.	X	X	X	X
Flow	X	--	--	X
Met. & Org.	--	--	--	X
Sediment				
Met. & Org.	X	X	X	X
PCBs	X	--	X	--
Costs				
Labor [a]	$175	$75	$75	$1,625
Laboratory [b]	$600	$400	$600	$1,525
Total	**$775**	**$475**	**$675**	**$3,150**

Notes

Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.

Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index; ShC = Shantee Creek.

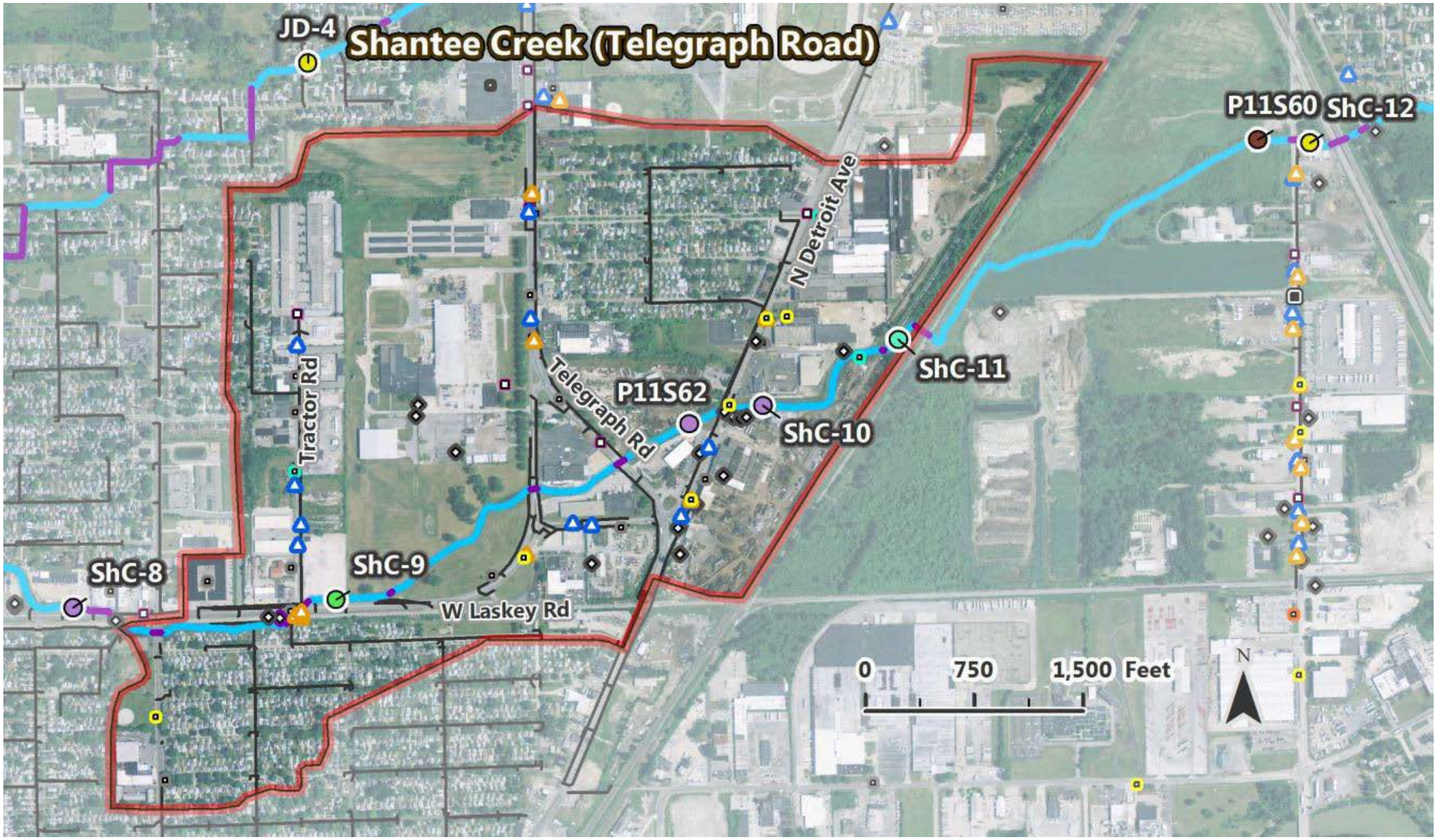
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.

During the HSSCA, habitat restoration opportunities along a single segment of Shantee Creek in this critical area wereidentified during field visits and GIS analyses. While a comprehensive analysis was not performed, the cursory results are presented herein for consideration as future activities. Any restoration activities would need to consider the city of Toledo and Lucas County's stormwater management objectives with Shantee Creek and activities that may affect restoration (e.g., use of heavy equipment to remove large woody debris to maintain an open stormwater channel).

There is limited potential for habitat restoration along Shantee Creek in this critical area. Much of Shantee Creek in this critical area flows through commercial and industrial properties and is often adjacent to roads, buildings, or parking lots (Figure 22). However just east of Tractor Road, Shantee Creek flows through vacant lots (Figure 23), and this segment would have sufficient room for restoration activities.

Figure 22. Shantee Creek at Telegraph Road (facing east, downstream).



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 21 and is also shown on Figure E-1 in Appendix E.

Figure 23. Recommended sampling locations along Shantee Creek in the Telegraph Road critical area.

5.4 Shantee Creek (Stickney Avenue)

USTs, LUSTs, regulated facilities (NPDES and RCRA), and spills are along Stickney Avenue (Figure 24; Appendix D). Shantee Creek flows through this area just before flowing due north along Enterprise Boulevard into Silver Creek, which was the major re-route of Shantee Creek in the early 1970s. The southern boundary of this critical area is the HSSCA project boundary, while the eastern and western boundaries are the railroad lines. The Shantee Creek (Stickney Avenue) subwatershed is 279 acres, is 39 percent developed land (plus an additional 41 percent as open developed land), and is 28 percent impervious cover (Appendix D). Commercial and industrial properties are along Stickney Avenue in this critical area.

5.4.1 Water Quality

Shantee Creek Diversion at Stickney Avenue (P11S60) is an Ohio EPA sample site. Ohio EPA collected water column samples once in 1987, twice in 1992 and 1994, and five times in 2011. Aluminum, arsenic, copper, iron, lead, manganese, and zinc were regularly detected, while cadmium, chromium, manganese, mercury, and nickel were occasionally detected. Samples of copper, lead, and zinc exceeded WQS. One sample collected in 1992 was evaluated for 99 organic constituents and eight pesticides; one organic constituent (1,1,1-trichloroethane) and three pesticides (Endrin, Methoxychlor, and Mirex) were detected. One sample collected in 2011 was evaluated for 112 organic constituents and none were detected. Refer back to Section 3.5 for a discussion of water column chemistry results at site P11S60.

Fish and macroinvertebrate samples were collected in 1992, 1994, and 2011. IBI scores were 12, 14, and 24, and MIwb scores were 2.069, 2.571, and 3.972. IBI scores below 20 and MIwb scores below 5.6 do not meet the biological criteria for modified warmwater habitat streams affected by channelization. Ohio EPA found macroinvertebrate community health to be low-fair or poor.

Silver Creek at Stickney Avenue (#20) is also a Toledo DES sample site. Toledo DES has collected water column samples from 1995 through 2013 and evaluated the samples for various metals. Chromium (total), nickel and zinc were regularly detected; copper, lead, and mercury were occasionally detected; cadmium and chromium (hexavalent) were rarely detected; and silver was never detected.

5.4.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, and RCRA. No facilities regulated through the following programs are in this critical area: Superfund, TSCA, and TRI. Nine UST records for eight locations and nine LUSTs records at seven locations are in this critical area (Figure 24). Four facilities regulated by RCRA are in this critical area; two of the RCRA facilities along Stickney Avenue were associated with UST records. One of the RCRA records is at the same location as an Ohio EPA DERR spills report; however, that spill did not reach a waterway. USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Northwest Bioenergy LLC (2IN00244) is the only facility covered by an individual NPDES permit; however, it is not permitted to discharge to surface waters. The facility is permitted to land apply, landfill, or transfer biosolids and sludge. This facility is not a source of POCs in this critical area.

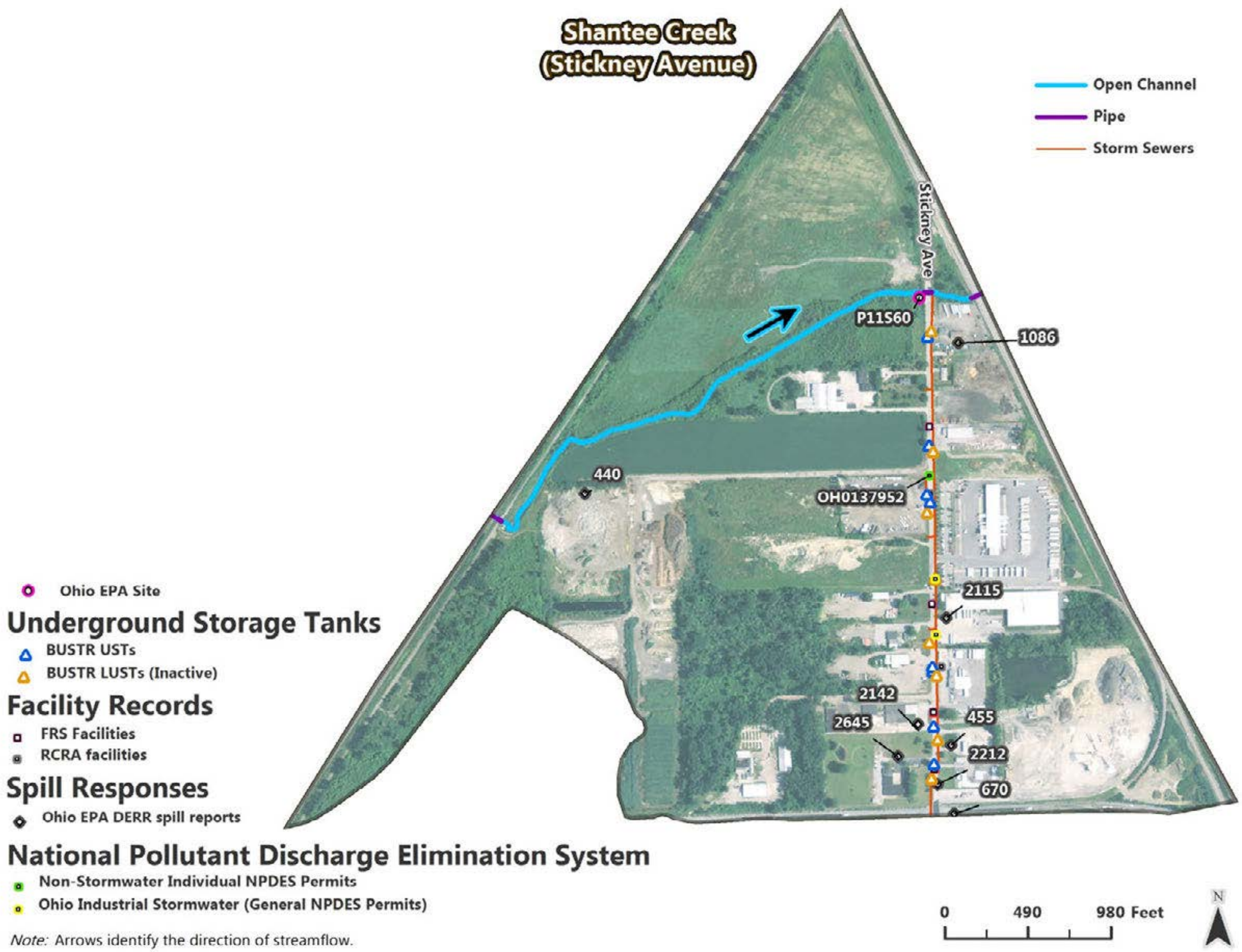


Figure 24. Shantee Creek (Stickney Avenue).

Two facilities hold general NPDES permits for stormwater associated with industrial activities: Pitt Ohio Express LLC (5200 Stickney Avenue; 2GR00498) and Viking Paper Corporation (5148 Stickney Avenue; 2GR01637). As with any facilities permitted to discharge stormwater offsite, these facilities are potential sources of future spills. All Ohio Ready Mix's Stickney Plant (4950 Stickney Avenue; 2IN00236) is adjacent to but directly south of the critical area; it is assumed that this facility's stormwater drains south into the Ottawa River watershed.

5.4.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR and Ohio EPA DERR. All nine LUSTs records are inactive. Seven records are for the closure of a regulated UST and two records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for eight of the LUST records. One record's status is disproval of a suspected release. With no proven releases, LUSTs should not be a source of POCs in this critical area.

Six spills reports in Ohio EPA DERR's spills database are for locations in this critical area (Figure 24)[11]. The six spills occurred between 1999 and 2012 (Table 22). U.S. EPA Region 5 does not have any spill reports for spills or releases in this critical area.

Table 22. Spills in the critical area: Shantee Creek (Stickney Avenue)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1999-2645	7/21/1999	chlorpyrifos	150	*none reported*	♦
DERR	2006-2212	6/23/2006	diesel fuel	100	*surface waters* [b]	♦♦♦
DERR	2007-2115	6/1/2007	hydraulic oil starch	15 *unknown*	Shantee Creek [c]	♦♦
DERR	2007-2142	6/4/2007	oil	10	Shantee Creek [c]	♦♦
DERR	2009-0455	2/16/2009	diesel fuel	50	Silver Creek [d]	♦♦
DERR	2012-1086	5/5/2012	*fish kill*	--	Shantee Creek [e]	♦♦♦♦♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.

b. The name of the surface waterbody was not reported.

c. Discharged to Shantee Creek via storm sewers.

d. Spill report 2009-0455 reports the receiving waterbody as Silver Creek via storm sewers. The spill address and geographic coordinates are consistent and the facility appears to drain to Shantee Creek. Toledo DES spill report 0058/09 also identifies the spill along the Stickney Avenue storm sewers as migrating to Shantee Creek (Toledo 2014b).

e. Spill report 2012-1086 plots in GIS along West Laskey Road near Bennett Road. The street address plots within this critical area. The spill report is assumed to be in this critical area (i.e., the street address is assumed to be correct and the geographic coordinates are assumed to be incorrect).

Spills 2006-2212, 2007-2115, 2007-2142, and 2009-0455 involved on-site leaks or releases at industrial properties that migrated to private storm sewers and then to public storm sewers or Shantee Creek. Localized flooding at the industrial facilities affected these spills. Two of the spills are for a single industrial property; all four spills occurred on adjacent properties along a one-half mile segment of Stickney Avenue. Spill 1999-2645 was not reported to affect a waterway, and thus, is not further evaluated herein.

A fish kill was observed just upstream of Raintree Village in Shantee Creek within this critical area. The stream was found to be black but without an odor. An investigation upstream found water with an orange

[11] While spill report 1996-0670 plots in GIS along Stickney Avenue, the spill street address plots in Toledo in the Ottawa River watershed. This spill report is assumed to be outside of the HSSCA project area and is not further discussed.

tint in Shantee Creek at North Detroit Avenue along with stressed fish. A yellow soluble material was identified near the former P&J Industries property. The source of the spill was never determined.

5.4.4 Summary and Recommendations

The Stickney Avenue critical area in the Shantee Creek watershed contains USTs regulated by BUSTR and facilities regulated by NPDES and RCRA. Analysis of LUST records and spills reports found that LUSTs are not releasing POCs. An evaluation of spills reports shows that minor spills have occurred at industrial properties that entered storm sewers and Shantee Creek. A fish kill occurred in 2012 but the source was never determined. Potential exists for future spills in this critical area due to the number of USTs and RCRA facilities and because historic and recent spills have occurred.

Due to a lack of environmental monitoring data, it is recommended that sediment samples be collected from Shantee Creek upstream and downstream of the Stickney Avenue bridge, to assess the impacts of spills to storm sewers that run along Stickney Avenue (Figure 25; Figure E-5 of Appendix E). At existing site P11S60, aquatic community health and habitat should be assessed (Table E-1 of Appendix E). Historically, Ohio EPA collected fish to assess the human health designated use through fish tissue analyses. This site should again be assessed. Sample types and estimated costs are in Table 23 and site location information is in Table E-1 of Appendix E.

Flow and field parameters should be measured near the mouth of Shantee Creek on Silver Creek in the Shantee Creek (lower) subwatershed, which is the next downstream subwatershed. This sample will allow for the assessment of urban residential stormwater from the Raintree residential development. Shantee Creek (lower) should be sampled when Shantee Creek (Stickney Avenue) is sampled to also allow for the evaluation of downstream impacts from the Stickney Avenue critical area. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample these two subwatersheds are $5,650.

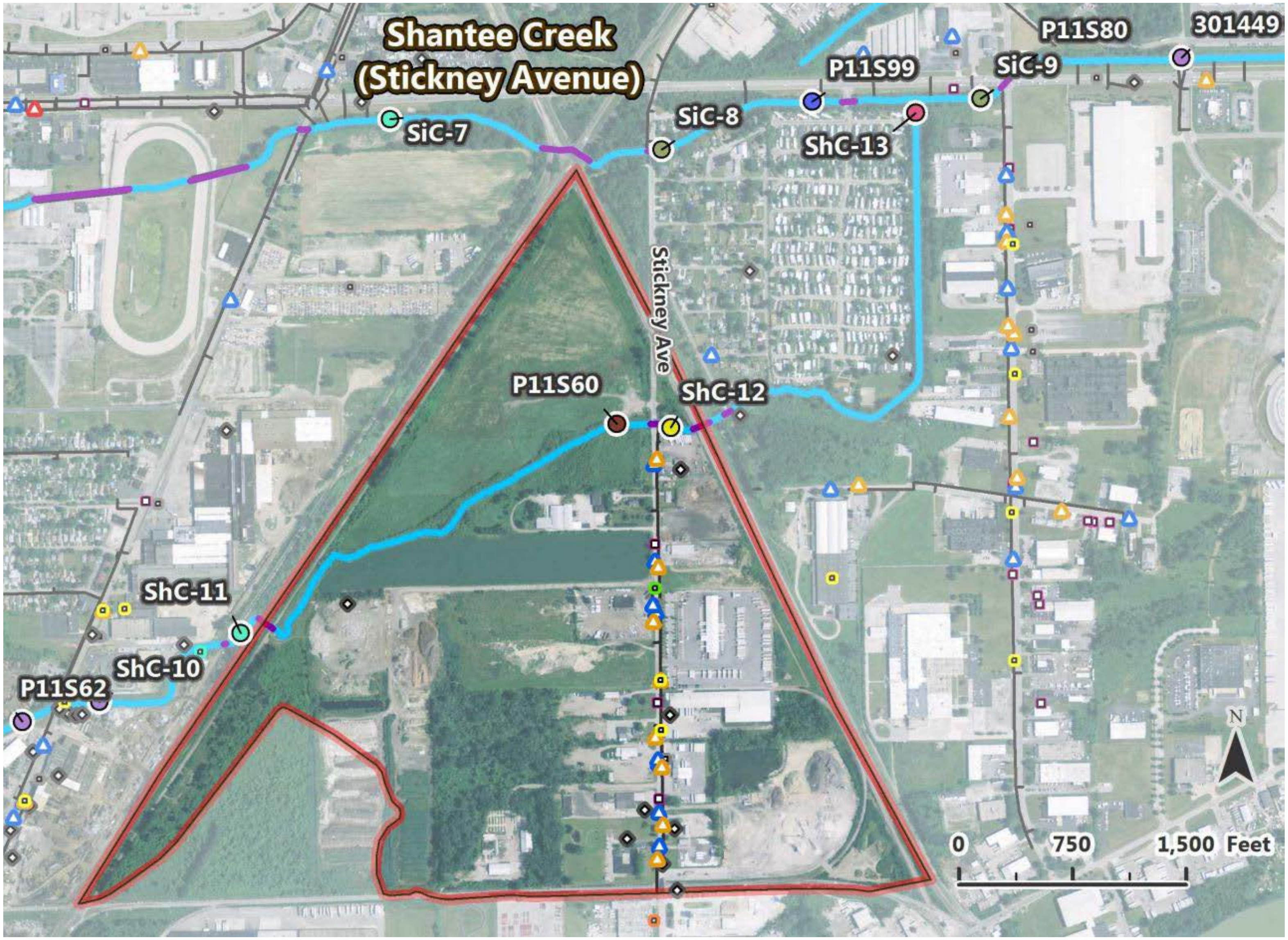
Table 23. Sample recommendations for Shantee Creek (Stickney Avenue and lower)

Samples	Shantee Creek (Stickney Avenue)		ShC (lower)
Site ID	P11S60	ShC-12	ShC-13
Biology			
IBI & MIwb	X	--	--
ICI	X	--	--
QHEI	X	--	--
Fish tissue	X	--	--
Water			
Field Par.	X	X	X
Flow	--	X	X
Met. & Org.	--	X	
Sediment			
Met. & Org.	X	X	--
PCBs	--	X	--
Costs			
Labor [a]	$1,675	$225	$125
Laboratory [b]	$2,400	$1,225	--
Total	**$4,075**	**$1,450**	**$125**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index; ShC = Shantee Creek.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.

During the HSSCA, a habitat restoration opportunity was identified during GIS analyses. While a comprehensive analysis was not performed, the cursory results are presented herein for consideration as future activities. Any restoration activities would need to consider the city of Toledo and Lucas County's stormwater management objectives with Shantee Creek and activities that may affect restoration (e.g., use of heavy equipment to remove large woody debris to maintain an open stormwater channel).

Shantee Creek between the railroad right-of-ways flow through open land, until it flows under Stickney Avenue (Figure 25). From the western edge of this critical area, Shantee Creek flows northeast along the railroad right-of-way and then along a row crop field, and finally, through vacant land. This segment through vacant land is not constrained by roads, parking lots, buildings, and residential development, and it has sufficient area for restoration activities, including the restoration of a meandering stream channel.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 24.

Figure 25. Recommended sampling locations along Shantee Creek in and downstream of the Stickney Avenue critical area.

5.5 Silver Creek (General Motors)

USTs, LUSTs, regulated facilities (NPDES, RCRA, and TRI) and spills are along West Alexis Road between Jackman Road and Raddatz Drive (Figure 26). This area is along the middle of Silver Creek. The north side of West Alexis Road adjacent to Lewis Avenue drains to a tributary of Halfway Creek via storm sewers. The Silver Creek (General Motors) subwatershed is 409 acres, is 77 percent developed land (excluding open developed land), and is 56 percent impervious cover (Appendix D).The land use is predominantly commercial along the West Alexis Road. Residential developments directly abut the north side of West Alexis Road and are also behind the commercial properties.

5.5.1 Water Quality

Silver Creek at Jackman Road (P11P30) and Silver Creek at Lewis Avenue (P11S79) are Ohio EPA sample sites. Site P11P30 is near the upstream boundary of this critical area and site P11S79 is near the downstream boundary of this critical area. Ohio EPA collected water column samples at site P11P30 once in 1977 and twice in 1994. The 1997 sample was evaluated for metals and lead and zinc were detected. The two 1994 samples were evaluated for metals, organics, and pesticides (one sample). Aluminum, arsenic (one sample), copper, iron, lead, and zinc (one sample) were detected. One PAH was detected (chloroform at 0.7 µg/L) and no pesticides were detected.

Ohio EPA collected water column samples at site P11S79 twice in 1992 and 1994 and five times in 2011 and analyzed for metals. Aluminum, arsenic, copper, iron, lead, nickel and zinc were regularly detected while cadmium was detected once in 1992. A single sample collected in 1992 was evaluated for 99 PAHs; none were detected.

Fish and macroinvertebrate samples were collected in 1993 at site P11P30 and in 2011 at site P11S79. IBI scores of 12 and 16 were calculated, which represents poor fish community health, and Ohio EPA found qualitative macroinvertebrate community health to be poor.

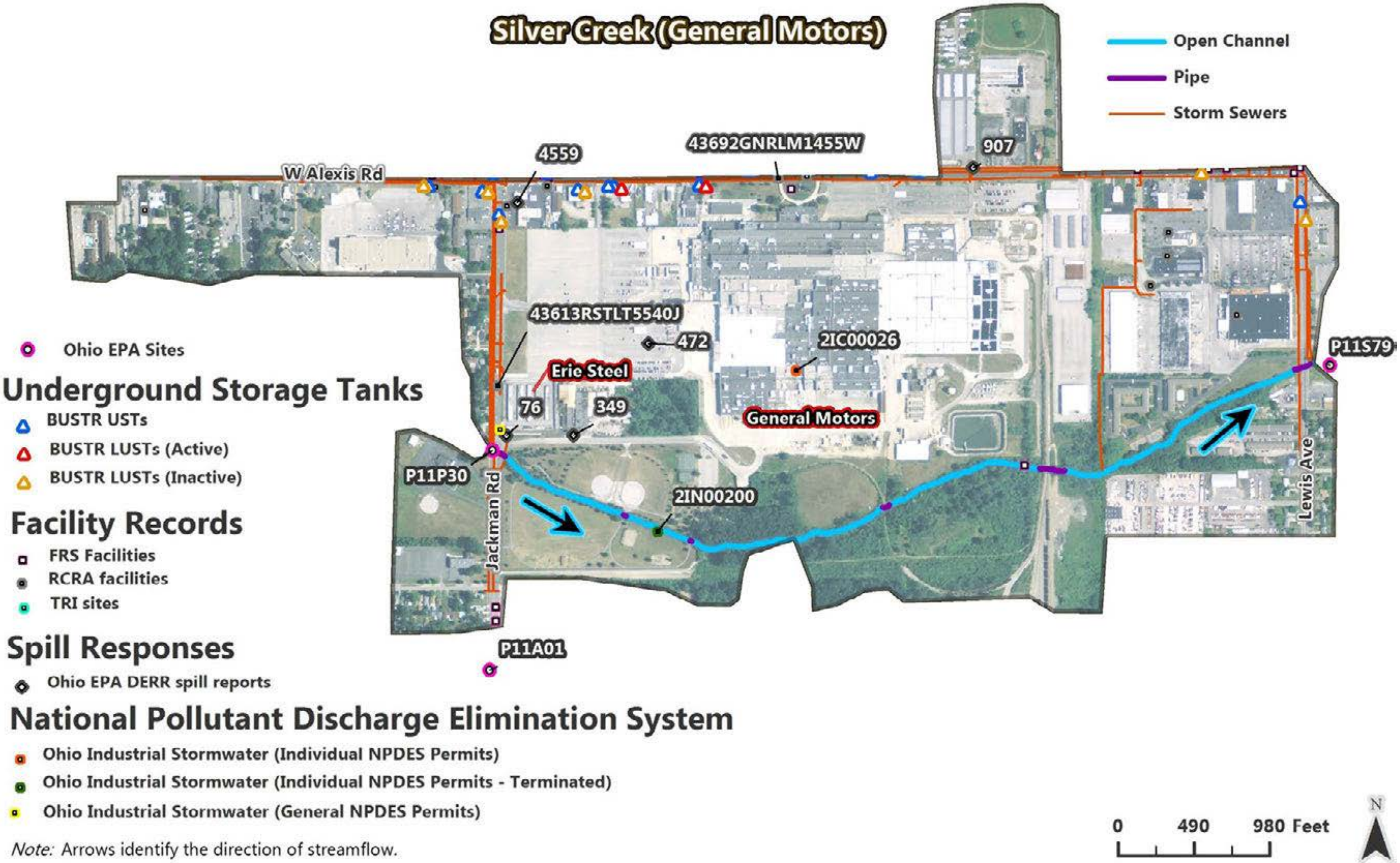


Figure 26. Silver Creek (General Motors): West Alexis Road from Jackman Road to Raddatz Drive.

5.5.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA and TRI. No facilities regulated through Superfund are in this critical area. Properties along the north side of West Alexis Road drained northerly to Halfway Creek and such properties were also regulated by some of the aforementioned authorities. Thirteen UST records for eight locations and 14 LUSTs records at eight locations are in this critical area (Figure 26). Fourteen facilities regulated by RCRA are in this critical area. Many of the RCRA facilities along West Alexis Road were associated with UST records USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

The General Motors facility and RACER Trust on West Alexis Road have individual NPDES permits for industrial stormwater (2IC00026 and 2IN00200). General Motors is required to sample their stormwater that discharges to Silver Creek or Toledo's storm sewers. While oil and grease have occasionally been detected in General Motor's stormwater samples from three of eight outfalls, the following toxic substances have not been detected: benzene, cyanide, chromium (hexavalent), ethylbenzene, toluene, and xylene. Similarly, RACER Trust is required to sample its stormwater that discharges to Ketcham Ditch and Silver Creek and oil and grease were detected in a few samples from a few outfalls. Neither facility appears to be a source of POCs to Ketcham Ditch or Silver Creek, but both facilities have the potential for future releases of POCs to surface waters.

Ohio EPA has issued general NPDES permit coverage for stormwater associated with industrial activity to one property that abuts Silver Creek. The facility, Erie Steel Ltd., is on Jackman Road near Ohio EPA sample site P11P30; a spill to storm sewers occurred at this facility (2010-0349). As with any facilities permitted to discharge stormwater offsite, this facility is a potential source of future spills.

Two facilities are on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A):

- General Motors LLC – Toledo Plant (43692GNRLM1455W) for 16 materials between 1987 and 2012, including organic compounds, PAHs, and metals.
- Erie Steel Ltd (43613RSTLT5540J) for ammonia between 1989 and 2012.

5.5.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR and Ohio EPA DERR. Thirteen of the LUSTs records are inactive and one record is active. Five inactive records are for the closure of a regulated UST and eight inactive records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for all 13 of the inactive LUST records. The single active record has the following statuses: suspected contamination from a UST and site check & tank tightness test. LUSTs should not be a current source of POCs in this critical area but could become a source in the future. With no proven releases, excepting the active record, LUSTs should not be a source of POCs in this critical area.

Five spills reports in Ohio EPA DERR's spills database are for locations in this critical area (Figure 26). The five spills occurred between 1995 and 2010 (Table 24). U.S. EPA Region 5 does not have any spill reports for spills or release in this critical area.

Table 24. Spills in the critical area: Silver Creek (General Motors)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spills [a]
DERR	1995-0472	2/8/1995	ferric sulfate	20,000 [b]	*none reported*	♦
DERR	1996-4559	10/29/1996	diesel fuel	*25*	storm sewers	♦♦
DERR	2004-0907	3/7/2004	oil	200	Silver Creek [c]	♦♦
DERR	2005-0076	1/3/2005	waste oil sheen	--	Silver Creek	♦♦
DERR	2010-0349	2/19/2010	quench oil	500	Silver Creek [c]	♦♦♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.

b. The weight is 20,000 pounds.

c. Discharged to Silver Creek via storm sewers.

Two spills occurred at General Motor's Powertrain facility (1995-0472 and 2004-0907); however, additional information is not available for spill 1995-0472. In 2004, General Motors reported that about 200 gallons of used oil were spilled (2004-0907) and the spill migrated through storm sewers to Silver Creek. General Motors' contractor cleaned up the property, storm sewers, and stream; approximately 150 gallons was recovered from the property, 50 gallons from storm sewers, and 5 gallons from Silver Creek.

The spills in 1996 and 2004 to Silver Creek were small. A saddle tank on a truck was punctured (1996-4559) and most of the diesel fuel was contained upon the road surface. Some diesel fuel entered the sewer system. Contractors were hired to clean up the road surface and storm sewers. A waste oil sheen was observed in Silver Creek during a high flow period (2005-0076) and may have come from multiple sources. The spill eventually dissipated.

Spill 2010-0349 occurred at Erie Steel, which has a no exposure stormwater NPDES permit and is on TRI. About 100 gallons of oil were released that migrated through storm sewers and into Silver Creek. Contractors pumped the oil-water separator and storm sewers and cleaned up the creek over a two week time period during the winter.

5.5.4 Summary and Recommendations

The Silver Creek (General Motors) subwatershed contains facilities regulated by BUSTR, NPDES, RCRA, and TRI. An evaluation of spills reports shows that minor spills have occurred at industrial properties along West Alexis Road and Jackman Road that entered storm sewers and Silver Creek. Both the General Motors and Erie Steel properties are regulated by multiple authorities and have had spills in the past. Potential exists for future spills in this critical area due to the number of regulated facilities and because historic and recent spills have occurred.

Sampling is also recommended for this critical area. Historic and recent water column chemistry and biological sampling has occurred but stream bottom sediments have not been sampled from Silver Creek in this critical area. Existing sites P11P30 and P11S79 should again be sampled to assess aquatic community health; water column and sediment samples should also be collected at these locations to assess the sources of POCs. A baseline sediment sample is recommended at the Silver Creek Road bridge since the watershed upstream of P11P30 is residential (Figure 27; Figure E-6 of Appendix E). Field measurements along Silver Creek below storm sewer outlets are a lower priority recommendation; monitoring these sites may allow for the assessment of commercial stormwater along West Alexis Road.

Sample types and estimated costs are in Table 25 and site location information is in Table E-1 of Appendix E. To fully assess Silver Creek upstream of Shantee Creek, the following subwatersheds should be sampled during the same timeframe: Silver Creek (General Motors), Ketcham Ditch (lower), Jamieson Ditch (middle), Jamieson Ditch (lower), Silver Creek (North Towne Square), and Silver Creek (Railroad Crossing). The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample these six subwatersheds are $18,325, while the costs for just the Silver Creek subwatersheds are $13,300.

Table 25. Sample Recommendations for Silver Creek (General Motors)

Samples	**Silver Creek (General Motors)**				
Site ID	SiC-1	P11P30	SiC-2	SiC-3	P11S79
Biology					
IBI & MIwb	--	X	--	--	X
ICI	--	X	--	--	X
QHEI	--	X	--	--	X
Water					
Field Par.	X	X	X	X	X
Flow	--	X	--	--	X
Met. & Org.	--	X	--	--	X
Sediment					
Met. & Org.	X	X	--	--	X
PCBs	--	--	--	--	X
Costs					
Labor [a]	$75	$1,625	$25	$25	$1,625
Laboratory [b]	$400	$1,525	--	--	$1,725
Total	**$475**	**$3,150**	**$25**	**$25**	**$3,350**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; Met. & Org. = metals and organic constituents; PCBs = polychlorinated biphenyls; SiC = Silver Creek.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.

During the HSSCA, a habitat restoration opportunity was identified during GIS analyses. While a comprehensive analysis was not performed, the cursory results are presented herein for consideration as future activities. Any restoration activities would need to consider the city of Toledo and Lucas County's stormwater management objectives with Silver Creek and activities that may affect restoration (e.g., use of heavy equipment to remove large woody debris to maintain an open stormwater channel).

Silver Creek flows through undeveloped land south of Erie Steel and General Motors (Figure 26). The segment is channelized as it flows beside baseball diamonds and has a forest riparian corridor from east of the baseball diamonds to the railroad right-of-way. This segment is not constrained by development (except for the baseball diamonds), and it has sufficient area for restoration activities, including the restoration of a meandering stream channel. The mouth of Ketcham Ditch is also on this segment and lower Ketcham Ditch could be simultaneously restored.

Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 26 and is also shown on Figure E-1 in Appendix E.

Figure 27. Recommended sampling locations along Silver Creek upstream of and in the General Motors critical area.

5.6 Ketcham Ditch (Lower):

Facilities regulated by NPDES, RCRA, and TRI are along Jackman Road, Coining Drive, and Prosperity Road in the Ketcham Ditch (lower) subwatershed (Figure 28; Appendix D). This area is along the lower segments of Ketcham Ditch just upstream of the confluence with Silver Creek. The Ketcham Ditch (lower) subwatershed is 60 acres, is 74 percent developed land (excluding open developed land), and is 53 percent impervious cover (Appendix D). The land use is predominantly commercial and industrial along the each roadway. A large forested area is to the east of the subwatershed and residential developments are to the east.

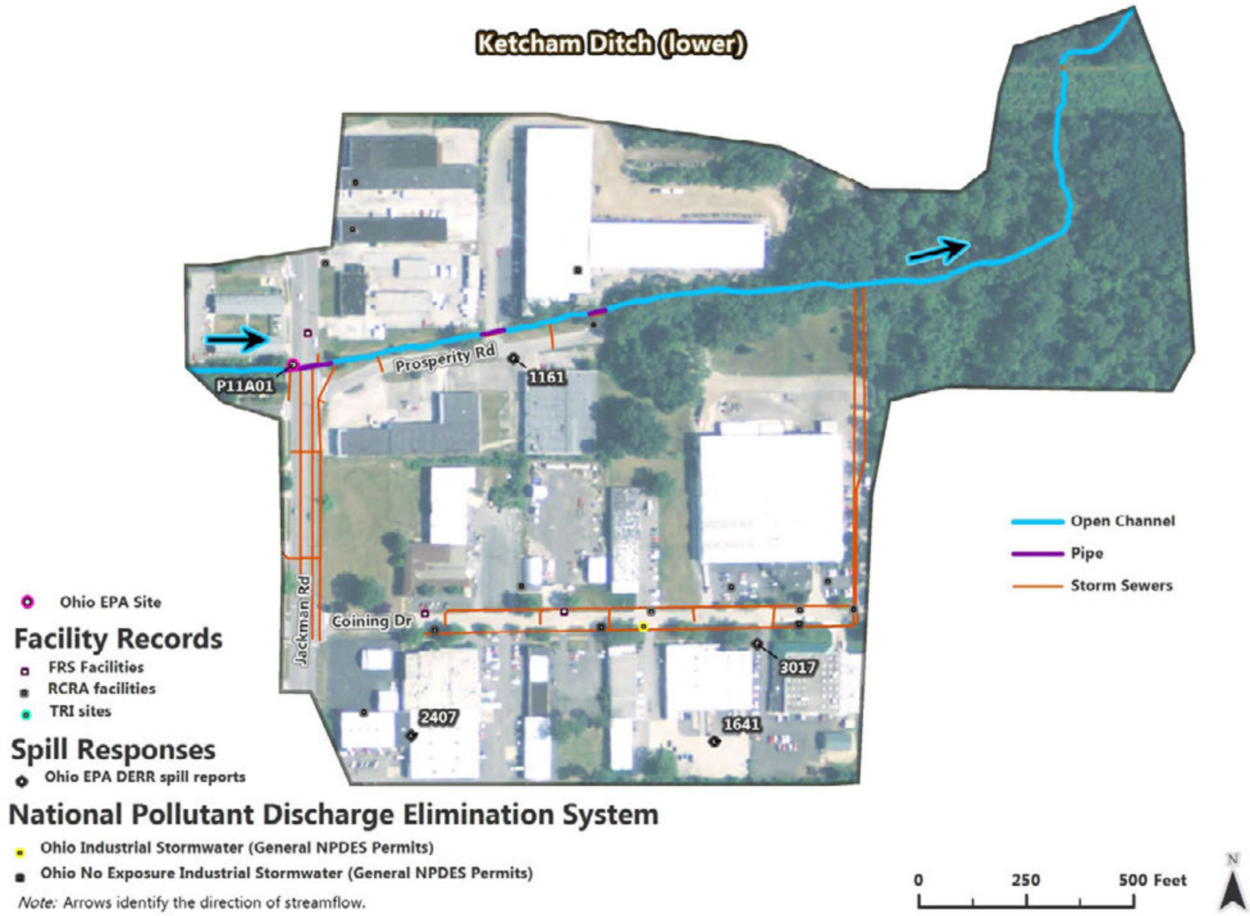


Figure 28. Ketcham Ditch (lower): Jackman Road, Coining Drive, and Prosperity Road.

5.6.1 Water Quality

Ketcham Ditch at Jackman Road (P11A01) is an Ohio EPA sample site. QHEI was assessed at this site in 1993 with a score of 21, which is very poor for a headwaters size stream. No fish, macroinvertebrate, water column, or sediment samples were collected at this site.

5.6.2 Facilities

Facilities in this critical area are regulated by NPDES, RCRA, and TRI. No facilities regulated through the following programs are in this critical area: BUSTR and Superfund. No UST or LUST records are located in this critical area (Figure 28). Twelve facilities regulated by RCRA are in this critical area. Facilities regulated by RCRA are potential sites for future spills and releases.

Ohio EPA has issued general NPDES permit coverage for four properties along Corning Road. Three properties are designated no exposure and should not discharge stormwater offsite. One property is covered by the general NPDES permit for stormwater associated with industrial activities: Hammill Manufacturing Co. (1517 Coining Drive; 2GR00308). This facility had a spill in 1997 that is discussed in the next section. As with any facilities permitted to discharge stormwater offsite, this facility is a potential source of future spills.

One facility is on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A): Maclean Flowform LLC (43612FLWFR163CI) for zinc compounds between 2001 and 2008. As no known spills or releases occurred at this facility and no toxic materials are currently permitted to be on-site, this facility was not and is not a source of POCs in this critical area.

5.6.3 Spills and Releases

The only spills and releases records associated with sites within this critical area are from Ohio EPA DERR. Four spill reports in Ohio EPA DERR's spills database are for locations in this critical area (Figure 28). The four spills occurred between 1997 and 2012 (Table 26).

Table 26. Spills in the critical area: Ketcham Ditch (lower)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spills [a]
DERR	1997-1641	4/29/1997	*oil sheen* white material	-- --	Ketcham Ditch [b]	♦♦
DERR	1997-3017	7/24/1997	oil runoff from scrap bins	*unknown*	Ketcham Ditch	♦♦
DERR	2012-1161	5/10/2012	red printing ink	5	Ketcham Ditch [b]	♦♦
DERR	2012-2407	10/2/2012	diesel fuel	60	storm sewers	♦♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.

b. Discharged to Ketcham Ditch via storm sewers.

c. The name of the surface waterbody was not reported.

Oil sheens in Ketcham Ditch on the General Motor's property were twice observed; in both cases, the sources were upstream of the General Motor's facility. A spill of unknown substances that left a white residue and oil sheen in storm sewer catch basins occurred at Hamill Manufacturing's parking lot (1997-1641. Waste top oil from scrap bins and uncovered, overflowing drums leaked oil to storm sewers and then to Ketcham Ditch (1997-3017). Contractors were hired to clean up the stream and storm sewers. A total of 8,900 gallons of water (contaminated stream water from Ketcham Ditch and water used to flush the storm sewer lines) were collected and discharged to Toledo's sanitary sewers for treatment (Toledo 2014b).

Waste red printing ink was dumped into a storm sewer catch basin by an employee of Ciralsky & Associates that eventually discharged to Ketcham Ditch and red discoloration was observed in Ketcham Ditch and Silver Creek (2012-2407). Contractors were hired to clean up the stream and storm sewers.

A diesel fuel spill occurred in 2012 at the Cenevo Inc. property from a tanker truck. The spill was contained within the truck loading bay and storm sewers; upstream and downstream storm sewer lines were not affected. Contractors were hired to clean up the truck loading bay and storm sewers.

5.6.4 Summary and Recommendations

The Ketcham Ditch (lower) subwatershed contains facilities regulated by NPDES, RCRA, and TRI. An evaluation of spills reports shows that minor spills have occurred at industrial properties along Jackman Road, Coining Drive, and Prosperity Road that entered storm sewers and Ketcham Ditch. Potential exists for future spills in this critical area due to the number of regulated facilities and because historic and recent spills have occurred.

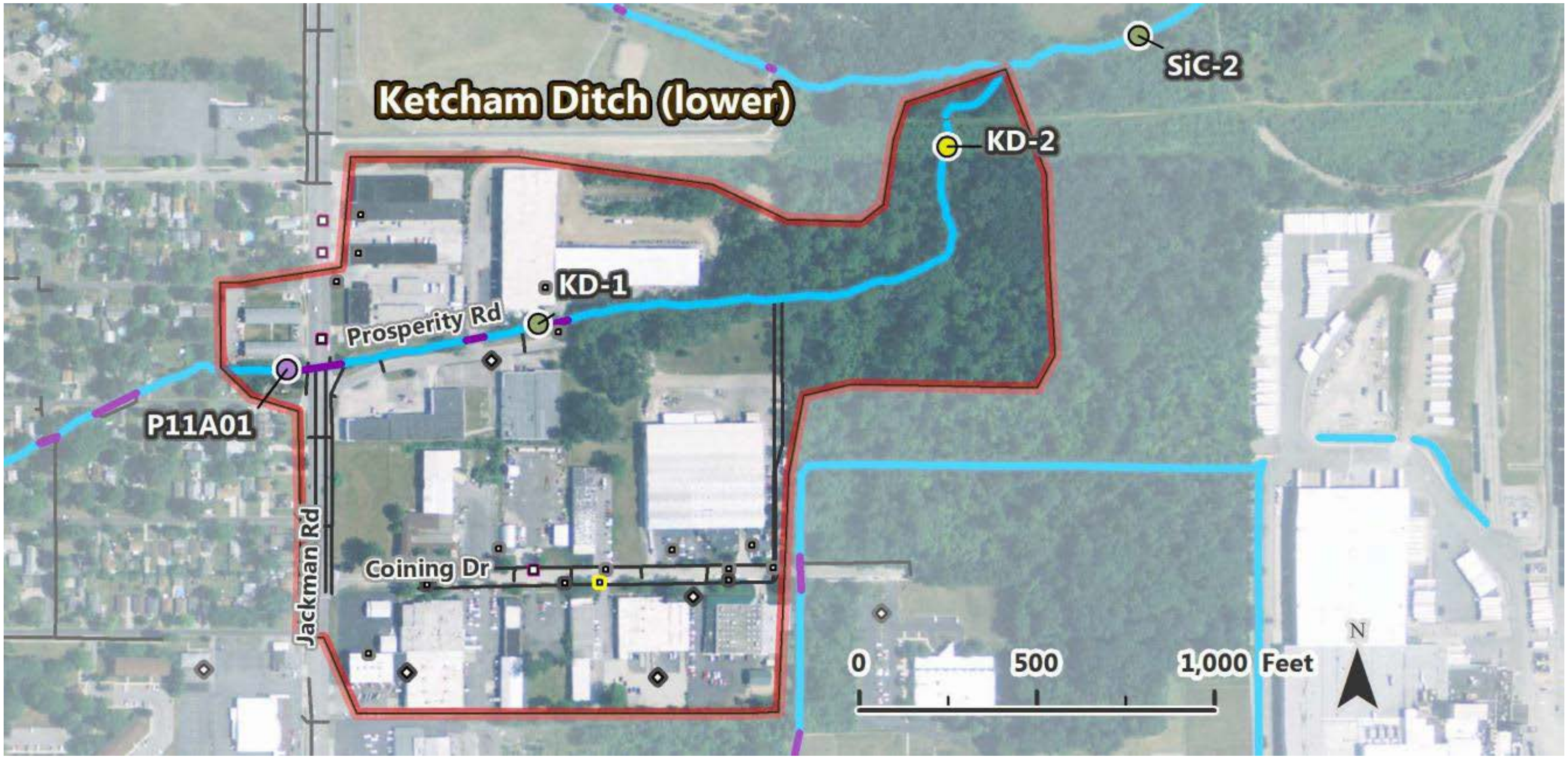
Due to a lack of environmental data from Ketcham Ditch, it is recommended that water column and sediment samples be collected to evaluate potential contamination. Water column and sediment samples should be collected and flow monitored near the mouth of Ketcham Ditch on Silver Creek (Figure 29; Figure E-7 of Appendix E). As Ketcham Ditch is primary headwaters habitat, it is too small to evaluate aquatic community health. Additional high priority sediment sampling should be performed at existing site P11A01 since Ketcham Ditch upstream of the Ketcham Ditch (lower) critical area subwatershed is predominantly residential; this sample will serve as a baseline for the analysis of industrial facilities in Ketcham Ditch (lower). Field parameters could also be collected along Ketcham Ditch within the industrial development (Table E-1 of Appendix E).

Sample types and estimated costs are in Table 27 and site location information is in Table E-1 of Appendix E.As discussed in Section 5.5.4, it is recommended that six subwatersheds be sampled together for total labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment), of $18,325.

Table 27. Sample recommendations for Ketcham Ditch (lower)

Samples	Ketcham Ditch (lower)		
Site ID	P11A01	KD-1	KD-2
Water			
Field Par.	X	X	X
Flow	--	--	X
Met. & Org.	--	--	X
Sediment			
Met. & Org.	X	--	X
PCBs	--	--	X
Costs			
Labor [a]	$75	$25	$225
Laboratory [b]	$400	--	$1,225
Total	**$475**	**$25**	**$1,450**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; KD = Ketcham Ditch; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index;.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 28 and is also shown on Figure E-1 in Appendix E.

Figure 29. Recommended sampling locations in the Ketcham Ditch (lower) critical area.

There is limited potential for habitat restoration along much of Ketcham Ditch. The stream is channelized through much of the residential areas (Figure 30 and Figure 31), which tend not to have curbs and gutters. Due to the channelization, use of riprap for bank stabilization, and nearby structures, it's not feasible for channel or habitat restoration. However, there are isolated properties (e.g., a small vacant parcel) that could providerestoration opportunities along Ketcham Ditch. With the exception of the mouth of Ketcham Ditch, which is in a forested riparian corridor, resources should be devoted to other subwatersheds in the HSSCA project area with better restoration opportunities.

Figure 30. Ketcham Ditch at Adella Street (facing west, upstream).

Figure 31. Ketcham Ditch at Ketner Avenue (facing northeast, downstream).

5.7 Jamieson Ditch (Middle)

USTs, LUSTs, regulated facilities (NPDES, RCRA, and TRI) and spills are in the Jamieson Ditch (middle) subwatershed of the Silver Creek watershed (Figure 19; Appendix D). The Jamieson Ditch subwatershed flows easterly between Silver and Shantee creeks, and is a tributary to Silver Creek. The Jamieson Ditch (middle) subwatershed is 221 acres, is 76 percent developed land (excluding open developed land), and is 56 percent impervious cover (Appendix D).The land use is predominantly commercial and industrial.

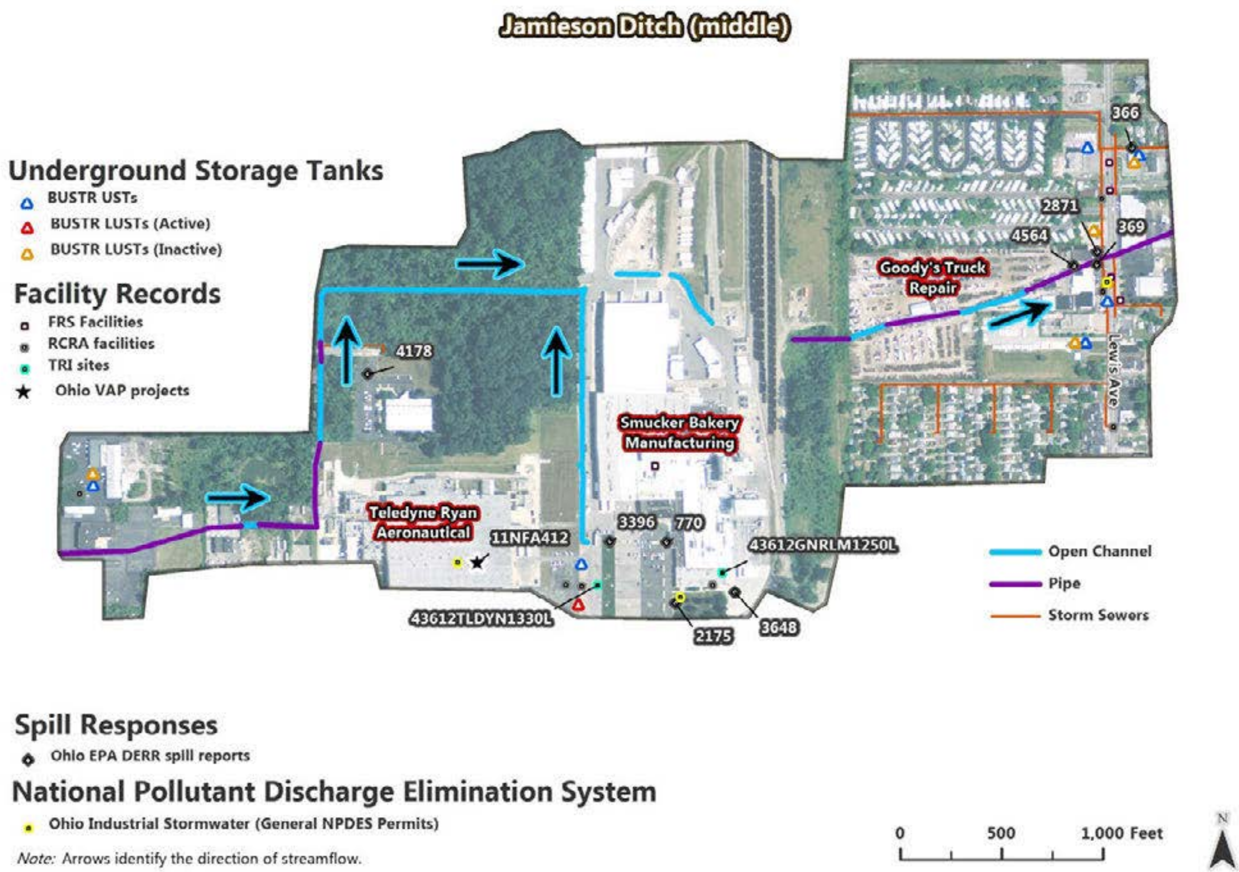


Figure 32. Jamieson Ditch (middle).

5.7.1 Water Quality

No environmental monitoring has occurred within this critical area.

5.7.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, TRI, and VAP. Twelve UST records for six locations and 12 LUSTs records at six locations are in this critical area (Figure 19). Seven facilities regulated by RCRA are in this critical area. RCRA records are associated with many of the properties regulated under additional authorities (i.e., NPDES, TRI, and VAP). USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Ohio EPA has issued general NPDES permit coverage for two properties along West Laskey Road. Smucker Bakery Manufacturing (1250 West Laskey Road; 2GR00562) and Teledyne Turbine Engines (1330 West Laskey Road; 2GR00577) both have general NPDES permit coverage stormwater associated with industrial activities. Spills have occurred at each of these sites. As with any facilities permitted to discharge stormwater offsite, this facility is a potential source of future spills.

Naval Weapons Industrial Reserve Plant (11NFA412) is the only VAP project in the HSSCA project area and is along West Laskey Road in this critical area. After numerous environmental site investigations and remediation, the site was issued a covenant not to sue on May 2, 2011. Remediation activities include the removal of contaminated soils. Additionally, the property is limited to commercial/industrial use and potable use of groundwater is prohibited. Since the site was cleaned-up and remediated, it should not be a future source of POCs.

Two facilities are on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A):

- Smucker Bakery Manufacturing Inc. (43612GNRLM1250L) for nine materials between 2000 and 2007, including organic compounds, PAHs, and metals.
- Teledyne Ryan Aeronautical (43612TLDYN1330L) for seven materials between 1987 and 1997, including organic compounds, PAHs, and PCBs.

Spills and releases occurred historically and recently at these TRI sites. Smucker Bakery Manufacturing Inc. subleases warehouse space from Teledyne Ryan Aeronautical, which is the VAP project previously discussed. The potential exists for future spills; however, neither of the facilities currently possess materials regulated under the TRI.

One salvage facility was identified in this critical area from a study of scrapyards and salvage facilities (Tetra Tech 2013): Goody's Truck Parts (5245 Lewis Avenue). The salvage facility declined to participate in the study (i.e., it was not inspected and BMPs were not recommended). As discussed in Section 5.7.3, spills have occurred at this salvage facility.

5.7.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and VAP. Nine LUSTs records are inactive and three records are active. Six of the inactive records are for the closure of a regulated UST and three records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for all nine inactive LUST records. The three active records are for the closure of a regulated UST; all three records statuses are no further action data cleaning. With no proven releases, LUSTs should not be a source of POCs in this critical area.

Nine spills reports in Ohio EPA DERR's spills database[12] are for locations in this critical area (Figure 19). The nine spills occurred between 2000 and 2013 (Table 18).

[12] Spill report 2013-0850 plots in GIS within this critical area. However, the spilled material is identified as pollen; this spill report will not be further discussed.

Table 28. Spills in the critical area: Jamieson Ditch (middle)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	2000-2871	7/29/2000	used motor oil	1,000	*none affected*	♦
DERR	2004-3396	8/9/2004	sewage	*unknown*	*surface waters* [b]	♦
DERR	2007-2175	6/6/2007	vegetable oil	500	storm sewer catch basin	♦♦
DERR	2007-4178	11/13/2007	white material	*unknown*	*surface waters* [b]	
DERR	2007-4564	12/12/2007	*petroleum sheen*	--	Jamieson Ditch	♦♦♦
DERR	2008-3648	9/5/2008	soybean oil	2,000 [c]	storm sewers	♦♦
DERR	2011-0369	2/19/2011	waste oil	200	Silver Creek	♦♦♦♦
DERR	2012-0366	2/13/2012	gasoline	1	Jamieson Ditch [d]	♦♦
DERR	2013-0770	4/11/2013	*petroleum sheen*	--	tributary to Jamieson Ditch	♦♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization. R5 = U.S. EPA Region 5.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. The name of the surface waterbody was not reported.
c. The weight is 2,000 pounds.
d. Discharged to Jamieson Ditch via storm sewers.

Multiple spills have occurred at the Smucker's and adjacent Teledyne property. In 2007, 2,000 to 4,000 gallons of vegetable oil and icing material were spilled but contained on-site when the valve to the storm sewers was closed (2007-2175). In 2008, about 2,000 gallons of soybean oil spilled during a tanker overflow that Smucker's had cleaned up (2008-3648); some soybean oil had entered the storm sewers but was not observed in Jamieson Ditch or Shantee Creek[13]. In April 2013, an oil sheen following a heavy rain was observed at the Teledyne property but dissipated on its own (2013-0770); Teledyne staff indicated that the discharge was likely 1.0 to 1.5 gallons of decayed organic sludge or emulsified oil that was released when the plug of the storm sewer was broken (Toledo 2014b).

Multiple spills have occurred at the Circle K gas station and Goody's Truck Repair (also known as LKQ Heavy Truck) on Lewis Avenue, north of West Laskey Road. About 1,000 gallons of used motor oil were spilled at Goody's Truck Repair (2000-2871) but the used motor oil did not migrate off-site. Waste oil leaked from the Goodie/LKQ property for weeks in February through April 2011; it was investigated by Ohio EPA DERR, Toledo DES, and the U.S. Coast Guard (2011-0369). Excessive buildup may have affected Goody's oil separator in 2008 when a sheen was detected in a ditch along Goodwood Avenue (spill 0135/08 in Toledo 2014b). In 2007, oil sheens in stormwater and Jamieson Creek were observed that appeared to come from both Goody's and Circle K (2007-4564). Waste oil was observed in area storm sewers and in Silver Creek. At the Circle K gas station spilled gasoline, from an overfill, migrated to storm sewers and Jamieson Ditch (2012-0366).

5.7.4 Summary and Recommendations

The Jamieson Ditch (middle) critical area in the Shantee Creek watershed contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, TRI, and VAP. Analysis of LUST records and spills reports found that LUSTs are not known to have released POCs. An evaluation of spills reports shows that major and minor spills have occurred that entered storm sewers and Silver Creek. Potential exists for future spills in this critical area due to the numbers of USTs and NPDES, RCRA, and TRI facilities and

[13] The Smucker's facility drains to both Jamieson Ditch (middle) and Shantee Creek (West Laskey Road). Sufficient data are not available to determine which parts of the property drain to which waterbody. The Toledo DES spill report (0524/08 in Toledo 2014b) identified Shantee Creek as the waterbody that this spill would drain to through ditches and storm sewers, if the spill had not been contained.

because historic and recent spills have occurred. Additionally, a few properties are regulated under multiple programs and spills have occurred at these properties.

Environmental monitoring data were not collected from Jamieson Ditch; therefore, it is recommended that extensive sampling be performed. Sample types and estimated costs are in Table 29 and site location information is in Table E-1 of Appendix E. Due to limited access, it may not be possible to sample much of Jamieson Ditch (middle). High priority sampling is recommended near Lewis Avenue, downstream of much of the industrial development in the critical area. Sediment and water column sample collection is also recommended near the mouth of Jamieson Ditch (Figure 33; Figure E-8 of Appendix E). Jamieson Ditch is primary headwaters habitat and is too small to evaluate aquatic community health. As discussed in Section 5.5.4, it is recommended that six subwatersheds be sampled together for total labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment), of $18,325. The costs for Jamieson Ditch alone are $3,075 (Table 29).

Table 29. Sample recommendations for Jamieson Ditch (middle and lower)

Samples	Jamieson Ditch (middle)			JD (lower)
Site ID	JD-1	JD-2	JD-3	JD-4
Water				
Field Par.	X	X	X	X
Flow	--	--	--	X
Met. & Org.	--	--	--	X
Sediment				
Met. & Org.	X	X	X	X
PCBs			X	X
Costs				
Labor [a]	$75	$75	$75	$225
Laboratory [b]	$400	$400	$600	$1,225
Total	**$475**	**$475**	**$675**	**$1,450**

Notes

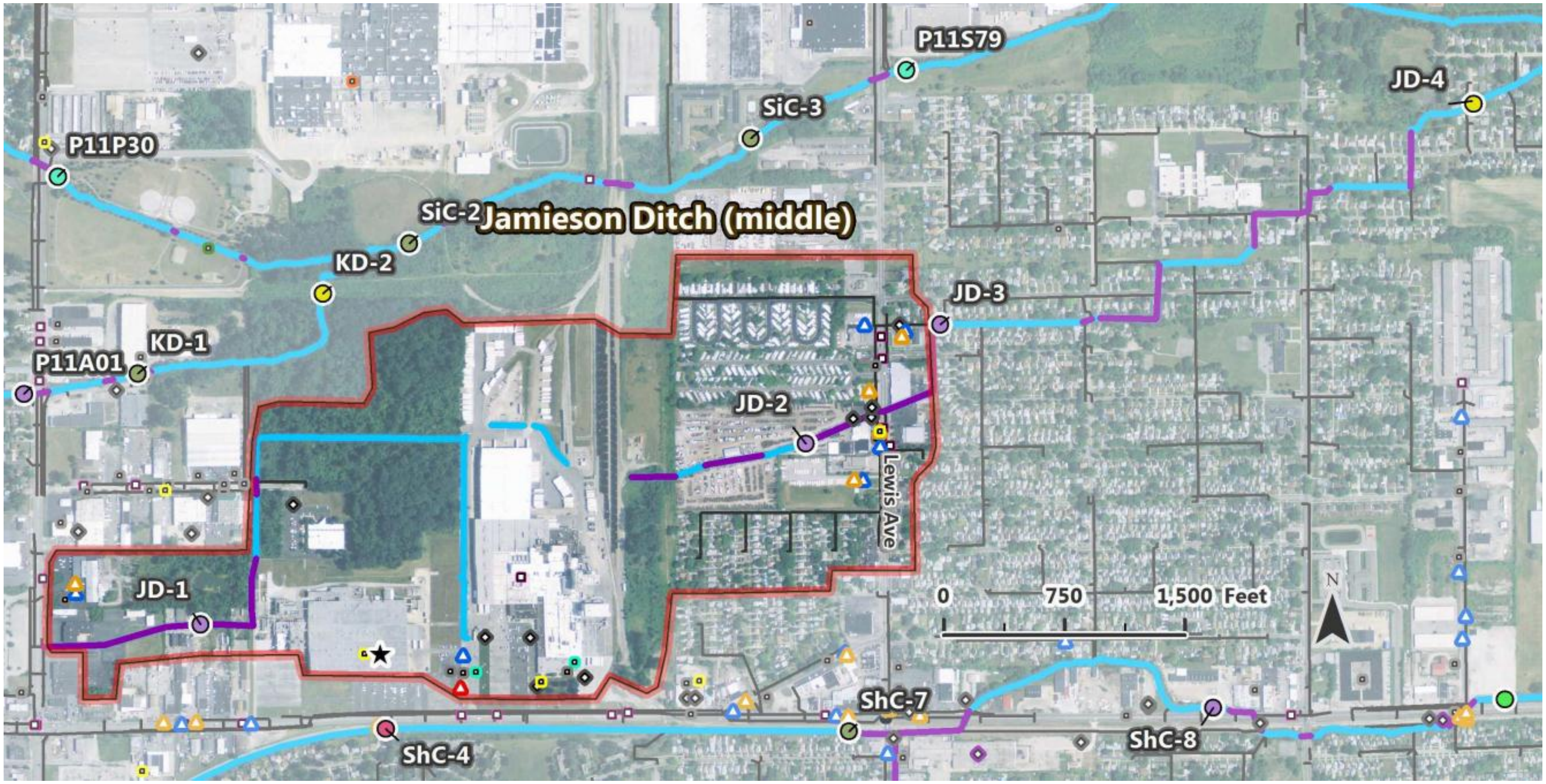
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.

Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; JD = Jamieson Ditch; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index.

a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.

There is limited potential for habitat restoration along Jamieson Ditch. A segment of the ditch is forested in this critical area; however, much of Jamieson Ditch is channelized or piped underground as it flows through commercial and industrial properties or through residential developments. Public access to much of the ditch is limited or not possible, which would prevent restoration activities.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 32 and is also shown on Figure E-1 in Appendix E.

Figure 33. Recommended sampling locations along Jamieson Ditch.

5.8 Silver Creek (North Towne Square)

USTs, LUSTs, regulated facilities (NPDES, RCRA, and Superfund), and spills are along West Alexis Road between Lewis Avenue and North Detroit Avenue Drive (Figure 34). This area is along the middle of Silver Creek with a northern boundary of the Halfway Creek watershed. The north side of West Alexis Road adjacent to Lewis Avenue drains to a tributary of Halfway Creek via storm sewers. The Silver Creek (North Towne Square) subwatershed is 453 acres, is 77 percent developed land (excluding open developed land), and is 52 percent impervious cover (Appendix D). The land use is predominantly commercial and industrial along West Alexis Road between Lewis Avenue and North Detroit Avenue. The critical area is surrounded by residential areas and commercial/industrial areas.

5.8.1 Water Quality

Silver Creek at Lewis Avenue (P11S79) is an Ohio EPA sample site at the upstream boundary of this critical area. Refer back to Section 5.5.1 for a description of the water quality at this site.

5.8.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, and Superfund. Properties along the north side of West Alexis Road drained northerly to Halfway Creek and such properties were also regulated by some of the aforementioned authorities. Nineteen UST records for 14 locations and 16 LUSTs records at 11 locations are in this critical area (Figure 34). Seventeen facilities regulated by RCRA are in this critical area and many of the RCRA facilities along West Alexis Road were associated with UST records. USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Grimes, Inc. (2PR00218) is the only facility covered by an individual NPDES permit. The facility is a small sanitary wastewater treatment facility. The facility is not required to monitor its effluent for metals, PAHs, or PCBs, nor is it permitted to discharge these constituents. This facility is not a source of POCs in this critical area.

Cherry Picked Auto Parts (5650 North Detroit Avenue; 2GR01816) has a general NPDES permit for stormwater associated with industrial activity[14]. The facility also has a UST record in BUSTR. Lott Industries (5500 Telegraph Road; 2GRN00374) has no exposure from industrial stormwater (i.e., stormwater does not discharge off-site). This facility is also regulated by RCRA and has UST and LUST records. A property that has no exposure coverage should not discharge stormwater offsite.

Impact Stamping, a former metal stamping facility, is a Superfund site (OHD987046265) within this critical area. The facility was abandoned by 1991 and multiple site assessments conducted by U.S. EPA, Ohio EPA, and U.S. EPA contractors identified hazardous and toxic materials (U.S. EPA 2014b). Approximately 120 55-gallon drums and about 60 smaller containers were in various states of deterioration inside and outside the building and some had leaked their contents into soils. Within the main building, wood-block floors were contaminated with PCBs, light ballasts contained PCBs, and numerous pits contained mixtures of water and oil. Outside the building, two USTs with pumps contained gasoline solvents and a removed UST was located on the surface near the USTs. U.S. EPA contractors conducted additional site assessments and removal activities. Such removal activities included treatment (e.g., 195,000 gallons of nonhazardous wastewater, 880 gallons of sodium hydroxide, 275 gallons of lead

[14] When the NPDES information is plotted in GIS, the facility plots south of its actual location and within the Shantee Creek (Telegraph Road) critical area near OmniSource. An evaluation of BUSTR and RCRA records and the use of GoogleEarth™ show that Cherry Picked Auto Parts is in the Silver Creek (North Towne Square) critical area.

and chrome waste), recycling (i.e., 150 gallons of gasoline), fuel blending (e.g., 440 gallons of 1,1,1-trichloroethane), and incineration (i.e., 55 gallons of PCB-contaminated oil). U.S. EPA and their contractor reports did not identify off-site migration of hazardous or toxic materials and found that the potential for off-site migration to surface wasters was low. As hazardous and toxic materials and contaminated soils were removed from the site, it no longer poses a risk as a future source of POCs.

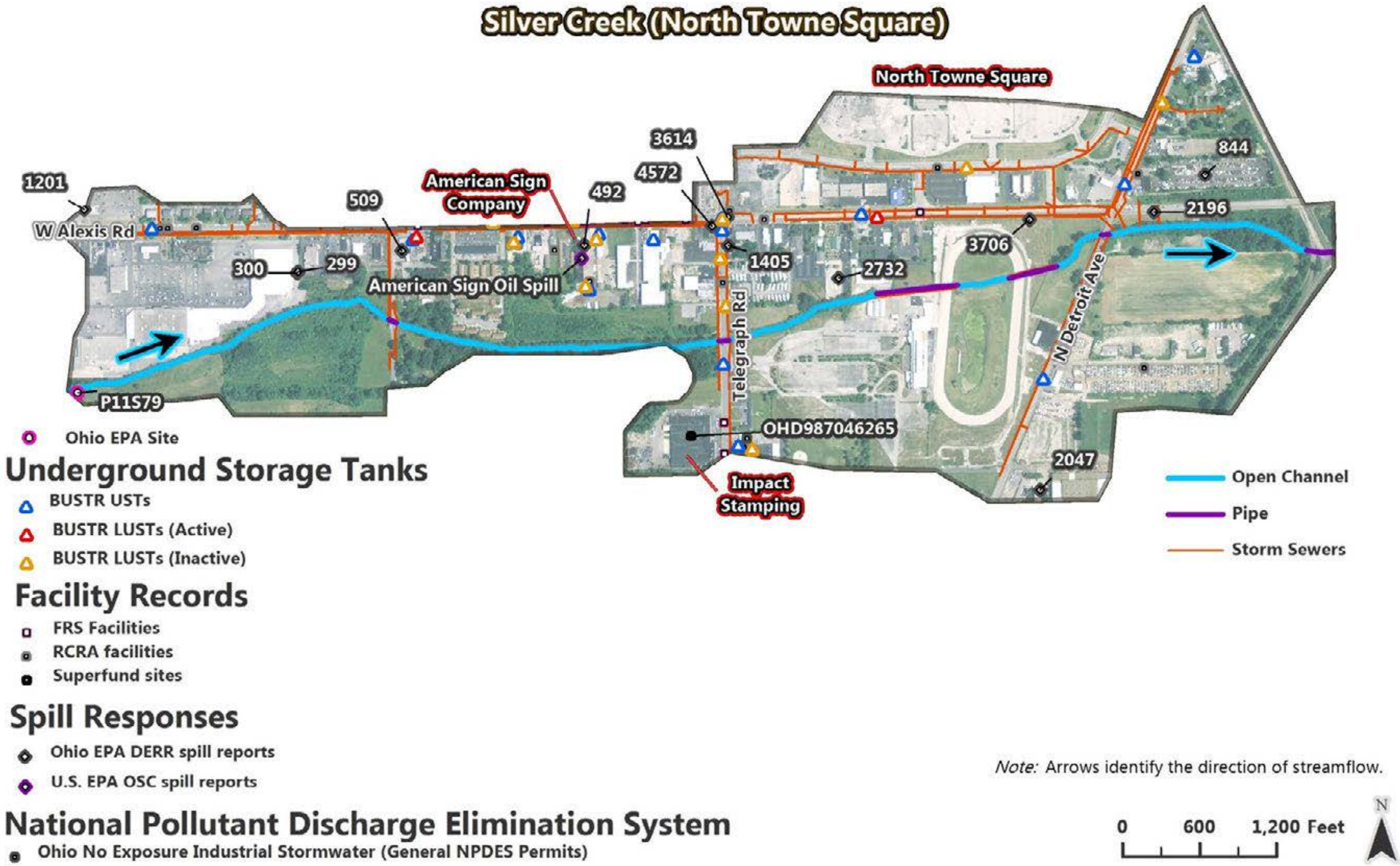


Figure 34. Silver Creek (North Towne Square): West Alexis Road from Bennett Road to North Detroit Avenue.

Three salvage facilities were identified in this critical area from a study of scrapyards and salvage facilities (Tetra Tech 2013):

- A&D Auto Parts (5846 North Detroit Avenue).
- Cherry Picked Auto Parts (5650 North Detroit Avenue).
- Voll Auto Parts (429 Terminal Road).

A&D Auto Parts was inspected and participated in the study. The salvage facility did not implement the recommended best management practices (BMPs; Tetra Tech 2013). Cherry Picked Auto Parts also participated in the study and did implement some BMPs. Voll Auto Parts ceased operations prior to the study; the facility was not inspected.

5.8.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and U.S. EPA Region 5. Fourteen of the LUSTs records are inactive and two records are active. Seven inactive records are for the closure of a regulated UST and seven inactive records are for a suspected contamination from a UST. BUSTR determined that no further action was necessary for 10 of the inactive records; four inactive LUST records had a disproval of release. The two active LUST records are designated as (1) closure of a regulated UST and no further action data cleaning and (2) suspected contamination from a UST and tier I source investigation. With the possible exception of the LUST undergoing a tier I source investigation, with no proven releases, LUSTs should not be a source of POCs in this critical area.

Eleven spills reports in Ohio EPA DERR's spills database and one spill report from U.S. EPA are for locations in this critical area (Figure 26)[15]. The eleven spills occurred between 1995 and 2013 (Table 30).

Table 30. Spills in the critical area: Silver Creek (North Towne Square)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spills [a]
DERR	1995-3614	8/22/1995	orphan drums	8 [b]	*none reported*	♦
DERR	1996-1201	3/28/1995	diesel fuel	38	*none reported*	♦
DERR	1996-4572	10/30/1996	waste oil sheen	*unknown*	Silver Creek	♦♦
DERR	1999-3706	10/15/1999	diesel fuel	30	*none reported*	♦
DERR	2000-2047	6/4/2000	wastewater	300,000	storm sewers	♦
DERR	2002-0844	3/12/2002	oil	*unknown*	*none reported*	♦
DERR	2006-0299	1/26/2006	transformer oil	*unknown*	Silver Creek [c]	♦♦
DERR	2010-0492	3/9/2010	waste oil	50	Silver Creek [c]	♦♦♦
R5	E10511					
DERR	2010-0509	3/10/2010	gasoline	100	Silver Creek [c]	♦♦♦
DERR	2011-1405	4/28/2011	transformer oil	40	Silver Creek [c]	♦♦
DERR	2013-2196	9/27/2013	diesel fuel	50	Silver Creek [c]	♦♦

Notes
DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization; R5 = U.S. EPA Region 5.
a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. Eight 55-gallons drums were reported.
c. Discharged to Silver Creek via storm sewers.

[15] While Ohio EPA DERR spill report 2006-0300 plots in GIS along West Alexis Road, the street address plots in Toledo between the Ottawa and Maumee rivers. This spill report is assumed to be outside of the HSSCA project area and is not further discussed.

U.S. EPA Region 5, Ohio EPA DERR, and Toledo DES responded to a report of oil discharging from storm sewers into Silver Creek (2010-0492 and E10511). Ohio EPA DERR and Toledo DES responded, and the spill was traced to the American Sign Company's building composed of multiple bays, with each bay managed by a different company. Waste oil, including transmission oil and motor oil, was spilled at multiple locations on the American Sign Company property and migrated to the storm sewers. While separate contractors were initially hired for clean-up, the contractors ceased operations due to financial issues with the site owners and bay managers. U.S. EPA then hired a contractor for site cleanup and began oversight of the spill response.

Gasoline was leaked at a Marathon service station, and gasoline migrated to sanitary and storm sewers and sheens were observed in Silver Creek (2010-0509). Gasoline was also found in groundwater samples collected from monitoring wells. BUSTR took over the investigation after Ohio EPA DERR and Toledo DES determine that the leak originated from USTs or the gasoline dispensers.

Two spills involved transformer oil. A transformer leaked oil onto a Target property after being struck by a truck (2006-0299). Transformer oil migrated into storm sewers, Target's drainage retention pond, and Silver Creek. Three pole-mounted transformers leaked oil onto roadways and migrated into storm sewers when the pole was broken (2011-1405). In both cases, contractors were hired to clean up the spills on the surface, storm sewers, and Silver Creek.

Diesel fuel leaked from a ruptured saddle tank on a FedEx truck and migrated across the roadway to Toledo's storm sewer system (2013-2196). Deployed containment booms prevented downstream migration of diesel fuel along Silver Creek. A contractor was hired to clean up the roadway, catch basins, storm sewers, and Silver Creek.

A small spill that lead to an oil sheen in Silver Creek was investigated at a Valvoline Instant Oil facility (1996-4572); the facility cleaned its oil water separator, the floor of the oil changing station, and storm sewers. Four spills did not impact waterways. They were intact orphan drums (1995-3614), a release of diesel fuel to land at a Sunoco service station (1996-1201), a spill of diesel fuel following a traffic accident where a bystander used tree lawn soil to create an earthen dike to contain the spilled diesel (1999-3706), and auto-crusher oil runoff across a property, following a fire, that did not migrate off-site and was cleaned up by a contractor (2002-0844). The release of sanitary wastewater to storm sewers did not involve metals, PAHs, or PCBs; thus, it is outside the scope of the HSSCA.

5.8.4 Summary and Recommendations

The Silver Creek (North Towne Square) subwatershed contains facilities regulated by BUSTR, NPDES, RCRA, and Superfund. An evaluation of spills reports shows that major and minor spills have occurred at industrial properties along West Alexis Road that entered storm sewers and Silver Creek. Many of the spills were associated with automobile service stations or leaks and spills from trucks. Potential exists for future spills in this critical area due to the number of regulated facilities and because historic and recent spills have occurred.

Environmental monitoring should be performed at select locations along Silver Creek in this critical area. Samples should be collected near Bennett Road, Telegraph Road, and North Detroit Avenue where storm sewers along these roads and West Alexis Road are routed to Silver Creek (Figure 35; Figure E-9 of Appendix E). Aquatic community health and habitat should be assessed near the downstream terminus of this critical area; sample types and estimated costs are in Table 29 and site location information is in Table E-1 of Appendix E.

Sampling is also recommended for Silver Creek (Railroad Crossing), which is the next downstream subwatershed (refer back to Table 9 for a list of the delineated subwatersheds; additional subwatershed information is in Appendix D). Measurement of field parameters is recommended to assess stormwater from the railroad right-of-ways. P11S99 (labelled in Figure E-10 of Appendix E), also in Silver Creek (Railroad Crossing) was historically sampled for fish tissue evaluation; this site should be sampled again to assess the human health designated use. Sediment and water column samples should also be collected to assess sources and compare with Shantee Creek (North Towne Square) and Silver Creek (East Alexis Road) critical areas.

As discussed in Section 5.5.4, it is recommended that six subwatersheds be sampled together for total labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment), of $18,325. The costs for the Silver Creek subwatersheds are $13,300.

Table 31. Sample recommendations for Silver Creek (North Towne Square)

Samples	Silver Creek (North Towne Square)				Silver Creek (Railroad Crossing)	
Site ID	SiC-4	SiC-5	SiC-6	SiC-7	SiC-4	P11S99
Biology						
IBI & MIwb	--	--	--	X	--	--
ICI	--	--	--	X	--	--
QHEI	--	--	--	X	--	--
Fish tissue	--	--	--	--	--	X
Water Column						
Field Par.	X	X	X	X	X	X
Flow	--	--	--	X	--	--
Met. & Org.	--	--	--	X	--	--
Sediment						
Met. & Org.	--	X	--	X	--	X
PCBs	--	--	--	X	--	X
Cost						
Labor [a]	$25	$75	$25	$1,625	$25	$275
Laboratory [b]	--	$400	--	$1,725	--	$2,100
Total	**$25**	**$475**	**$25**	**$3,350**	**$25**	**$2,375**

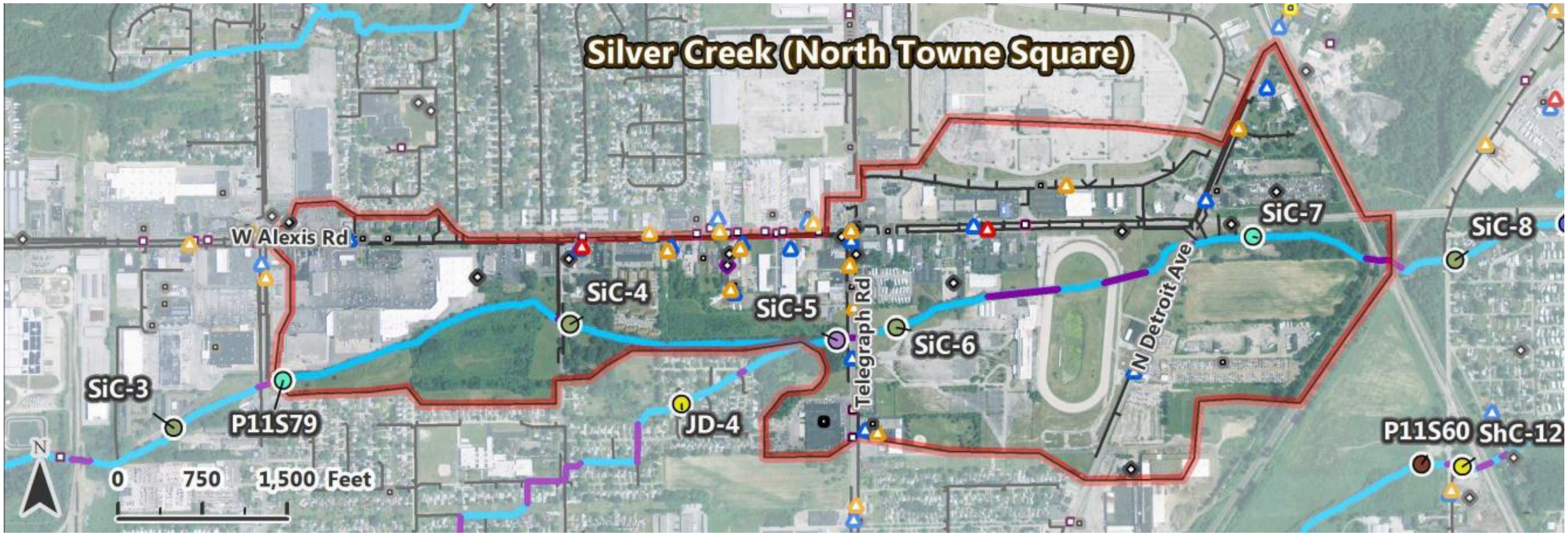
Notes

Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.

Field Par. = field parameters; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index; SiC = Silver Creek.

a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.

b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 34 and is also shown on Figure E-1 in Appendix E.

Figure 35. Recommended sampling locations in and downstream of the North Towne Square critical area.

During the HSSCA, a habitat restoration opportunity was identified during field visits and GIS analyses. While a comprehensive analysis was not performed, the cursory results are presented herein for consideration as future activities. Any restoration activities would need to consider the city of Toledo and Lucas County's stormwater management objectives with Silver Creek and activities that may affect restoration (e.g., use of heavy equipment to remove large woody debris to maintain an open stormwater channel).

Long segments of Silver Creek in this critical area are open channels with forested riparian areas (Figure 36), which may be the remnants of the former Sunnybrook golf course. Unlike many other subwatersheds, where streams are frequently culverted and routed through underground pipes, this subwatershed has the potential for riparian habitat restoration. For example, sufficient land is available along Silver Creek east of Lewis Avenue for restoration activities and some segments already include trees within the riparian corridor (Figure 36). Restoration opportunities are likely limited between Telegraph Road and North Detroit Avenue as Silver Creek flows through commercial properties. The city of Toledo is working on Silver Creek from North Detroit Avenue to the railroad right-of-way (Figure 36) and anticipates installing a two-stage ditch in this area.

Figure 36. Lewis Avenue bridge over Silver Creek (facing east, downstream).

5.9 Silver Creek (East Alexis Road)

USTs, LUSTs, a Superfund site, spills and NPDES permittees are along East Alexis Road, Enterprise Boulevard, and Hagman (Figure 37). This critical area includes Silver Creek from Raintree Parkway (just east of the Silver Creek cutoff) to the Hagman Road bridge over Silver Creek. The Silver Creek (lower) subwatershed is 279 acres, is 66 percent developed land (plus an additional 23 percent as open developed land), and is 28 percent impervious cover (Appendix D). The predominant land use is commercial; cultivate crop fields and residential developments are adjacent to the eastern portion of this critical area.

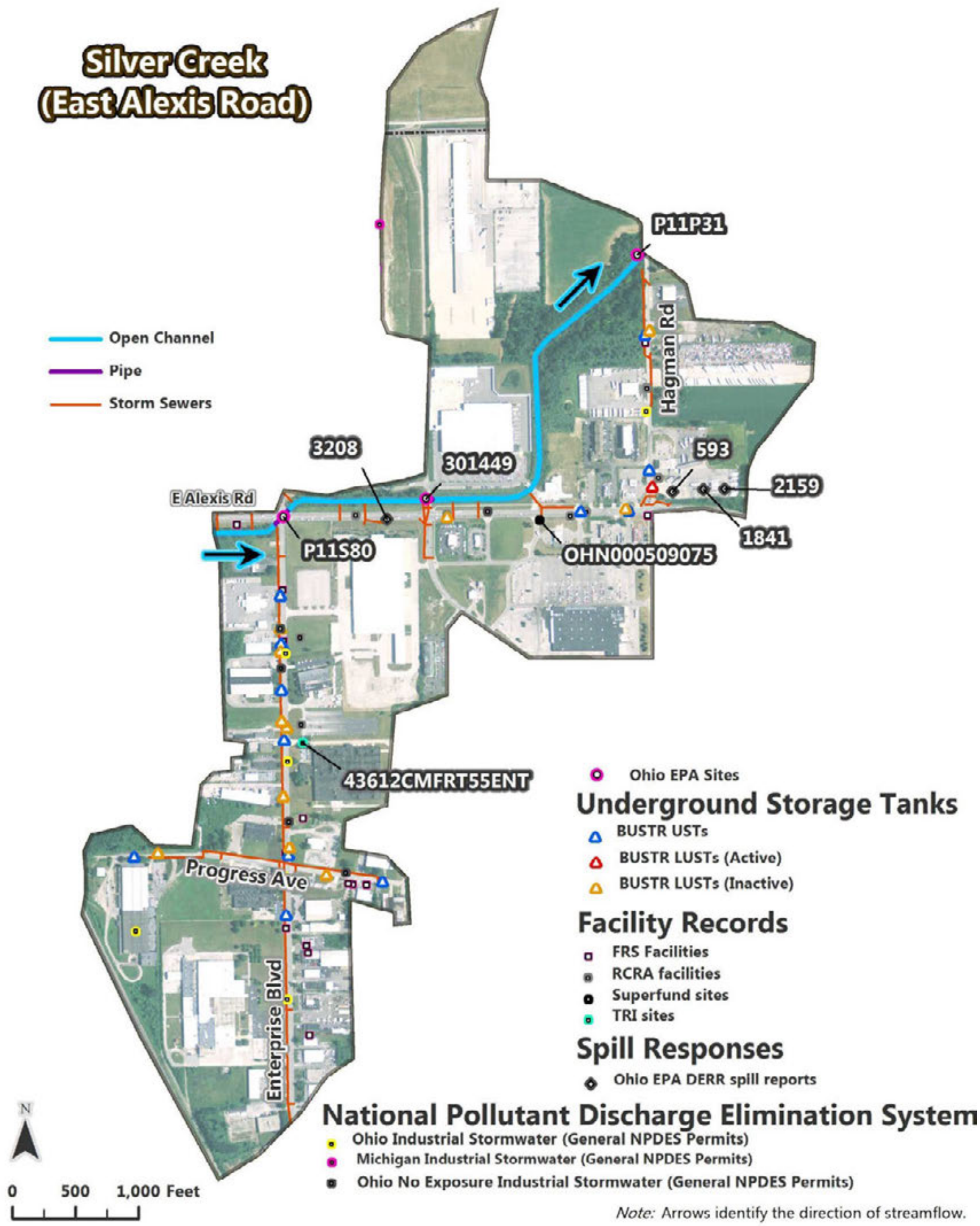


Figure 37. Silver Creek (lower): East Alexis Road, Enterprise Boulevard, and Hagman Road.

5.9.1 Water Quality

Two Ohio EPA sample sites are along Silver Creek in this critical area: Silver Creek at Futura Drive (301449) and Silver Creek at Hagman Road (P11P31). Silver Creek is designated modified warmwater habitat (due to channelization) along this segment. One water column sample was collected in 1976 at site P11P31 and chromium (total), lead, and zinc were detected. Five water column samples were collected in 2011 at site 301449 and evaluated for metals. Eight or nine metals were detected in each sample. Aluminum, arsenic, copper, iron, lead, manganese, nickel, and zinc were always detected below WQSs. Chromium was detected in four samples below WQSs and not detected in one sample. Cadmium and selenium were not detected.

A sediment sample was collected from site 301449 in 2011 and it was evaluated for inorganic and organic constituents. Cadmium, chromium, copper, lead, nickel and zinc were detected below sediment reference values (Ohio EPA 2008). No PCBs were detected. Six organic compounds were detected above sediment reference values:

- 2-Methylnapthalene
- Benz[a]anthracene
- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene.

Fish and benthic macroinvertebrates were collected in 2011 at site 301449. The IBI scores was 16, which indicates poor fish community health, and the MIwb scores was 6.976. Ohio EPA also found the macroinvertebrate community health to be poor in 2011. The QHEI score was 41 in 2011, which indicates poor habitat.

5.9.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, and Superfund. No TRI records are for facilities in this critical area. Twenty-two UST records for 13 locations and 17 LUSTs records for five locations are in this critical area (Figure 37). Nine facilities regulated by RCRA are in this critical area along the major roadways. USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Ohio EPA has issued general NPDES permit coverage for 11 properties in this critical area and most of the permittees are along Enterprise Boulevard. Five properties are designated no exposure:

- FedEx National LTL Inc. (5657 Enterprise Boulevard; 2GRN00323)
- Inceptor Inc. (1301 Progress Avenue; 2GRN00438)
- Shear Tech Steel LLC (5601 Enterprise Boulevard; 2GRN00296)
- Stericycle (1301 East Alexis Road; 2GRN00265)
- Toth Industries Inc. (5102 Enterprise Boulevard; 2GRN00333).

Properties with no exposure coverage should not discharge stormwater offsite. Six properties are covered by the general NPDES permit for stormwater associated with industrial activities:

- Chrysler Group Transport LLC (5925 Hagman Road; 2GR00583)
- Comfort Line LTC (5900 Enterprise Boulevard; 2GR01854)
- Crown Cork & Seal Co. Inc. (5201 Enterprise Boulevard; 2GR00072)
- EDCO Inc. (5244 Enterprise Boulevard; 2GR01536)
- Sterling Pipe and Tube Inc. (5335 Enterprise Boulevard; 2GR01629)
- Sterling Pipe and Tube Inc. (1050 Progress Avenue; 2GR01815).

As with any facilities permitted to discharge stormwater offsite, these facilities are potential sources of future spills.

A single Superfund site is in this critical area: Toledo PCB Emergency Response (OHN000509075). A pole-mounted transformer spilled PCBs when the pole was knocked down during a storm. The electrical company's contractor cleaned up the spill area, storm sewers, and Silver Creek. The investigation was conducted by U.S. EPA with Ohio EPA DERR, and Toledo DES. Refer to Section A-2.5 and Section A2.6 of Appendix A for discussions of the available information in the spill report and Superfund files, respectively. As with any pole-mounted transformer, there is potential for future spills and releases.

5.9.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR, Ohio EPA DERR, and Superfund. Nineteen LUST records are inactive and one record is active. Eleven LUST records, including the single active record, are for suspected contamination from a UST and nine records are for the closure of a regulated UST. BUSTR determined that no further action was necessary for twelve LUST records and releases were disproved for seven LUSTs records. The single active record requires a tier 1 source investigation. With the possible exception of the LUST undergoing a tier I source investigation, LUSTs should not be a current source of POCs in this critical area.

Four spills reports in Ohio EPA DERR's spills database are for locations in this critical area (Figure 26). The four spills occurred between 1997 and 2001 (Table 32). U.S. EPA Region 5 does not have any spill reports for spills or release in this critical area.

Table 32. Spills in the critical area: Silver Creek (lower)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spills [a]
DERR	1997-1841	5/12/1997	diesel fuel	50	storm sewer catch basin	♦
DERR	1998-3208	7/31/1998	diesel fuel	100	Silver Creek	♦♦♦
DERR	2000-0593	2/23/2000	ethyl alcohol [b]	*5*	storm sewers	♦
DERR	2001-2159	6/16/2001	diesel fuel	75	*none reported*	♦

Notes

DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization.

a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.

b. Ethyl alcohol 190 proof.

Spills reports 1997-1841 and 2000-0593 are at the same location (5820 Hagman Road), and 2001-2159 might also be at this location[16]. Two of these spills were from tanker trucks: diesel fuel from a tanker truck that was fully contained on-site (1997-1841) and ethyl alcohol from a tanker truck that was fully contained on-site (2000-0593). Spill 2001-2159 did not migrate to a storm sewers or a surface waterbody and is not further discussed. Similarly, in 2005, diesel spilled from a truck into a parking lot, but the spill did not migrate to storm sewers or surface streams (spill 0063/05 in Toledo 2014b). The last spill (1998-3208) was from an unreported source that migrated to Silver Creek.

[16] Spill report 2001-2159 plots in GIS in a row crop field adjacent to the Pilot Travel Center presently located at 5820 Hagman Road. There are insufficient information in the spill report to determine the location of the spill. The spill is assumed to be in the vicinity of 5820 Hagman Road.

5.9.4 Summary and Recommendations

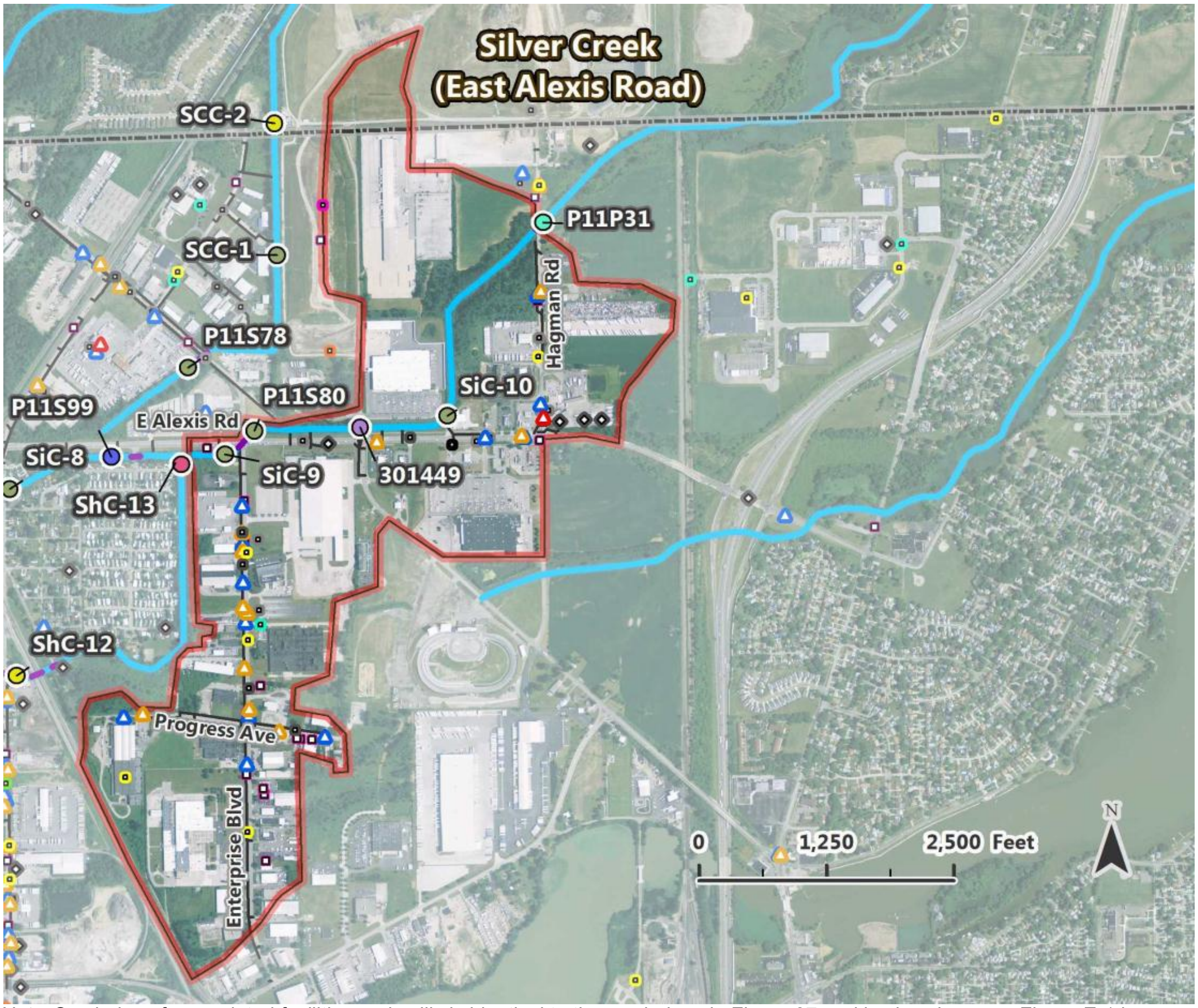
The Silver Creek (East Alexis Road) critical area in the Silver Creek watershed contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, and Superfund. Analysis of LUST records and spills reports found that LUSTs are not known to have released POCs, with the exception of the single LUST record for an ongoing investigation. An evaluation of spills reports shows that minor spills have occurred that entered storm sewers and Silver Creek. Potential exists for future spills in this critical area due to the numbers of USTs and NPDES, RCRA, and Superfund facilities and because historic spills have occurred. Additionally, a few properties are regulated under multiple programs and spills have occurred at these properties.

Limited environmental monitoring data were collected from Silver Creek (East Alexis Road); therefore, it is recommended that additional sampling be performed. Samples should bracket the outlets for storm sewers on Silver Creek that drain Enterprise Boulevard, Hagman Road and East Alexis Road. No spills were recorded for the numerous regulated properties along Enterprise Boulevard; thus, only field measurements are recommended above and below the storm sewers that drain this street. Sediment sampling is recommended at key sites to assess spills and regulated facilities; sample types and estimated costs are in Table 33 and site location information is in Table E-1 of Appendix E. Aquatic community health and habitat were historically assessed at site P11P31 (Figure 38; Figure E-10 of Appendix E) and should be assessed at this site again. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample this critical area are $3,900 (Table 33).

Table 33. Sample Recommendations for Silver Creek (East Alexis Road)

Samples	Silver Creek (General Motors)				
Site ID	SiC-9	P11S80	301449	SiC-10	P11P31
Biology					
IBI & MIwb	--	--	--	--	X
ICI	--	--	--	--	X
QHEI	--	--	--	--	X
Water					
Field Par.	X	X	X	X	X
Flow	--	--	--	--	X
Met. & Org.	--	--	--	--	X
Sediment					
Met. & Org.	--	--	X	--	X
PCBs	--	--	--	--	X
Costs					
Labor [a]	$25	$25	$75	$25	$1,625
Laboratory [b]	--	--	$400	--	$1,725
Total	**$25**	**$25**	**$475**	**$25**	**$3,350**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; Met. & Org. = metals and organic constituents; PCBs = polychlorinated biphenyls; SiC = Silver Creek.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 37 and is also shown on Figure E-1 in Appendix E.

Figure 38. Recommended sampling locations along Silver Creek in the East Alexis Road critical area.

There is limited potential for habitat restoration along Silver Creek in this critical area. The stream is channelized and culverted along East Alexis Road. The segment flowing northeast of Hagman Road at Ohio EPA site P11P31 (Figure 38) has a forested riparian corridor. The channel here is deep and may provide better habitat. The stream then flows along the state line before flowing northeast again into Michigan.

In this critical area, much of Silver Creek is a channelized stormwater conveyance that has insufficient adjacent land to restore a natural meander or to plant native vegetation. While there may be restoration opportunities along Silver Creek downstream of the commercial development, resources should be devoted to other subwatersheds in the HSSCA project area with better restoration opportunities.

5.10 Silver Creek Cutoff

USTs, LUSTs, facilities regulated under NPDES, RCRA, and TRI, and spills are in Silver Creek cutoff subwatershed (Figure 39). This segment was disconnected from Silver Creek when Silver Creek and Shantee Creek were re-routed along West and East Alexis Road. The Silver Creek Cutoff subwatershed is 197 acres, is 80 percent developed land (plus an additional 18 percent open developed land), and is 37 percent impervious cover (Appendix D). This subwatershed is composed of industrial and commercial properties, including a portion of the Lucas County Landfill. Residential neighborhoods are adjacent to this subwatershed to the south and northwest.

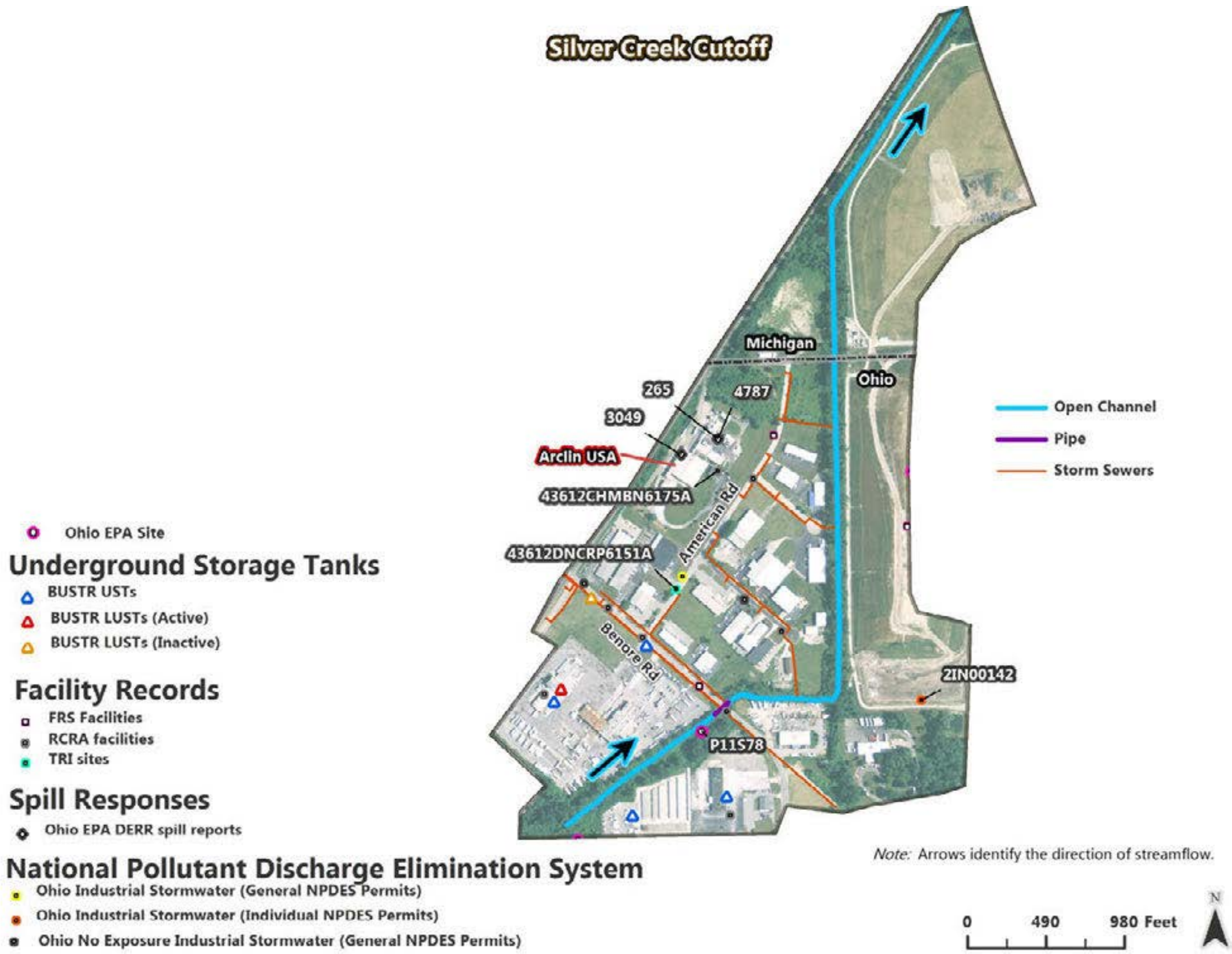


Figure 39. Silver Creek Cutoff.

5.10.1 Water Quality

Old Silver Creek at Benore Road (P11S78) is the only Ohio EPA sample station in this critical area. No water column or sediment samples were collected from Silver Creek Cutoff. Ohio EPA found the macroinvertebrate community health to be poor in 1992. The QHEI score was 18 in 1993, which indicates very poor habitat for a headwaters stream.

5.10.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, and TRI. No facilities regulated by Superfund are in this critical area. Five UST records for four locations and one LUST record at one location are in this critical area (Figure 39). Eight facilities regulated by RCRA are in this critical area and a few are co-located at facilities with USTs. One RCRA location, presently Arlin USA LLC at 6175 American Road, also has records for TRI and spills. The USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

The Lucas County Landfill is permitted to discharge stormwater associated with industrial activities via an individual NPDES permit (2IN00142). This property is partially within the Silver Creek Cutoff subwatershed and partially within the Silver Creek (East Alexis Road) subwatershed. Lucas County Landfill is required to sample its stormwater. From 2011 through 2013, copper (4 to 9 µg/L), iron (143 to 1,680 µg/L), and zinc (15 to 52 µg/L) were detected. During the same years, benzene, cadmium, ethylbenzene, oil and grease (hexane extraction method), toluene, and xylene were not detected. Only TSS levels have exceeded the permit limits and no code violations were reported. Thus, the landfill is a minor source of metals and has the potential to be a source of POCs in future stormwater discharges.

Ohio EPA has issued general NPDES permit coverage for three properties in this critical area. Two properties are designated no exposure: Kay Toledo Tag Inc. (6050 Benore Road; 2GRN00200) and Projects Designed and Built Inc. (5949 American Road East; 2GRN00271). Properties with no exposure coverage should not discharge stormwater offsite. Arclin USA LLC (6175 American Road; 2GR00236) is the single property covered by the general NPDES permit for stormwater associated with industrial activities. As with any facilities permitted to discharge stormwater offsite, this facility is a potential source of future spills.

Two facilities are on the TRI list in this critical area (for additional information see Section A-2.7 in Appendix A):

- Arclin USA LLC (43612CHMBN6175A) for 10 materials between 1989 and 2012, including organic compounds.
- Dana Corp. Spicer Driveshaft Division (43612DNCRP6151A); no TRI data are available.

5.10.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR and Ohio EPA DERR. The single LUST record is inactive and was for the closure of a regulated UST. BUSTR determined that no further action was necessary. This LUST should not be a current source of POCs in this critical area.

Three spill reports in Ohio EPA DERR's spills database are for a location in this critical (Figure 39). The three spill events occurred between 1991 and 2012 (Table 34). U.S. EPA Region 5 does not have any spill reports for spills or release in this critical area.

Table 34. Spills in the critical area: Silver Creek cutoff

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1991-4787 [b]	11/11/1991	Phenol formaldehyde resin	9,000	Silver Creek	♦♦♦♦
DERR	1992-0265	1/24/1992	Phenol formaldehyde resin	*unknown*	*none reported*	♦
DERR	2012-3049	12/21/2012	Phenol and formaldehyde	10,000 [c]	*none reported*	♦ [d]

Notes
DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization. R5 = U.S. EPA Region 5.
a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.
b. Spill report 1991-4787 is not available for review.
c. 10,000 pounds
d. Since this spill migrated to the air and contaminated structures and the land but no waterways, it received a low qualitative ranking. Had the spill migrated from the air to Silver Creek, it would have a very high qualitative ranking.

Spills were at 6175 American Road, which was NESTE Resins Corp and is now Arclin USA LLC. No further information regarding spill 1991-4787 is available[17]; therefore, this spill is not further evaluated. A thermocouple on an above ground storage tank broke and released phenol formaldehyde resin onto the ground below the tank that then migrated into ambient air (1992-0265). Phenol formaldehyde released into the air. Roadways, parking lots, and roofs were cleaned and contaminated vegetation and soil were removed from the facility and adjacent, downwind buildings (2012-3049). The airborne release did not migrate to the cutoff segment of Silver Creek, which was partially frozen. During the evacuation, Arclin employees closed stormwater valves and plugged a culvert, which prevented offsite migration of stormwater; it snowed five days after the spill while cleanup operations were ongoing. Finally, an additional small spill of phenol occurred at Arclin in September 2012 that was investigated by TES (Toledo 2014b); the spill did not migrate to surface waterways or storm sewers and was not investigated by Ohio EPA or U.S. EPA.

5.10.4 Summary and Recommendations

The Silver Creek Cutoff critical area contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, and TRI. Analysis of LUST records and spills reports found that LUSTs are not known to have released POCs. An evaluation of spills reports shows that major and minor spills have occurred that migrated to Silver Creek. Two spills are considered minor because they did not migrate to surface waterways but would be major spills if they had migrated to Silver Creek. Potential exists for future spills in this critical area due to the numbers of RCRA facilities and because historic and recent spills have occurred.

Limited environmental monitoring data were collected from Silver Creek Cutoff. Today, this historic segment of Silver Creek is disconnected from the Silver Creek watershed. Therefore, the sampling recommendations in this critical area are not high priority. Additionally, this critical area is too small to evaluate aquatic community health. Water column and sediment samples are recommended on the Silver Creek Cutoff near the state border to determine what pollutants may be discharged from Ohio to Michigan (Figure 40; Figure E-11 of Appendix E). Field measurements along Silver Creek Cutoff near storm sewer outlets may also be performed to assess the impacts of storm sewers draining industrial facilities. Sample types and estimated costs are in Table 35 and site location information is in Table E-1

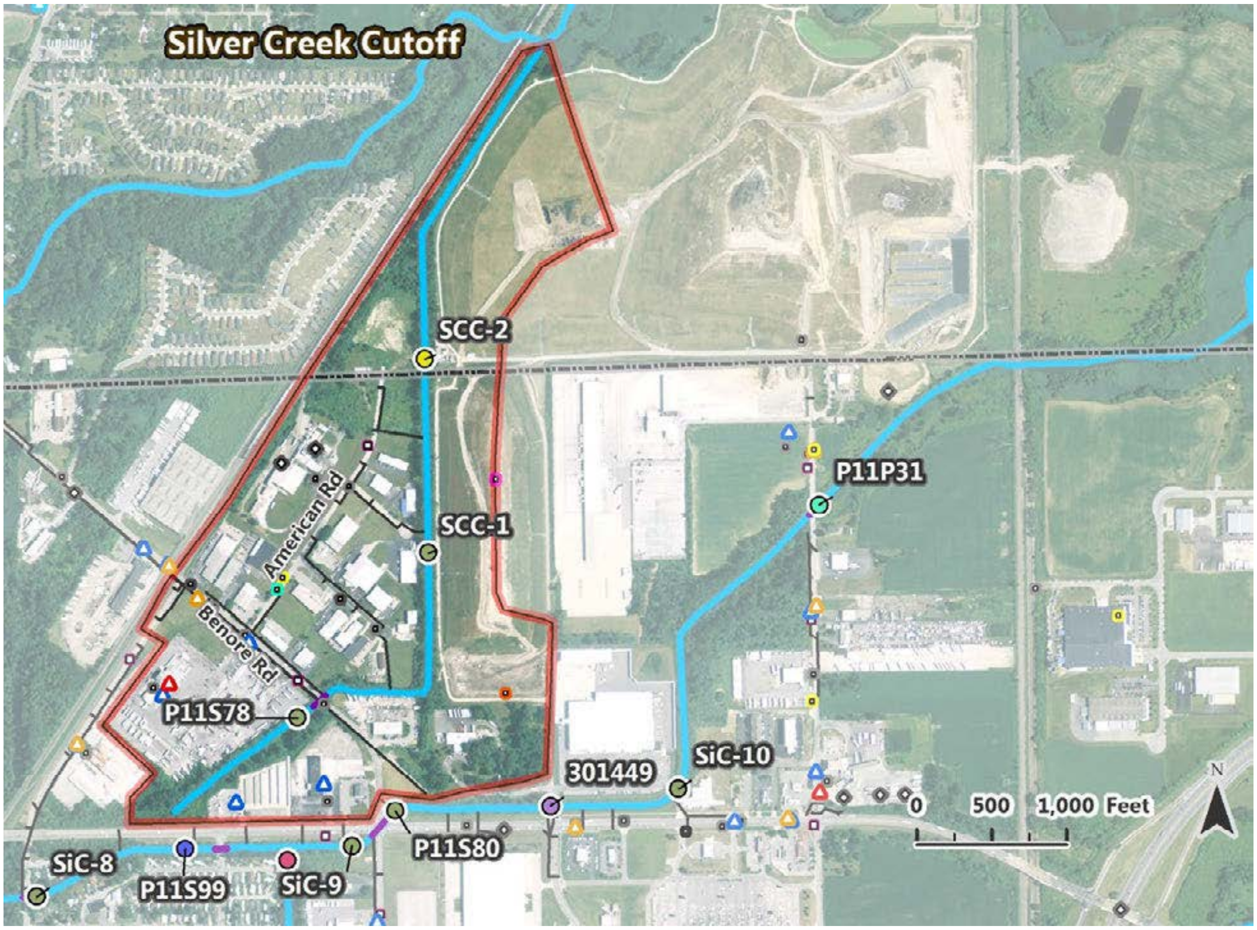
[17] The narrative of the spill report, provided by Ohio EPA (2014a), indicates that an error occurred during a past migration of data from one database to another and that the data did not transfer to the new spills database.

of Appendix E. The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample this critical area are $1,500 (Table 35).

Table 35. Sample recommendations for Silver Creek Cutoff

Samples	Silver Creek Cutoff		
Site ID	P11S78	SCC-1	SCC-2
Water			
Field Par.	X	X	X
Flow	--	--	X
Met. & Org.	--	--	X
Sediment			
Met. & Org.	--	--	X
PCBs	--	--	X
Costs			
Labor [a]	$25	$25	$225
Laboratory [b]	--	--	$1,225
Total	**$25**	**$25**	**$1,450**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; Met. & Org. = metals and organic constituents; PCBs = polychlorinated biphenyls; SCC = Silver Creek Cutoff.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 39 and is also shown on Figure E-1 in Appendix E.

Figure 40. Recommended sampling locations along Silver Creek Cutoff.

5.11 Halfway Creek (North Towne Square)

USTs, LUSTs, facilities regulated under NPDES, RCRA, and TRI, and spills are in the Halfway Creek (North Towne Square) subwatershed (Figure 41). The subwatershed is 380 acres, is 66 percent developed land (plus an additional 25 percent open developed land), and is 42 percent impervious cover (Appendix D). This subwatershed is composed of industrial and commercial properties, including facilities along Telegraph Road and North Detroit Avenue. Residential neighborhoods are adjacent to this subwatershed to the west and northwest. A few apartment complexes are along Mel Simon Drive that is across from the former North Towne Square.

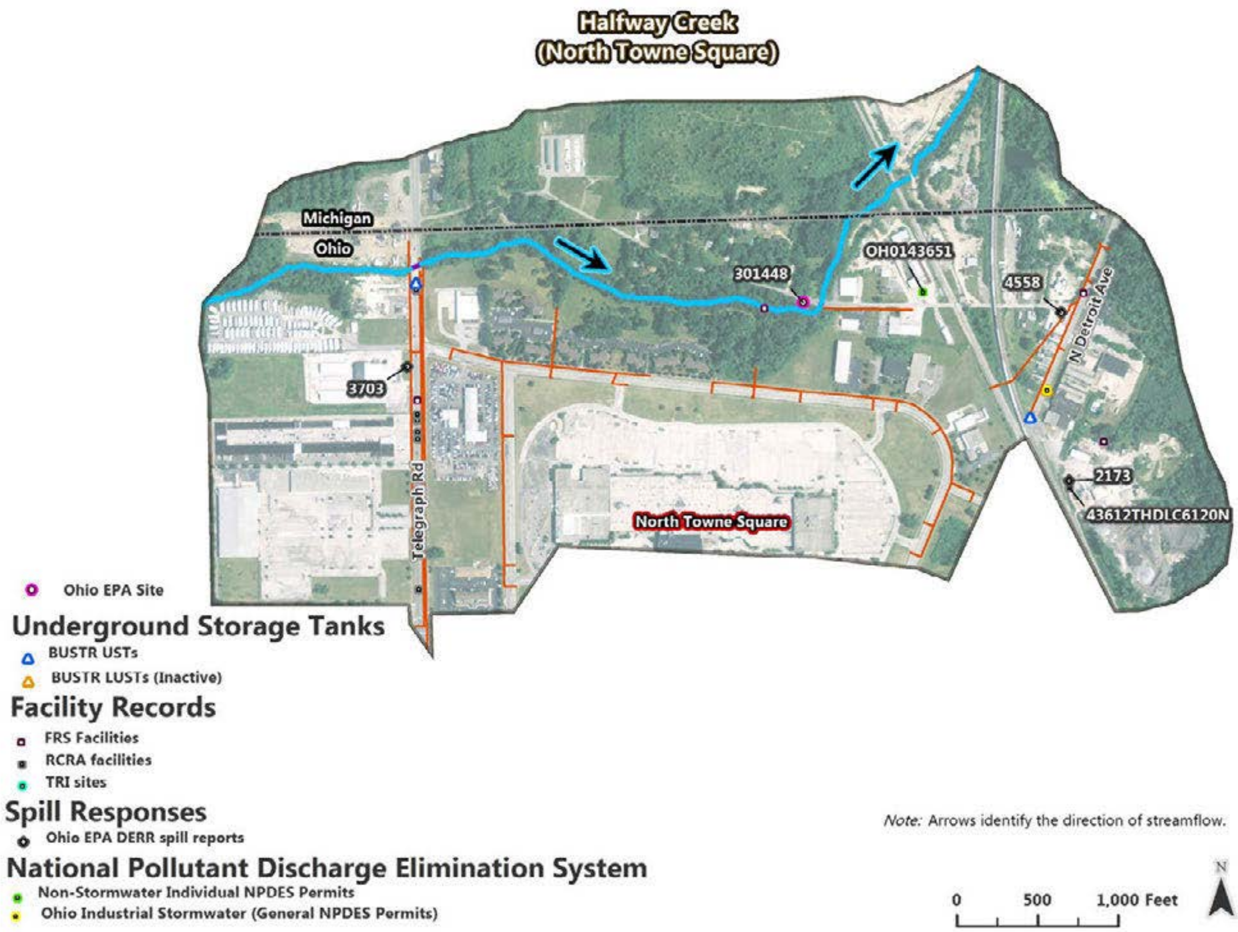


Figure 41. Halfway Creek (North Towne Square).

5.11.1 Water Quality

Halfway Creek near Ohio/Michigan border at East State Line Road (301448) is the only Ohio EPA sample site in this subwatershed. Five water column samples were collected in 2011. Three to six metals were detected in each sample and no metal concentration exceeded WQSs. Iron, manganese, and nickel were always detected while aluminum, copper, and zinc were sometimes detected. Arsenic, cadmium, chromium, lead, and selenium were never detected.

A single sediment sample was also collected in 2011 and it was evaluated for inorganic and organic constituents. Cadmium, chromium, copper, lead, mercury, nickel and zinc were detected below sediment reference values (Ohio EPA 2008). No PCBs were detected. Nine inorganic compounds were detected and all but benzo[b]fluoranthene were detected above sediment reverence values:

- Benz[a]anthracene
- Benzo[a]pyrene
- Benzo[b]fluoranthene
- Benzo[g,h,i]perylene
- Benzo[k]fluoranthene
- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene

Fish and macroinvertebrate samples were collected in 2011. The IBI score was 36 and the MIwb score was 7.959. These scores indicate fair fish community health. Ohio EPA also found qualitative macroinvertebrate community health to be fair. The QHEI score was 50 in 2011, which indicates fair habitat for a wading-size stream.

5.11.2 Facilities

Facilities in this critical area are regulated by BUSTR, NPDES, RCRA, and TRI. Two UST records for two locations and one LUST record at one location are in this critical area (Figure 41). Eight facilities regulated by RCRA are in this critical area and two facilities also have USTs. The USTs regulated by BUSTR and facilities regulated by RCRA are potential sites for future spills and releases.

Ohio EPA has issued a general NPDES permit for stormwater associated with industrial activities to Gerken Materials Inc. (6100 North Detroit Avenue; 2GR01913). As with any facilities permitted to discharge stormwater offsite, this facility is a potential source of future spills.

One facility is on the TRI list (for additional information see Section A-2.7 in Appendix A): Dial Corp (43612THDLC6120N) for four materials between 1987 and 1988, excluding any POCs.

5.11.3 Spills and Releases

Spills and releases records from the following datasets are associated with sites within this critical area: BUSTR and Ohio EPA DERR. The single LUST record is inactive and was for suspected contamination from a UST. BUSTR determined that no further action was necessary. This LUST should not be a source of POCs in this critical area.

Three spill reports in Ohio EPA DERR's spills database are for locations in this critical area (Figure 41). The three spill events occurred in 1997 and 2008 (Table 36). U.S. EPA Region 5 does not have any spill reports for spills or release in this critical area.

Table 36. Spills in the critical area: Halfway Creek (North Towne Square)

Agency	Spill ID	Date spill reported	Spilled product name	Volume (gallons)	Receiving waterbody	Importance of spill [a]
DERR	1997-2173	6/2/1997	Fuel oil Residual asphalt material	1,000	marsh area adjacent to plant	♦♦♦♦
DERR	1997-4558	11/19/1997	Paint products runoff	*unknown*	*Tributary to Halfway Creek*	♦♦♦
DERR	2008-3703	9/10/2008	Diesel fuel	75	Halfway Creek	♦♦♦

Notes
DERR = Ohio Environmental Protection Agency Division of Environmental Response and Revitalization.
a. The importance of spills is a qualitative ranking that is discussed at the beginning of Section 5. As the number of diamonds increase, the significance of the spill increases.

Fuel oil leaked from a heater unit associated with an above ground storage tank of asphalt material (1997-2173). The spilled oil migrated to a wetland adjacent to the facility during high flow conditions; soil around the aboveground storage tank area was removed, as were contaminated plants and soil from the marsh/wetland area. Runoff containing oil-based paints, due to damages sustained from a fire at the Arlington Rack and Packing Company (6120 North Detroit Avenue), migrated to storm sewers and then to a tributary of Halfway Creek (1997-4558). A USA Trucking truck involved in an automobile accident leaked diesel fuel that migrated to storm sewers and Halfway Creek (2008-3703); a contractor contained the spill and removed the product and contaminated soil.

5.11.4 Summary and Recommendations

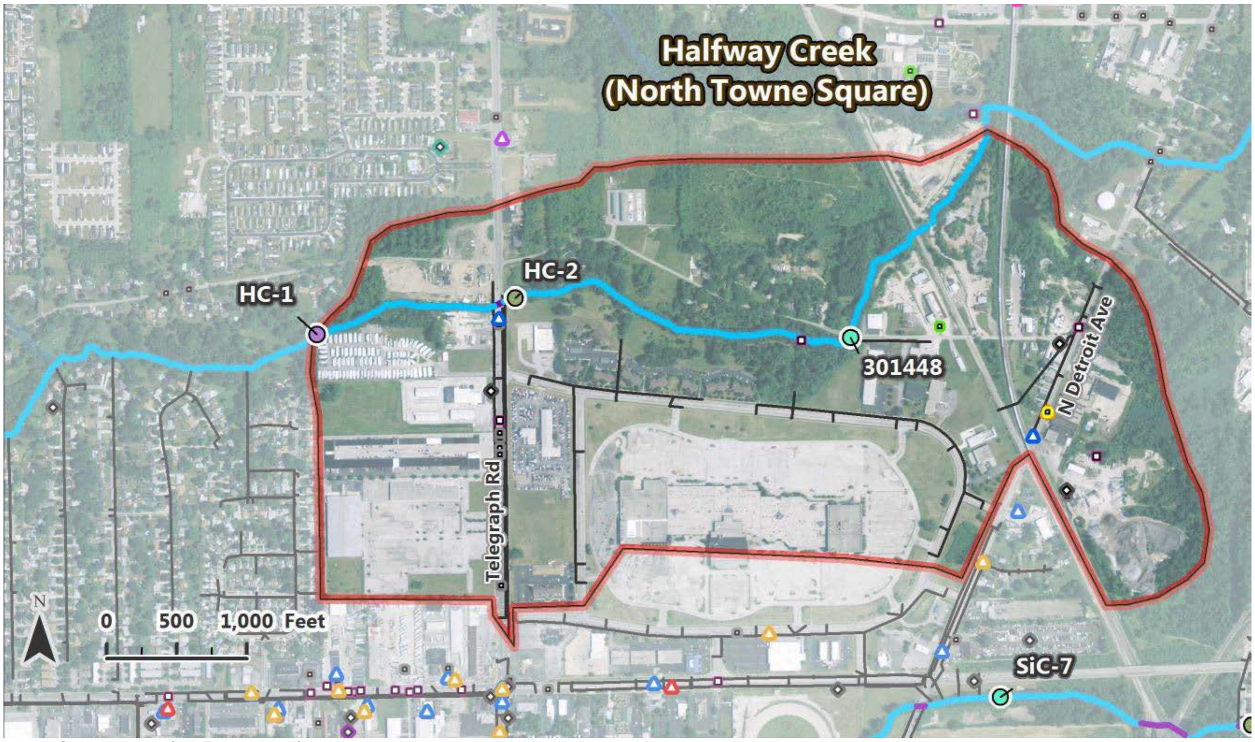
The Halfway Creek (North Towne Square) critical area contains USTs regulated by BUSTR and facilities regulated by NPDES, RCRA, and TRI. Analysis of LUST records and spills reports found that LUSTs are not known to have released POCs. An evaluation of spills reports shows that major and minor spills have occurred that entered storm sewers and Halfway Creek. Potential exists for future spills in this critical area due to the numbers of RCRA facilities and because historic spills have occurred.

Limited environmental monitoring data were collected from Halfway Creek (North Towne Square); therefore, it is recommended that additional sampling be performed. Samples should be collected from Halfway Creek where the stream flows into and out of Ohio (Figure 42; Figure E-12 of Appendix E). Field measurements could also be monitored near the storm sewer outlets that drain Telegraph Road and the eastern portion of the critical area with multiple industrial properties (Table E-1 of Appendix E). The estimated labor and laboratory costs, excluding other direct costs (e.g., lodging, equipment) to sample this critical area are $3,275 (Table 38); additional site information is in Table E-1 of Appendix E.

Table 37. Sample recommendations for Halfway Creek (North Towne Square)

Samples	Halfway Creek (North Towne Square)		
Site ID	HC-1	HC-2	301448
Biology			
IBI & MIwb	--	--	X
ICI	--	--	X
QHEI	--	--	X
Water			
Field Par.	X	X	X
Flow	--	--	
Met. & Org.	--	--	
Sediment			
Met. & Org.	X	--	X
PCBs	X	--	X
Costs			
Labor [a]	$75	$25	$1,475
Laboratory [b]	$600	--	$1,100
Total	**$675**	**$25**	**$2,575**

Notes
Unit costs per sample are presented in Table 15. Location information for each site is presented in Table E-1 of Appendix E.
Field Par. = field parameters; HC = Halfway Creek; IBI = Index of Biotic Integrity; ICI = Invertebrate Community Index; Met. & Org. = metals and organic constituents; MIwb = Modified Index of well-being; PCBs = polychlorinated biphenyls; QHEI = Qualitative Habitat Evaluation Index.
a. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
b. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1.



Note: Symbology for regulated facilities and spills is identical to the symbology in Figure 42 and is also shown on Figure E-1 in Appendix E.

Figure 42. Recommended sampling locations along Halfway Creek in the North Towne Square critical area.

Halfway Creek flows through a forested riparian buffer through most of this critical area (Figure 42); this is probably one of the least impacted segments of the creek within the city of Toledo. Future activities may be able to further enhance the existing habitat of Halfway Creek in this critical area through stream restoration activities (Figure 43). Habitat could also be improved by widening the riparian corridor along some segments of this critical area where manicured fields are mowed up to a thin line of trees along the stream.

Figure 43. Halfway Creek at East State Line Road.

6 Assumptions and Uncertainties

The analyses and results of the HSSCA contain limitations and uncertainties and were based, in part, upon various assumptions. The HSSCA incorporated secondary data, typically of known quality, and required the evaluation of limitations and uncertainties of the secondary data. Assumptions were made, as necessary, to support the use of secondary data. This section presents a summary of the assumptions, limitations, and uncertainties of the HSSCA.

6.1 Identification of Pollutants of Concern

Environmental monitoring data and spill reports were used to identify the POCs. Both datasets were limited spatially and temporally. All secondary data from government regulatory agencies were assumed to be accurate, complete, and representative of conditions at the time of sampling or reporting.

6.1.1 Environmental Monitoring Data Limitations

Water column samples were collected in the 1990s, 2000s, and 2010s but sediment samples were only collected in 2011 and fish samples (for tissue analyses) were only collected in 1993. No environmental data are available prior to 1977. Ohio EPA evaluated eight water column samples (Shantee Creek, 3 samples; Silver Creek, 5 samples) for metals and PAHs and three sediment samples (one each from Halfway, Silver, and Shantee creeks) for metals, PAHs, and PCBs. Ohio EPA also evaluated fish tissue samples for metals, PAHs, and PCBs at one location each on Silver and Shantee creeks. Michigan DEQ and Toledo DES evaluated water column samples for metals.

6.1.2 Spill Reports Limitations

Spills reports are available from multiple agencies but do not include spills prior to the mid-1990s. Most Ohio EPA DERR spill reports are from the late 1990s through 2013, which is a similar time period for the U.S. EPA Region 5 spill reports. Michigan DEQ spill reports are only available from 1997 to 2011; Michigan's records retention policy results in the destruction of records older than 15 years. Limited information and data are included in some of the earlier spills reports.

Spill reports only cover spills investigated by the various agencies; additional spills may have occurred but were not investigated if not reported to a government agency. Typically, spills reports from U.S. EPA and Ohio EPA cover significant spills and releases. Spills reports from Toledo DES cover both significant and insignificant spills; for example, insignificant spills include dumping trash or leaves into a creek, dye testing, and water and sewer pipeline work).

6.2 Identification of Potential Sources of Pollution

The federal and state government agencies databases of facilities are assumed to be complete with respect to current records but may include historic data gaps. Facilities with significant historic spills or releases should be well-represented in the databases. Data gaps may include smaller historic spills or releases from facilities that existed and closed prior to the adoption of the various environmental laws that now govern such facilities (i.e., no records are likely to be available for facilities that closed prior to the 1960s). Refer to Section 6.1.2 for additional imitations regarding spill reports.

Facilities and spills datasets were generally limited to electronic datasets; however, scans of some Michigan DEQ Part 201 sites' files and spill reports were obtained. Paper hardcopy files are available for various federal and state datasets but were not obtained due to project scope and level of effort issues. For example, 39 bound reports and 11 hardcopy files are available for the single VAP project in the HSSCA project area.

Many U.S.EPA Region 5, Ohio EPA DERR, and Toledo DES spill reports discuss the collection of environmental monitoring data (e.g., water column, sediment, groundwater, soil). These media were sampled to characterize the spills and to evaluate remediation. Samples were collected by government regulatory agencies, responsible parties, and contractors hired by responsible parties. None of the spill reports include the laboratory results from analyses of the samples and few reports describe the results. None of these data are readily available. Considerable levels of effort would be necessary to obtain spill reports environmental monitoring data from government regulatory agencies; even more effort would likely be necessary to obtain data from responsible parties or their contractors.

6.3 Evaluation of the Fate and Transport of Pollutants of Concern

Considerable gaps in the hydrography and hydrology datasets limit fate and transport evaluations. Little is known of the hydrodynamics of the streams and ditches in the HSSCA project area. The three major data gaps in the hydrography and hydrology datasets are: stream re-routing, information on Lake Erie seiches (e.g., the extent to which Lake Erie water is pushed by wind upstream into the HSSCA project area), and flow data.

Segments of the major streams and ditches have been re-routed, channelized, and piped as the greater Toledo area developed. Major re-routes occurred in the late 1960s and early 1970s: (1) Shantee Creek was re-routed into Silver Creek, thus cutting off lower Shantee Creek, which still flows into Lake Erie and (2) Silver Creek was re-routed such that the mouth of Silver Creek on Halfway Creek was moved downstream. Additional re-routes of smaller segments have occurred numerous times over the past decades for a variety of reasons, including stormwater management and infrastructure construction. Many segments of these streams and their tributaries flow under roadways through culverts and some segments are piped under roads and various properties for hundreds of feet.

Lake Erie seiches reverse the flow direction in the lower reaches of Halfway, Silver, and Shantee creeks and Lake Erie backwater flows up into these streams. Limited observational data that document the extent of the Lake Erie backflow are available, but seiches are believed to affect the lower 3 to 4 miles of Halfway Creek and the lower 1 to 2 miles of Silver Creek and lower Shantee Creek cutoff (Section A-5.2 of Appendix A). In the lacustrine zones, the fate and transport of POCs in the HSSCA project area is likely significantly affected by seiches and Lake Erie. For example, POCs may be transported upstream from their sources in the HSSCA project area and POCs in North Maumee Bay may be transported into the HSSCA project area.

No field-monitored flow data are available for any waterbody in the HSSCA project area. No permanent or temporary flow gages are known to exist. Except for a few flows monitored by Toledo DES, instantaneous flow was not monitored. Fate and transport evaluations will need to rely on estimated flow data and anecdotal qualitative flow information.

6.4 Spatial Analyses

Many of the tasks of the HSSCA relied upon spatial analyses in GIS. This section presents the assumptions, limitations, and uncertainties with the georeferenced spatial datasets and the GIS-analyses performed using these datasets.

6.4.1 Hydrography and Hydrology Datasets

Spatial hydrography data were obtained from government agencies. Considerable uncertainty was associated with the spatial hydrography data since the streams and ditches throughout the HSSCA project area were channelized and re-routed as they were managed for stormwater conveyance. Many segments of the NHD high (USGS 2013), when plotted in GIS with aerial imagery and other georeferenced spatial datasets, were not representative of the actually hydrography of the streams and ditches. Additionally, nomenclature in the NHD high was inconsistent with nomenclature used by Ohio EPA and the city of Toledo. Similarly, Ohio EPA's designated uses stream shapefile (2010) was inconsistent with aerial imagery and other georeferenced spatial datasets. Streams, ditches, and storm sewer georeferenced spatial data provided by the Toledo Division of Engineering Services (Toledo 2014a) was generally consistent with aerial imagery and other georeferenced spatial datasets. However, these data are limited to the city of Toledo. The datasets, along with all georeferenced spatial data, are presented in Section A-3 of Appendix A.

A new streams shapefile was created using the NHD high (USGS 2013) and streams, ditches, and storm sewers provided by the Toledo Division of Engineering Services (Toledo 2014a). The Michigan portion of the HSSCA project area is composed of the NHD high. Most of the Ohio portion of the HSSCA project area is composed of streams and ditches provided by the Toledo Division of Engineering Services. The Ohio portion also includes piped sections of the major streams and ditches (e.g., Shantee Creek, Ketcham Ditch) and segments of the NHD high. This new shapefile is assumed to be the most representative spatial hydrography data that is available.

6.4.2 Facilities and Spills Datasets

Georeferenced spatial datasets are generally assumed to be accurate but are also considered to contain uncertainties. Basic quality assurance was implemented to ensure that facilities and spill records plotted correctly. Intensive quality assurance was implemented within each of the 10 critical areas to ensure the plotting accuracy since the critical areas were further evaluated. Plotting issues were identified in many datasets.

The most common plotting error was with the datasets that were geocoded. In most cases, records in these datasets had street addresses; the street addresses were assumed to be accurate. In each critical area, the datasets that were geocoded were queried to ensure that they were plotting reasonably accurately; GoogleEarth™ (Google Inc. 2013) was used to verify address locations. Often, records plotting near the boundary of a critical area had to be moved into or out of the critical area, depending upon the street addresses.

Ohio EPA DERR spill records (a file with basic information from each spill report) within each critical area were also further assessed since the spill reports were one of the primary datasets used throughout the HSSCA. The DERR spill records typically contained addresses and geographic coordinates. Some coordinates did not plot properly; in these cases, the street addresses were geocoded to plot the spill records. In each critical area, the street address within the spill record was compared with the plotted location of the spill records. Generally, the plotting was accurate. In isolated cases, the spill record was moved to the location of the street address. Discrepancies between street addresses and geographic coordinates may be result of the street address representing the responsible party and the geographic coordinates representing the location of the spill or detrimental impacts from the spill. For the HSSCA, it was decided that records should be plotted at the location of the responsible party.

The third most common plotting issue was when individual properties drained to more than one delineated subwatershed. Such occurrences were common along West Laskey Road where the northern portions of properties drained to Jamieson Ditch while the smaller southern portions of the properties drained to Shantee Creek. For the HSSCA summary statistics, it was decided that records for facilities that drained to two waterbodies should be plotted in the larger portion of the property and the facility was assumed to drain to the waterbody that received the larger portion of the property's drainage.

Finally, additional quality assurance should be performed for future activities that rely upon this report. It was beyond the scope of the HSSCA to extensively assess the quality and representativeness of the obtained georeferenced datasets. Even with the basic quality assurance performed on all major datasets used in the HSSCA and the more intensive quality assurance performed on data within the critical areas, there are likely still plotting issues. Stakeholders should obtain revised or newer versions of the georeferenced spatial datasets from the originating entity and should intensively assess the quality of the data with respect to the stakeholders' data quality objectives.

7 Recommendations

Prior to remediation, it is important to identify and control existing sources of toxic pollution. Environmental monitoring data may be used to identify and assess current and historic sources of the POCs. However, in the case of the HSSCA, very few environmental monitoring data are available. Thus, future restoration and remediation activities cannot be recommended until the areas of contamination are specifically identified and delineated.

The first set of recommendations (Section 7.1) pertains to the collection of additional environmental monitoring data to support future characterization of toxic contamination in the HSSCA project area. The future sampling recommendations are followed by recommendations for future data management practices that may streamline future secondary data assessments (Section 7.2). Recommendations are summarized in Section 7.3

7.1 Water Quality Assessment

Limited environmental monitoring data were collected from the HSSCA project area. As discussed in Section 3 and Section A-1 of Appendix A, much of the available data are metals concentrations for water column samples. As the POCs are metals, PAHs, and PCBs, additional samples need to be collected and analyzed for PAHs and PCBs. The objective of the next round of sample collection is to identify areas of potential contamination, based upon the source analyses presented in this report. If POCs are detected in the sample results from the potential areas of contamination, further source analysis may be necessary and additional sampling will be necessary to specifically delineate the actual area of contamination for remediation. For example, if PCBs are detected in a recommended grab sediment sample from an individual segment but are not detected in segments upstream or downstream of the segment with the detection, then additional, extensive sampling may be necessary in the segment with the detection to delineate the contaminated sediment.

At present, there are insufficient environmental monitoring data to identify and delineate contaminated segments of the streams throughout the HSSCA project area. Additional data need to be collected to locate areas of contamination. Until in-stream contamination is located and the contamination is delineated, it is not possible to thoroughly evaluate the fate and transport of POCs from their upland and riparian sources to the principal streams or eventually to North Maumee Bay. Also, future restoration and remediation activities cannot be completed until the areas of contamination are specifically identified and delineated. Once the areas of contamination are identified, additional sampling would be necessary for certain future remedial activities (e.g., transects of sediment samples along an area of contamination to define the exact area of sediment for removal).

Very limited water quality data are available from Michigan DEQ. The Department should sample sites where Halfway Creek flows over the Ohio-Michigan state line. Such samples could be used to assess the potential effects of Michigan's segments of Halfway Creek upon Ohio's segments of Halfway Creek and visa versa. Michigan DEQ should assess aquatic community health, human health (via fish tissue analyses), hydrology, sediment chemistry, and water chemistry.

The following subsections present recommendations for future environmental monitoring; additional data, including maps and a table, are presented in Appendix E. These recommendations are for the Ohio portion of the HSSCA project area. A synopsis of recommended future sampling in Ohio is presented in Table 38.

Table 38. Summary of environmental sample recommendations

Sample type	Description	Number of samples
Aquatic community health	Fish (IBI and MIwb), macroinvertebrates (qualitative), and QHEI	9
Human Health	Fish tissue	2
Hydrology	Instantaneous discharge	17
Sediment	Metals and organics	30
	PCBs	15
Water column	Field parameters	50
	Metals and organics	12

Note: IBI = Index of Biotic Integrity; MIwb = Modified Index of well-being; QHEI = Qualitative Habitat Evaluation Index; PCBs = polychlorinated biphenyls.

7.1.1 Aquatic Community Health

Fish, macroinvertebrates, and habitat were evaluated at sites throughout the lower segments of Halfway, Silver, and Shantee creeks since the 1980s. Often, only a few sites were monitored in a given year. To fully assess the impacts of toxic pollution in the HSSCA project area upon aquatic life, many sites should be monitored within a single summer sample season, coincident with water column and sediment sample collection. As the aquatic communities integrate the effects of stressors over time, only a single set of samples will be necessary. Similarly, with the proper selection of habitat assessment sites, the QHEI also integrate factors that affect habitat over time.

The collection of additional fish and macroinvertebrate data, coupled with the collection of additional water column and sediment chemistry data, will allow for the assessment of the fate and transport of toxic pollutants from the potential sources identified in this report. Ohio EPA may use the fish data and calculated IBI and MIwb scores for the assessment of BUIs #3 (Degradation of fish and wildlife populations) and #4 (Fish tumors and other deformities). The Agency may also be able to use the qualitative evaluation of macroinvertebrate community health data for the assessment of BUI #6 (Degradation of benthos).

The monitoring of habitat and calculation of QHEI will inform the assessment of aquatic community health because habitat, along with other stressors, may be responsible for degrading aquatic community health. Ohio EPA may use QHEI data for the assessment of BUI #14 (Loss of fish and wildlife habitat).

While the primary objectives of the HSSCA are to support future activities in the HSSCA project area as related to the Maumee AOC, it may be beneficial to Ohio EPA to have fish and macroinvertebrates collected and habitat monitored by level III qualified data collectors. Such data could then also be used in other Ohio EPA programs (e.g., the total maximum daily load program)

Sites for future assessment of aquatic community health were selected base upon historic biological assessments, spills information, and regulated facilities information. Field biologists will have to determine the exact reaches to sample based upon local factors, such as site access, outfall location, streamflow, and depth. Additional biological data collection will allow for both spatial and temporal evaluations of aquatic community health and for the assessment of known and potential sources of toxic pollutants. Habitat should also be evaluated, through the QHEI, because poor habitat is another significant stressor that may affect aquatic community health as much as toxic pollution.

Recommendations:

Fish and macroinvertebrates should be collected to evaluate aquatic community health at nine locations in the HSSCA project area (see maps and Table E-1 in Appendix E). One round of sampling is recommended.

QHEI should be evaluated, following Ohio EPA (2006) habitat monitoring protocol, at the nine locations of fish and macroinvertebrate collection to evaluate aquatic habitat. One round of sampling is recommended.

7.1.2 Human Health

In Ohio, threats to human health from waterbodies are typically evaluated through fish tissue analyses. Fish were last collected from Silver and Shantee creeks in 1993 and their tissues were evaluated for metals, PCBs, and pesticides. While no fish consumption advisories were issued, metals, PCBs, and pesticides were detected. Since fish were last collected in 1993, hundreds of spills and releases of toxic material to the waterways of the HSSCA project area have occurred. Ohio EPA encountered difficulties catching enough fish for tissue analysis in 1993 and such difficulties may be encountered in the future; the Agency should attempt to sample the same locations.

The collection of additional fish tissue data, coupled with the collection of additional water column and sediment chemistry data, will allow for the assessment of the fate and transport of toxic pollutants from the potential sources identified in this report. Ohio EPA may also use the fish data for the assessment of BUI #1. (Restriction on fish and wildlife consumption)

Recommendation:

Fish should be collected, following Ohio EPA (2012a) fish tissue sampling protocol, at the two sites previously evaluated in 1993 (P11S60 and P11S99) and should evaluate the fish tissues for metals and PCBs. One round of sampling is recommended.

7.1.3 Hydrology

The hydrography and hydrology of the HSSCA project area is complex. Streams and ditches have been channelized, re-routed, culverted, and piped underground. The collection of instantaneous discharge will support a better characterization of the hydrography of the HSSCA project area. Additionally, when instantaneous discharge is measured during the collection of water column samples, the discharge data may be used with POCs data to calculate loads.

Recommendation:

Instantaneous discharge should be monitored at 17 sites, following Ohio EPA (2012b) flow monitoring protocol, in the HSSCA project area (see maps and table in Appendix E). One round of monitoring is recommended.

7.1.4 Water Column

Water column samples were collected throughout the HSSCA project area, but only five samples were collected during Ohio EPA's recent sample collection effort in 2011. Additionally, only one of the five 2011 water column samples was evaluated for organic constituents. Only one round of sampling is recommended, with the objective of ensuring that no sources are actively discharging PAHs or PCBs to the surface waterways in the HSSCA project area. Should PAHs or PCBs be detected, additional water column samples may need to be collected to determine the source(s) of the PAHs and PCBs. Metals were detected in Ohio EPA's 2011 sampling and will likely be detected in future water column samples. Only one round of sampling is recommended at this time. If metals concentrations exceed the OMZA or OMZM standards, additional sampling may be necessary to locate anthropogenic sources of metals.

The collection of additional water column data will allow for the assessment of the fate and transport of toxic pollutants from the potential sources identified in this report. Along with QHEI, fish, macroinvertebrate, and sediment chemistry data, water column chemistry data may help in the assessment of stressors that degrade aquatic community health.

Similar to data collection to evaluate aquatic community health, it may be beneficial to Ohio EPA to have samples collected monitored by level III qualified data collectors. Such data could then also be used in other Ohio EPA programs (e.g., the total maximum daily load program).

Sites for future water column sample collection were selected base upon historic sampling, spills information, and regulated facilities information. Field staff will have to determine the exact locations to sample based upon local factors, such as site access, outfall location, streamflow, and depth. Additional water chemistry data will allow for both spatial and temporal evaluations and for the assessment of known and potential sources of toxic pollutants. The monitoring of field parameters (i.e., conductivity, dissolved oxygen, ph, and temperature) is also recommended for biological and sediment sampling. The monitoring of field parameters is also recommended for additional sites that are not anticipated to have high levels of POCs (e.g., urban residential storm sewersheds). Ohio EPA used a YSI meter to monitor field parameters in the past (Ohio EPA 2011) that would be sufficient for future monitoring.

Recommendations:

Field parameters should be monitored at 50 sites in the HSSCA project area (see maps and Table E-1 in Appendix E).

7.1.4.1 Metals

Ohio EPA, Michigan DEQ, and Toledo DES evaluated water column samples for a combined 14 metals, including arsenic and mercury (Section 3.5.1 and Appendix C). While selenium and silver were never detected, the following 12 metals were detected in one or more samples:

- Aluminum
- Arsenic
- Cadmium
- Chromium (total)
- Chromium (hexavalent)
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Zinc

Future water column samples should be evaluated for these 12 metals. In 2011, Ohio EPA only evaluated water column samples for arsenic, cadmium, chromium (total), copper, lead, nickel, and selenium; Ohio EPA's laboratory used U.S. EPA method 200.8 (Ohio EPA 2011). Method 200.8 may be used to analyze samples for 10 of the 12 recommended metals analyses; method 200.8 cannot be used to detect chromium (hexavalent) or iron (U.S. EPA 2007a).

Given limited time and budget, metals detected at levels that exceed the WQSs are recommended as a higher priority than metals that were detected below WQSs or were not detected. The prioritization is summarized in Table 39.

Table 39. Prioritization of recommended water column metals analyses

High priority	Medium priority	Low priority [c]
▪ Chromium ▪ Copper ▪ Lead ▪ Mercury ▪ Zinc	▪ Aluminum ▪ Arsenic ▪ Cadmium ▪ Manganese ▪ Nickel	▪ Chromium (hexavalent) ▪ Iron

Notes
a. High priority metals were previously detected above WQSs in samples collected by Ohio EPA in 2011 or by Toledo DES.
b. Medium priority metals were previously detected below WQSs or were not detected in samples collected by Ohio EPA in 2011.
c. Low priority metals cannot be detected using Method 200.8 (U.S. EPA 2007a).

Hardness and total suspended solids (TSS) should be evaluated for all water column samples that are analyzed for metals. Hardness data are necessary since metals WQSs vary by hardness. TSS should be sampled for future evaluation of habitat degradation and the impacts of urban stormwater runoff, which directly affects habitat (e.g., flashy flows with more stream power increase stream bank erosion). Ohio EPA used U.S. EPA method 160.2 to detect TSS (Ohio EPA 2011) in 2011; this method should be used for future sampling.

Recommendations:

Water column (12 sites) samples should be collected, throughout the HSSCA project area and evaluated for metals, hardness, and TSS (see maps and Table E-1 in Appendix E).

- Samples should be collected following Ohio EPA (2012b) protocol, and samples should be evaluated following Ohio EPA (2010b) laboratory methods.
- Pending available resources, metals should be evaluated using the scheme presented in Table 39.
- One round of monitoring is initially recommended; additional water column chemistry sampling may be necessary if metals are detected above WQS in the initial round of sampling.

7.1.4.2 Organic Constituents

Ohio EPA evaluated water column samples for organic constituents (e.g., volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs]) in 1992, 1994, and 2011; the results are summarized in Section 3.5.2. Excluding pesticides, only two organic constituents were detected in the water column (1,1,1-trichloroethane and chloroform) and no organic constituents were detected in the single water column sample that Ohio EPA collected in 2011.

Ohio EPA used U.S. EPA methods 624 and 625 to evaluate VOCs and SVOCs (respectively) in their 2011 samples (Ohio EPA 2007). Method 624 can detect 31 purgeable VOCs (U.S. EPA 2007b). Method 625 can detect 61 organic base/neutral extractables (including seven PCB cogeners), 11 acids extractables, and nine additional extractable parameters (U.S. EPA. 2007c).

Ohio EPA evaluated water column samples for purgeable VOCs with method 624 and SVOCs with method 625. Ohio EPA did not evaluate the water column samples for PCBs. The same methods and suites of constituents that Ohio EPA used in 2011 could be used for future sampling.

Recommendations:

Water column (12 sites) samples should be collected throughout the HSSCA project area and evaluated for organics (see maps and Table E-1 in Appendix E).

- Samples should be collected following Ohio EPA (2012b) protocol, and samples should be evaluated following Ohio EPA (2010b) laboratory methods.
- One round of monitoring is initially recommended; additional water column chemistry sampling may be necessary if organics are detected in the initial round of sampling.

7.1.5 Sediment

Limited stream bottom sediment samples were collected in the HSSCA project area, and only three samples were collected during Ohio EPA's recent sample collection effort in 2011. Recent and historic sediment samples contained elevated levels of POCs. The initial recommendation is for a single round of sample collection. The results of the initial round of sampling should be used to guide future activities (e.g., further characterization, remediation efforts). It is anticipated that sediment collected from headwaters residential areas contain minimal levels of POCs. Such results could be used as baseline data for the HSSCA project area for comparison with areas of known contamination. Areas that drain industrial and commercial properties, especially those with numerous spills, are expected to contain higher levels of POCs; such areas may require secondary rounds of sampling to further characterize the areas of contamination.

Sites for future sediment sample collection were selected base upon historic sampling, spills information, and regulated facilities information. Field staff will have to determine the exact locations to sample based upon local factors, such as site access, outfall location, streamflow, and depth. Field staff should sample areas of active sedimentation and should not sample sediment from areas that appear to be scoured. Additional sediment chemistry data will allow for better spatial and temporal evaluations. Sediment data will also support the assessment of known sources of toxic pollutants and may be evaluated with water column chemistry and biological data to assess aquatic community health. The collection of sediment chemistry data will not directly assist Ohio EPA with the assessments of any BUIs.

7.1.5.1 Metals

Ohio EPA evaluated sediment samples for 11 metals, including arsenic and mercury (Section 3.6). While selenium was never detected, the following 10 metals were detected in one or more samples:

- Aluminum
- Arsenic
- Cadmium
- Chromium (hexavalent)
- Copper
- Iron
- Lead
- Mercury
- Nickel
- Zinc

Future sediment samples should be evaluated for these 10 metals. Refer to Ohio EPA (2011b) for the laboratory analytical methods used in 2011 and to Ohio EPA (2010b) for all of the Agency's laboratory methods.

All of these metals were regularly detected in stream bottom sediment samples collected in 1992, 1994, and 2011. Therefore, the previously identified suite of metals and laboratory methods should be used to analyze future sediment samples.

Recommendations:

Sediment (30) samples should be collected throughout the HSSCA project area and evaluated for metals, percent solids, and total organic carbon (see maps and Table E-1 in Appendix E).

- Samples should be collected following Ohio EPA (2001) sediment sampling protocol, and samples should be evaluated following Ohio EPA (2010b) laboratory methods.
- Samples should be evaluated for the 10 metals listed in the beginning of Section 7.1.5.1.
- One round of monitoring is initially recommended. Future sampling will depend upon the evaluation of the initial round of samples and the specific objectives of future activities.

7.1.5.2 Organic Constituents

Ohio EPA collected three sediment samples in 2011 and evaluated them for 86 organic constituents and six PCB cogeners (Section 3.6; Appendix E). Fourteen organic constituents, including two PCB cogeners, were detected (Table 8). The laboratory analysis methods that Ohio EPA used to evaluate for organic compounds in 2011 is presented in Table E-2 of Appendix E; refer to Ohio EPA (2010b) for all of the Agency's laboratory methods, with reporting limits.

Due to the limited number of previous samples (i.e., three), it is recommended that all of the future sediment samples be evaluated for the full suite of parameters that Ohio EPA selected for their 2011 samples, with the exception of PCBs. The sediment samples to be collected at certain sites should be evaluated for PCBs; PCBs were not detected in two of three samples collected in 2011 and are not anticipated to be detected in certain samples (e.g., a single family home residential development).

Recommendations:

Sediment samples (30) should be collected throughout the HSSCA project area and evaluated for organics (see maps and Table E-1 in Appendix E). One round of monitoring is initially recommended.

- Samples should be collected following Ohio EPA (2001) sediment sampling protocol, and samples should be evaluated following Ohio EPA (2010b) laboratory methods.
- One round of monitoring is initially recommended. Future sampling will depend upon the evaluation of the initial round of samples and the specific objectives of future activities.

Of the total 30 sediment samples, PCBs should be evaluated for 15 samples (see maps and Table E-1 in Appendix E).

- Samples should be collected following Ohio EPA (2001) sediment sampling protocol, and samples should be evaluated following Ohio EPA (2010b) laboratory methods.
- One round of monitoring is initially recommended; additional sediment chemistry sampling may be necessary if PCBs are detected in the initial round of sampling.

7.2 Data Management

Tetra Tech spent considerable time identifying and acquiring third party data for the HSSCA. Future data acquisition efforts could be streamlined if records are maintained electronically and if GIS is implemented. Such improvements would benefit both the entity that seeks data and the third party that maintains the data.

7.2.1 Electronic Records

Tetra Tech recommends that all records be compiled electronically. Considerable time was spent by state and local government agencies to manually search paper records. Tetra Tech staff had to travel to Toledo to review some hardcopy documents. Significant resources were expended by Tetra Tech and government regulatory agencies to determine which facilities and spills were within the HSSCA project area and to identify previous studies:

- Michigan DEQ WRD manually searched paper files of spills records in file cabinets using hardcopy maps.
- Ohio EPA DERR requires the submission of all VAP documents in hardcopy. The single VAP Project in the HSSCA project area has dozens of bound reports (Section A-2.10 of Appendix A).
- Toledo DES staff manually searched spills records using addresses and hardcopy maps.
- Toledo Division of Engineering Services only has hardcopies of many reports (Section A-5.1 of Appendix A).

Manual searching of hardcopy documents is time-consuming. Additionally, scanned reports are also time-consuming for Tetra Tech to review. If documents were maintained electronically in their original format (e.g., Microsoft Word™), then the documents' content would be electronically searchable and the documents would be easier to navigate.

In the future, if government agencies required the submission of documents in original electronic format and maintained searchable databases of the documents, then the documents could be more easily located and reviewed.

Recommendations:

State and local regulatory agencies should compile their documents in original electronic format and create electronic databases of their documents.

State and local regulatory agencies should require contractors and consultants to submit new documents in their original electronic format and should scan old documents into electronic formats.

7.2.2 Geographic Information Systems

Tetra Tech recommends the integration of GIS into facilities and spills records databases maintained by state and municipal government regulatory agencies. Much of the data acquisition phase of the HSSCA relied upon obtaining third party facilities and spills records that excluded geographic coordinates. In contrast, relatively little time was spent with many of the U.S. EPA databases, as they included geographic coordinates; some databases included spatial data to plot in GoogleEarth™ or could be plotted in a U.S. EPA-maintained online plotting application. Significant resources were expended by Tetra Tech and government regulatory agencies to determine which facilities and spills were within the HSSCA project area for the state and municipal non-georeferenced datasets:

- Michigan DEQ WRD manually searched paper files of spills records in file cabinets using hardcopy maps.
- Toledo DES staff manually searched spills records using addresses and hardcopy maps.
- Tetra Tech geocoded Ohio EPA general NPDES industrial stormwater permittees that are stored in an electronic database with street addresses.

- Tetra Tech geocoded BUSTR USTs and LUSTs records that are stored in electronic databases with street addresses.

Additionally, none of these datasets included a field for watershed. Thus, the manual searching occurred at the township-scale (Michigan DEQ spills records) and city-scale (Toledo DES). Geocoding was implemented at the city-scale while the databases were organized by county.

Manual searching and georeferencing records are a time-consuming process. In cases where the area-of-interest is small compared to the organization of the database (e.g., a small watershed that is a tiny portion of a county), much of the time may be consumed identifying records outside of the area-of-interest.

In the future, if geographic coordinates were recorded when agency personnel respond to spills complaints, the records could be electronically saved in a geodatabase and plotted in GIS. With georeferenced records, agency staff can rapidly identify which records are in a particular watershed of interest. Agencies would also be able to more easily perform spatial analyses if all records are plotted in GIS.

Recommendations:

Federal, state, and local regulatory agencies should include the following in all permits for regulated facilities and spills and releases reports:

- geographic coordinates of the facilities or properties
- geographic coordinates of the outfalls, spills, and releases (as applicable),
- receiving waterbody (as applicable)
- 12-digit HUC that the facilities or properties are within.

State government regulatory agencies should plot permitted facilities and spills reports in an online, searchable mapping program similar to U.S. EPA's Envirofacts's *EnviroMapper* (http://www.epa.gov/emefdata/em4ef.home) or Michigan DEQ's *Michigan Environmental Mapper* (http://www.mcgi.state.mi.us/environmentalmapper/)

7.3 Compilation and Summary of Recommendations by Agency

Recommended activities are summarized by government agency in this section.

7.3.1 Michigan DEQ

- WRD should include 12-digit HUCs on the general NPDES stormwater permittees lists. WRD could plot NPDES permitees on online mapping software similar to how the Department plots USTs, LUSTs, and Part 201 sites on its *Michigan Environmental Mapper* (http://www.mcgi.state.mi.us/environmentalmapper/).
- WRD should include geographic coordinates of spills, receiving waterbodies, and 12-digit HUCs in the Division's spills reports. WRD could plot spills reports on online mapping software similar to how the Department plots USTs, LUSTs, and Part 201 sites on its *Michigan Environmental Mapper* (http://www.mcgi.state.mi.us/environmentalmapper/).
- WRD should sample sites along Halfway Creek just upstream and just downstream of the Ohio-Michigan state line to assess the effects of each states' waters upon the other state. WRD should evaluate aquatic community health, human health (via fish tissue assessment), hydrology, sediment chemistry, and water column chemistry.

7.3.2 Ohio BUSTR

- BUSTR should include geographic coordinates of USTs and 12-digit HUCs in the Bureau's OTTER database. BUSTR could plot USTs and LUSTs on online mapping software similar to how Michigan DEQ plots USTs and LUSTs on its *Michigan Environmental Mapper* (http://www.mcgi.state.mi.us/environmentalmapper/).

7.3.3 Ohio EPA

- DSW (Division of Surface Water) should include geographic coordinates of stormwater outfalls, receiving waterbodies, and 12-digit HUCs on the online general NPDES stormwater permittees lists. DSW could plot industrial and marina stormwater on online mappers similar to how the Division plots individual NPDES permitees (http://wwwapp.epa.ohio.gov/dsw/gis/npdes/index.php).
- DSW should sample 50 sites within the Ohio portion of the HSSCA project area. The following should be monitored or collected: aquatic life (9 sites), field parameters (50 sites) fish tissue (2 sites), habitat (9 sites), sediment chemistry (28 sites), and water column chemistry (12 sites).
- DERR should include the 12-digit HUC in its spills reports and include 12-digit HUC as a searchable field in its electronic databases. DERR could plot spills reports on online mapping software similar to how the Division plots VAP projects on its *VAP 2008-2012: Summaries of CNS Projects* (http://www.epa.state.oh.us/derr/vap_cns_projects.aspx).
- DERR should require VAP projects to submit electronic versions of the materials for the *No Further Action* letter and *Covenant Not To Sue*.
- DERR should include pre-2008 VAP projects on its *VAP 2008-2012: Summaries of CNS Projects* (http://www.epa.state.oh.us/derr/vap_cns_projects.aspx) and should include geographic coordinates for post-2008 VAP projects on its VAP list.

7.3.4 Toledo Division of Engineering Services

- The Division of Engineering Services should require contractors to submit electronic versions of their documents.
- The Division of Engineering Services should electronically scan older reports written by contractors.

7.3.5 U.S. EPA

- Region 5 should include receiving waterbody and 12-digit HUC on its *On-Scene Coordinators* website (https://epaosc.org/site/region_list.aspx?region=5) as a searchable field. As GoogleEarth™ files can be downloaded for specific OSC spills reports, U.S. EPA could compile the data and then plot them on an online mapper.

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- Carbamates in Surface and Wastewater, Method 531.1
- Chlorinated Acid Herbicides in Surface and Wastewater, Method 515.1
- Fish Tissue Matrix, Consumption [metals]
- Glyphosate in Surface and Wastewater, Method 547
- Organic Compounds, SAS305 in Water
- Organic Compounds, SAS310 in Water
- Organochlorine Pesticides and PCBs in Aqueous Hazardous Waste, Method 8081A & 8082
- Organochlorine Pesticides and PCBs in Fish Tissue
- Organochlorine Pesticides and PCBs in Sediment and Soil, Method 8081A & 8082
- Organochlorine Pesticides and PCBs in Surface and Wastewater, Method 608

- Sediment, Regular Method [metals]
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- VOC Analysis in Hazardous Waste, Method 8260
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- VOC Analysis in Wastewater & Surface Water, Method 624

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Appendix A.

Data Inventory

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Abbreviations and Acronyms

BUSTR	Bureau of Under Ground Storage Tank Regulations (State Fire Marshal's Office)
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CO	Central Office (Ohio EPA)
CSO	combined sewer overflow
DERR	Division of Emergency Response and Revitalization (Ohio EPA)
DSW	Division of Surface Water (Ohio EPA)
FRS	Facility Registry System
HSSCA	Halfway, Silver, and Shantee Creeks Analysis
JDO	Jackson District Office (Michigan DEQ)
LUST	leaking underground storage tank
Michigan DEQ	Michigan Department of Environmental Quality
Michigan DTMB	Michigan Department of Technology, Management, and Budget
Michigan LARA	Michigan Department of Licensing and Regulatory Affairs
NPDES	National Pollutant Discharge Elimination System
NWDO	Northwest District Office (Ohio EPA)
NWIS	National Water Information System
ODOT	Ohio Department of Transprotation
Ohio EPA	Ohio Environmental Protection Agency
OSC	on-scene coordinator
PAH	polycyclic aromatic hydrocarbon [1]
PCB	polychlorinated biphenyl
QHEI	Qualitative Habitat Evaluation Index
RCRAInfo	Resource Conservation and Recovery Act Information database
SEMS	Superfund Enterprise Management System
TRI	Toxic Release Inventory
TSCA	Toxic Substance Control Act
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey (U.S. Department of the Interior)
UST	underground storage tank
WRD	Water Resources Division (Michigan DEQ)

[1] Polycyclic aromatic hydrocarbons are also known as polynuclear aromatic hydrocarbons.

A-1. Environmental Data

Environmental data were obtained from multiple state and federal agencies. These data include information on biological community health; habitat; fish tissue; sediment chemistry; surface water chemistry; groundwater; and flows. Figure A-1 shows and Table A-1 lists the various locations where the biological, habitat, sediment chemistry, and surface water chemistry data have been collected.

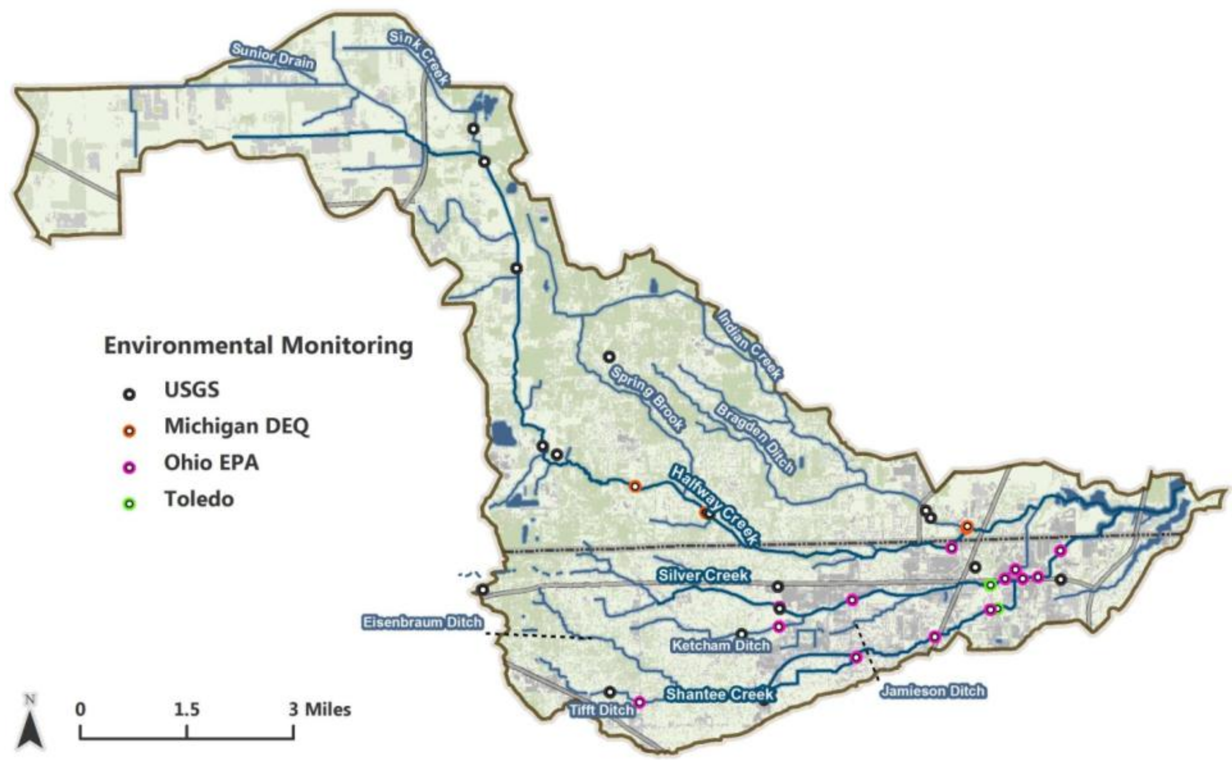

Figure A-1. Environmental sampling sites in the HSSCA project area.

Table A-1. Sites sampled by Ohio EPA and Michigan DEQ

RM [a]	Site name	Site ID	Use	Agency
Shantee Creek (HUC 04100001 03 01)				
Ketcham Ditch				
0.43	Ketcham Ditch at Toledo at Jackman Road	P11A01	LRW	Ohio EPA
Shantee Creek				
--	Shantee Creek at Toledo at Douglas Road	301916	LRW	Ohio EPA
2.90 3.10	Shantee Creek Diversion at Toledo at Lewis Avenue	P11S96	LRW	Ohio EPA
--	Shantee Creek Diversion at Laskey Road (lower crossing)	P11K66	LRW	Ohio EPA
2.10 1.60	Shantee Creek Diversion at Toledo at Detroit Avenue	P11S62	MWH	Ohio EPA
0.70	Shantee Creek Diversion at Toledo at Stickney Avenue	P11S60	MWH	Ohio EPA
--	Shantee Creek	#21	MWH	Toledo
0.10	Shantee Creek Diversion at Toledo at Enterprise Boulevard [b]	P11S80	MWH	Ohio EPA
Silver Creek				
4.60 4.70	Silver Creek at Toledo at Jackman Road	P11P30	LRW	Ohio EPA
5.11	Silver Creek at Toledo at Douglas Road	P11K68	LRW	Ohio EPA
4.64 4.50	Silver Creek at Toledo at Lewis Avenue	P11S79	LRW	Ohio EPA
2.50	Silver Creek at Toledo at U.S. Route 24 (Telegraph Road)	P11K67	LRW	Ohio EPA
--	Silver Creek	#20	MWH	Toledo
2.30	Silver Creek at Toledo adjacent to East Alexis Road near Raintree Parkway	P11S99	MWH	Ohio EPA
1.70 1.10	Silver Creek at Toledo at Futura Drive	301449	MWH	Ohio EPA
1.05	Silver Creek at Toledo at Hagman Road	P11P31	MWH	Ohio EPA
Silver Creek Cutoff				
1.00	Old Silver Creek at Toledo at Benore Road	P11S78	MWH	Ohio EPA
Tifft Ditch				
0.66	Tifft Ditch at Toledo at Secor Road	P11S97	LRW	Ohio EPA
Halfway Creek (HUC 04100001 03 02)				
Halfway Creek				
--	Halfway Creek at Secor and Underhill roads	580586	OIALW	Michigan DEQ
--	Halfway Creek at Smith Road	580056	OIALW	Michigan DEQ
4.88 5.10	Halfway Creek near Ohio/Michigan border at East State Line Road	301448	WWH	Ohio EPA
--	Halfway Creek downstream of Bedford WWTP	580450	OIALW	Michigan DEQ
Indian Creek				
--	Indian Creek upstream of Bedford WWTP	580449	OIALW	Michigan DEQ

Notes

HUC = hydrologic unit code; LRW = limited resource water; MWH = modified warmwater habitat due to channel modification; OIALW = Other Indigenous Aquatic Life and Wildlife; RM = river mile; WWTP = wastewater treatment plant.

Sample sites are listed by HUC and waterbody from top to bottom as headwaters to mouth.

A double dash indicates that fish and macroinvertebrates or QHEI were not monitored at the site.

a. River mile(s) reported with the fish, macroinvertebrate, and Qualitative Habitat Evaluation Index monitoring data for Ohio EPA sites.

b. Site no longer exists as Shantee Creek was re-routed and the channel at this location was filled in.

A-1.1 Biological Community Health

Fish and macroinvertebrate data were obtained from the Ohio EPA Division of Surface Water (DSW) at the Northwest District Office (NWDO). Macroninvertebrate data were obtained from Michigan DEQ Water Resources Division (WRD) at the Jackson District Office (JDO). The data included fish and macroinvertebrate taxa, compiled metric data, metric scores, and index scores. In Ohio, the fish community health indices are the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb); the macorinverterbrate index for community health is the Invertebrate Community Index (ICI). In Michigan, the index for macroinvertebrate community health is Procedure 51.

Fish data collection was limited to the lower reaches of Halfway Creek and Silver and Shantee creeks in Ohio (Figure A-2) and macroinvertebrate data collection occurred at the same locations in Ohio and three locations in Michigan along Halfway Creek (Figure A-3). Fish and macroinvertebrate community health index scores tended to be poor in Ohio and macroinvertebrate scores were better in Michigan.

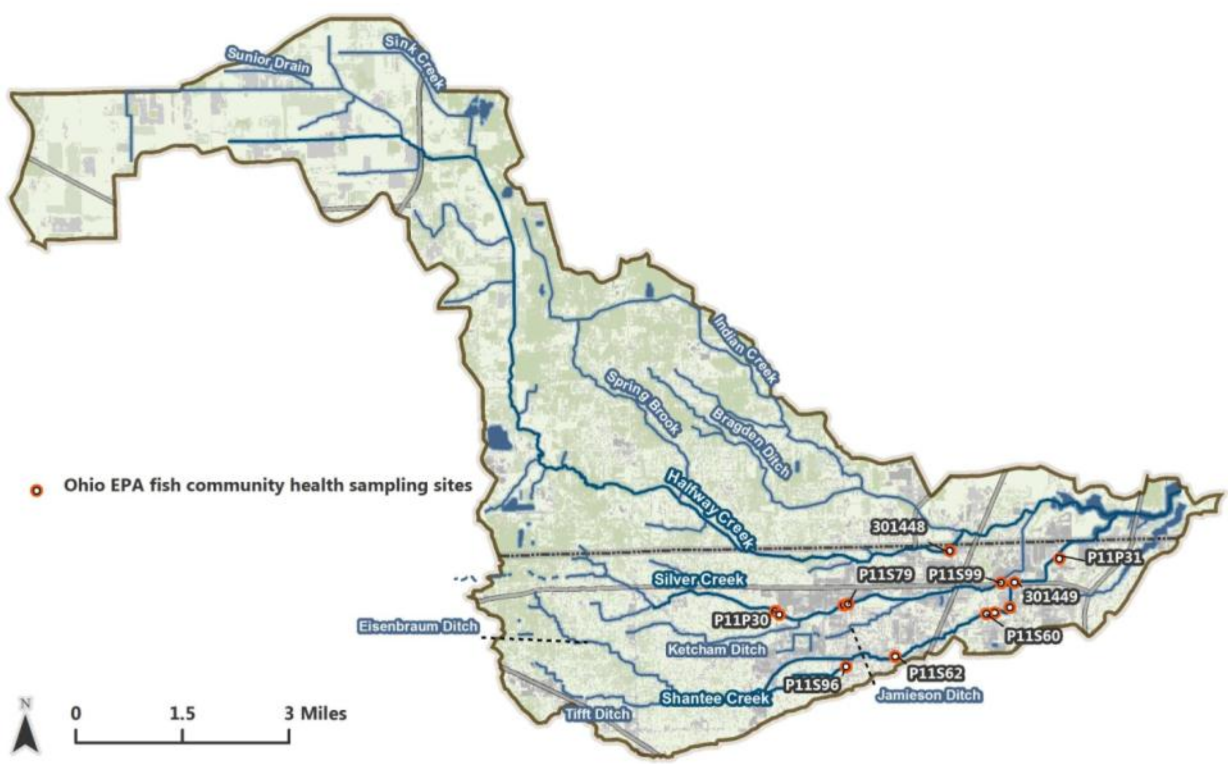

Figure A-2. Fish community health sampling sites in the HSSCA project area.

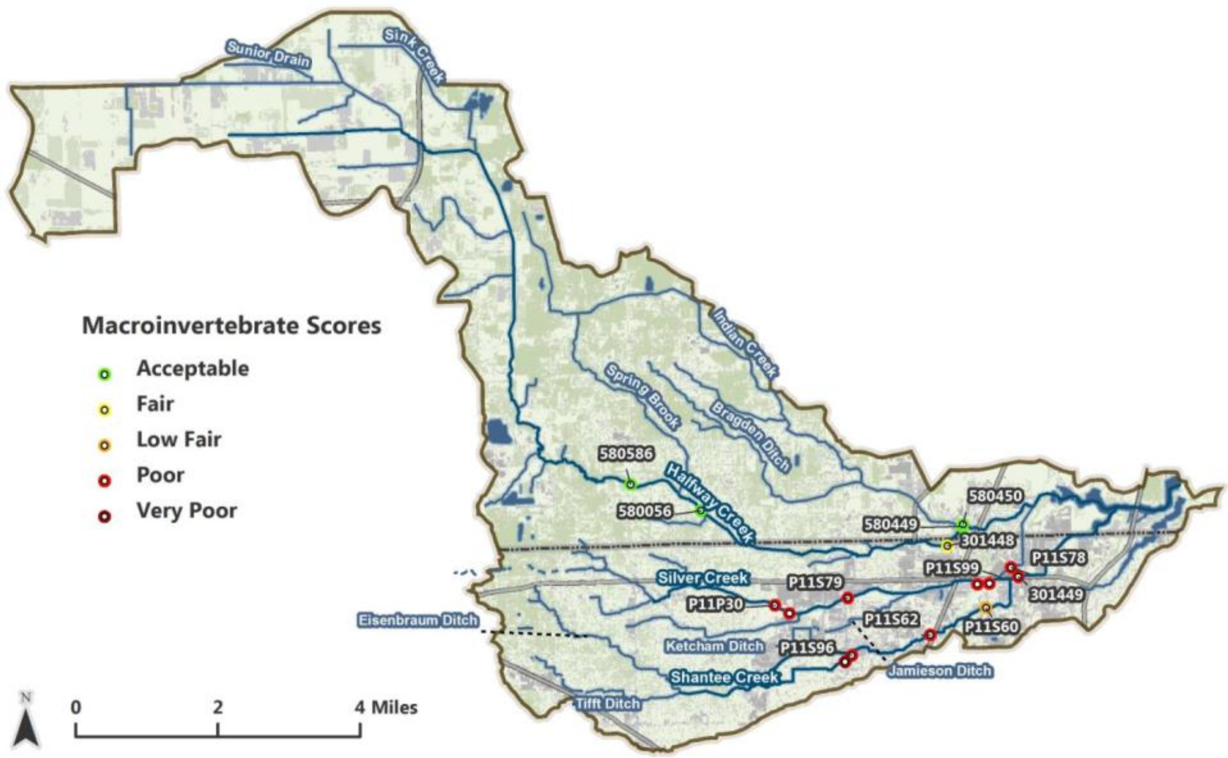

Figure A-3. Macroinvertebrate community health sampling sites in the HSSCA project area.

Ohio EPA (2014c) collected fish and macroinvertebrate data and calculated community health index scores for Shantee and Silver creeks in 1992, 1993 and 2011; Halfway Creek was only sampled in 2011 (Table A-2). The data were primarily collected in the lower reaches of each stream (Figure A-2 and Figure A-3). IBI scores were typically poor with most scores on Silver and Shantee creeks between 12 and 16;

Table A-2. Summary of fish and macroinvertebrate data provided by Ohio EPA

Stream	Site	RM	Data year	Number of samples		
				IBI	MIwb	ICI [a]
Shantee Creek (HUC 04100001 03 01)						
Shantee Creek	P11S96	3.10	1993	12	2.002	--
			2011	12	0.563	Very Poor
		2.90	1993	--	--	Poor
	P11S62	2.10	1993	14	1.710	--
		1.60	1992		--	Poor
	P11S60	0.80	1993	14	2.571	--
		0.70	1992	--	--	Poor
			2011	24	3.972	Low Fair
		0.60	1992	12	2.069	--
	P11S80	0.30	1992	12	1.071	--
		0.10	1993	--	--	Poor
Silver Creek	P11P30	4.70	1993	12	--	Poor
		4.60	1993	16	0.547	--
	P11S79	4.50	2011	16	0.781	Poor
	--	3.70	1992	12	0.172	--
	--	3.60	1992	--	--	Poor
	301449	1.40	1992	--	--	Poor
		1.20	1993	26	3.999	--
				18	4.330	--
		1.10	2011	16	6.976	Poor
Silver Creek (cutoff)	P11S78	1.00	1992	--	--	Poor
Halfway Creek (HUC 04100001 03 02)						
Halfway Creek	301448	5.10	2011	36	7.959	Fair

Source: Ohio EPA 2014c
Notes
IBI = Index of Biological Integrity; ICI = Invertebrate Community Index; MIwb = Modified Index of Well-Being.
Individual metric data and metric scores are available for each index.
a. All ICI scores are narrative only since only the number of qualitative taxa was monitored.

Michigan DEQ (2004, 2006, 2014d) collected benthic macroinvertebrate data and calculated index scores at two sites along Halfway Creek (-3 and -2) and one site on Indian Creek (-3) on September 13, 2000. Scores were also calculated for one site each from habitat data collected from Halfway Creek (-3) and Indian Creek (-1) on June 7, 2005. Finally, macroinvertebrate data were collected on June 30, 2010 at two sites on Halfway Creek and scores of -1 and -3 were calculated. All data were rated *acceptable*.

Ohio EPA (2014d) also provided macroinvertebrate data collected by students at Whitmer Senior High School, which is part of the Washington Local School District. The dataset includes ranges of the numbers of benthic macroinvertebrate taxa collected from Silver Creek at Clegg Drive from 1997 through 2011.

A-1.2 Habitat

Habitat data were obtained from Ohio EPA DSW at NWDO Michigan DEQ WRD at JDO. The data included attributes, metric scores, and the index score for the Qualitative Habitat Evaluation Index (QHEI). Similar to biological community health data, habitat data were sampled in the lower reaches of Halfway, Silver, and Shantee creeks and two ditches in Ohio. In Ohio, QHEI scores were creeks were very poor to fair, while habitat was rated fair or marginal along Halfway and Indian creeks in Michigan (Figure A-4).

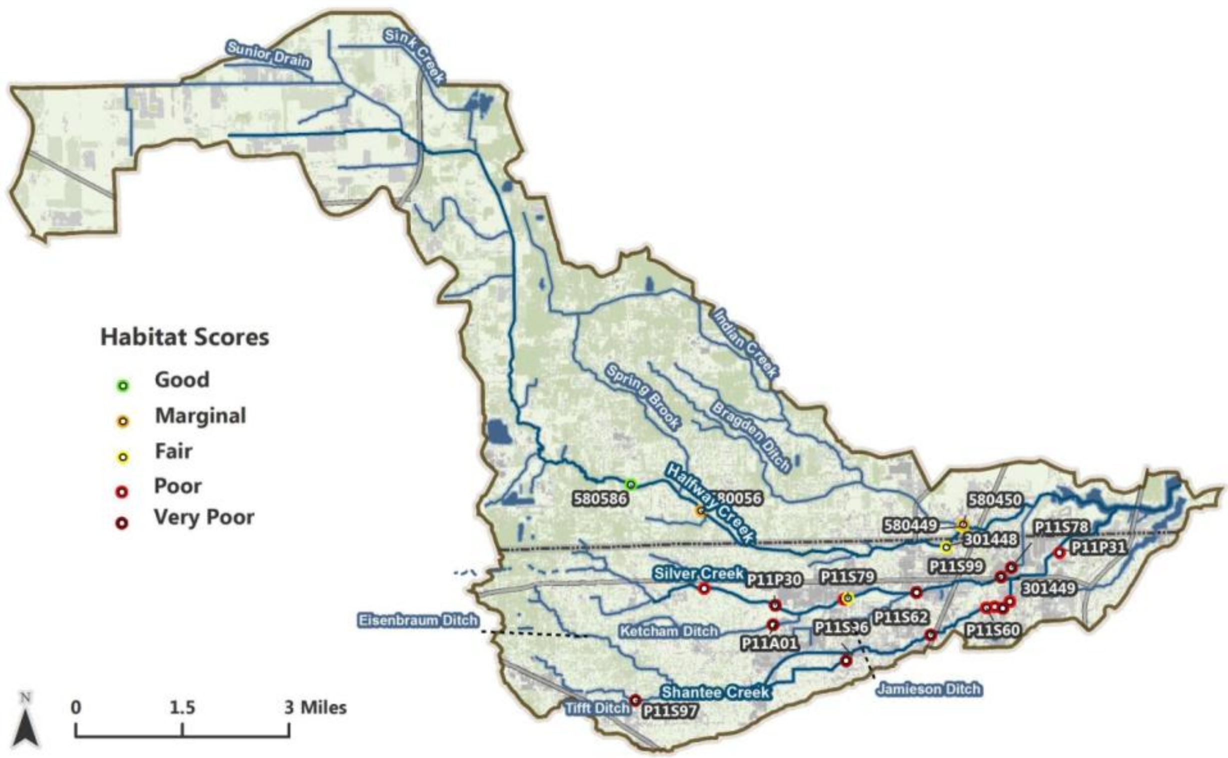

Figure A-4. Habitat monitoring sites in the HSSCA project area.

Ohio EPA (2014c) collected habitat data and calculated habitat quality index scores for Shantee and Silver creeks in 1992, 1993 and 2011; Halfway Creek was only sampled in 2011 (Table A-3). QHEI scores in Silver and Shantee creeks were typically poor and very poor; Halfway Creek had a fair QHEI score. A subset of the Ohio EPA data was reported in STORET (U.S. EPA 2014n); these data are not presented herein.

Table A-3. Summary of habitat data provided by Ohio EPA

Stream	Data years	No. of QHEI sites	QHEI scores [a]	
			Numeric	Narrative
Shantee Creek (HUC 04100001 03 01)				
Ketcham Ditch	1993	1	21	Very Poor
Shantee Creek	1992	2	35, 38	Poor
	1993	6	20.5 - 23	Very Poor
	2011	2	29, 35	Very Poor, Poor
Silver Creek	1992	1	33.5	Poor
	1993	7	18 - 36	Very Poor - Poor
	2011	2	41, 43	Poor, Fair
Tift Ditch	1993	1	21	Very Poor
Halfway Creek (HUC 04100001 03 02)				
Halfway Creek	2011	1	50	Fair

Source: Ohio EPA 2014c
Notes
QHEI = Qualitative Habitat Evaluation Index.
Each site was monitored once within a given year.
Individual metric data and metric scores are available.
a All QHEI scores are for headwaters streams, except for Halfway Creek, which is a wading stream.

Michigan DEQ (2004, 2006, 2014d) collected habitat data and calculated habitat quality index scores at (1) two sites along Halfway Creek and one site on Indian Creek on September 13, 2000, (2) one site each along Halfway and Indian creeks on June 7, 2005, and (3) t two sites along Halfway Creek on June 30, 2010 (Table A-4). No Michigan DEQ habitat data were reported in STORET (U.S. EPA 2014n).

Table A-4. Summary of habitat data provided by Michigan DEQ

Stream	Site	Data year(s)	Habitat scores [a]	
			Numeric	Narrative
Silver Creek (HUC 04100001 03 01)				
Halfway Creek	580056	2000	47	Fair
		2010	104	Marginal
	580586	2010	116	Good
	580450	2000	41	Fair
		2005	91	Marginal
Indian Creek	580449[b]	2000	48	Fair
		2005	82	Marginal

Sources: Michigan DEQ 2004, 2006, 2014d
Notes
a. The habitat index in 2000 was out of 135 posible points. In 2005 and 2010, the index was out of 200 possible points.
b. In 2000, site 580449 (upstream of the Bedford WWTP) was identified as on Halfway Creek, while in 2005 the site was identified as on Indian Creek (Michigan DEQ 2006).

A-1.3 Fish Tissue

Fish tissue data were obtained from Ohio EPA DSW at NWDO and Central Office. Fish tissue data are available from samples collected in 1993 for Silver and Shantee creeks; however, streams in the HSSCA project area were not sampled during the Agency's recent sampling efforts from 2006 through 2011[2].In the Ottawa River watershed, Ohio EPA has collected fish tissue data for multiple studies (Ohio EPA 1991, 1998, 2000, 2002). No fish tissue data were collected by Michigan DEQ along Halfway Creek.

Ohio EPA collected five common carp from Silver Creek and two common carp from Shantee Creek on August 25, 1993 (Figure A-5). Fish tissue samples were evaluated for metals[3], pesticides, and PCBs[4], and these constituents were detected in fish samples collected from both streams (Ohio EPA 2014h).

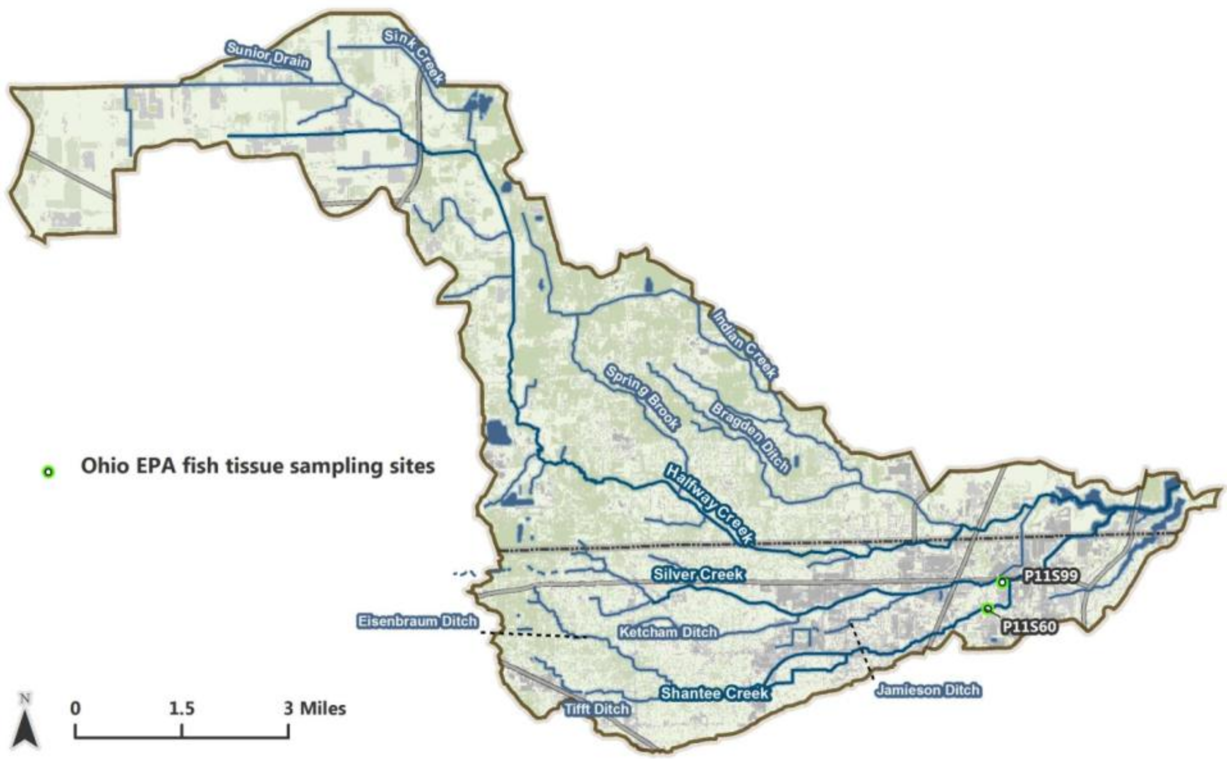

Figure A-5. Fish tissue sampling sites in the HSSCA project area.

[2] Fish tissue samples were evaluated from fish collected on the following waterbodies in the Maumee AOC (Ohio EPA 2014c): Duck Creek (2007, 1 site), Grassy Creek (2006, 1 site), the Maumee River (2008, 8 sites), the Ottawa River (2011, 5 sites), Otter Creek (2006, 1 site), Swan Creek (2006, 4 sites; 2008, 4 sites), and the Toussaint River (2008, 5 sites).
[3] Fish tissue samples were evaluated for five metals: arsenic, cadmium, lead, mercury, and selenium.
[4] Fish tissue samples were evaluated for seven PCB cogeners: 1016, 1221, 1242, 1248, 1254, and 1260.

A-1.4 Sediment Chemistry

In-stream bottom sediment chemistry data were obtained from Ohio EPA DSW at NWDO; no sediment chemistry data were available from Michigan DEQ. Ohio EPA sampled two locations each along the lower reaches of Silver and Shantee creeks in 1992 and one location each along lower Halfway, Silver, and Shantee creeks in 2011 (Figure A-6).

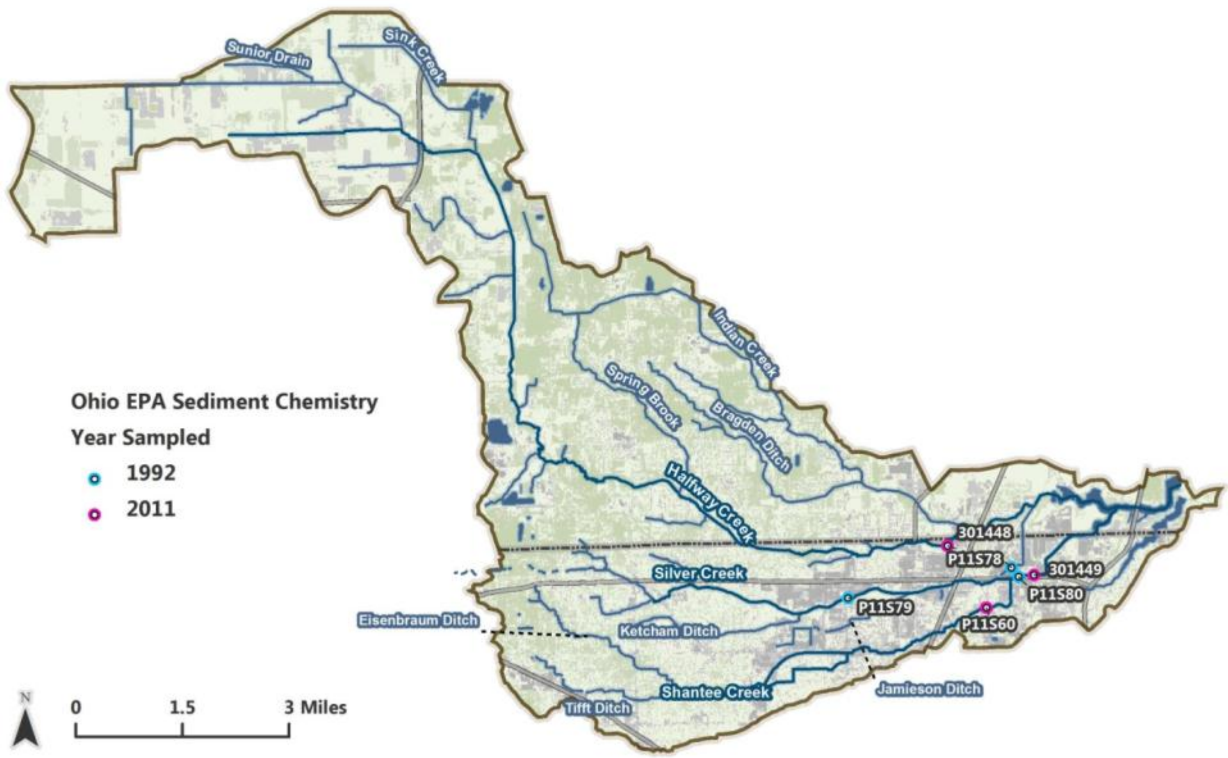

Figure A-6. Sediment chemistry sampling sites in the HSSCA project area.

Ohio EPA (2014c) sampled stream sediments on October 27, 1992 and August 30, 2011. In 1992, four locations were sampled and the sediment samples were evaluated for 14 metals[5]. In 2011, three locations were sampled and the samples were evaluated for 101 parameters, including metals (6)[6], polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs; 7)[7]. Few organic constituents were detected (Table A-5). A small subset of the Ohio EPA data was reported in STORET (U.S. EPA 2014n); these data are not presented herein.

[5] The fourteen metals evaluated from the October 27, 1992 sediment samples are: aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, sodium, strontium, and zinc.
[6] The six metals evaluated from the August 30, 2011 sediment samples are: cadmium, chromium, copper, lead, nickel, and zinc.
[7] The seven PCB aroclors evaluated from August 30, 2011 sediment samples are: 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

Table A-5. Summary of sediment chemistry data provided by Ohio EPA

Stream	Sample site	Detected constituents		
		Inorganic	Organic	
Halfway Creek	301448	▪ Cadmium ▪ Chromium ▪ Copper ▪ Lead ▪ Mercury ▪ Nickel ▪ Zinc	▪ Benz[a]anthracene ▪ Benzo[a]pyrene ▪ Benzo[b]fluoranthene ▪ Benzo[g,h,i]perylene ▪ Benzo[k]fluoranthene	▪ Chrysene ▪ Fluoranthene ▪ Indeno[1,2,3-cd]pyrene ▪ Phenanthrene ▪ Pyrene
Shantee Creek	P11S60		▪ Benz[a]anthracene ▪ Benzo[a]pyrene ▪ Benzo[b]fluoranthene ▪ Benzo[g,h,i]perylene ▪ Benzo[k]fluoranthene ▪ bis(2-Ethylhexyl)phthalate	▪ Chrysene ▪ Indeno[1,2,3-cd]pyrene ▪ PCB-1242 ▪ PCB-1260 ▪ Pyrene
Silver Creek	301449		▪ 2-Methylnaphthalene ▪ Benz[a]anthracene ▪ Chrysene	▪ Fluoranthene ▪ Phenanthrene ▪ Pyrene

Source: Ohio EPA 2014c
Note: Ohio EPA DSW collected sediment samples on August 30, 2011.

A-1.5 Surface Water Chemistry

In-stream water column chemistry data were obtained from Ohio EPA DSW at NWDO, Michigan DEQ WRD at JDO, and from the city of Toledo Department of Public Utilities Division of Environmental Services. Data were also downloaded from the U.S. Geological Survey's (USGS) National Water Information System (NWIS) and STORET. Ohio EPA collected samples at 10 sites between 1976 and 2011, Michigan DEQ collected samples at four sites between 2000 and 2010, Toledo collected samples at two sites between 1995 and 2013, and USGS collected samples at two sites between 1970 and 1991 (Figure A-7).

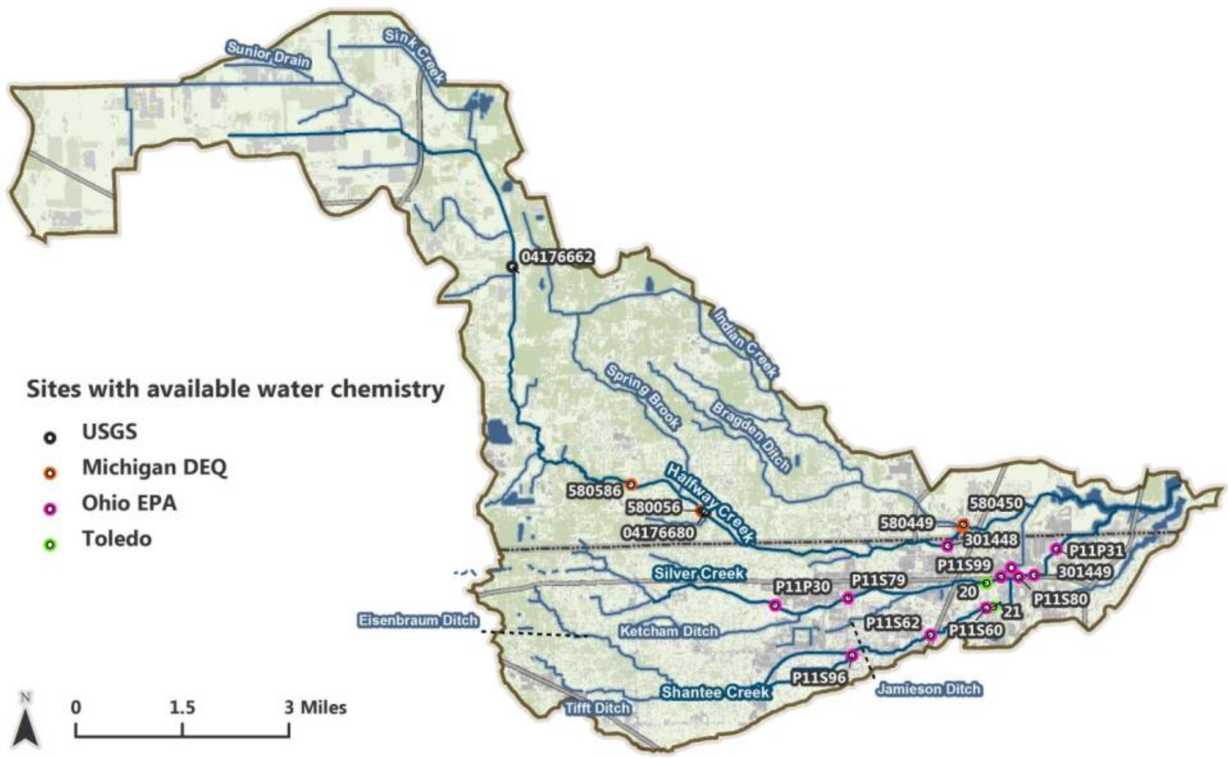

Figure A-7. Water chemistry sampling sites in the HSSCA project area.

Ohio EPA (2014d) collected surface water chemistry samples eight sites from 1979 through 1994 and at five sites in 2011 (Table A-6). Chloroform was detected in one sample from Silver Creek in 1994 and 1,1,1-trichloroethene was detected in one sample from Shantee Creek in 1992. During the most recent sampling efforts, no organic constituents were detected in Shantee Creek in 2011. Three pesticides were detected in once sample each at one or two sites on Shantee Creek in 1992: Eldrin, Methoxychlor, and Mirex. A small subset of the Ohio EPA data was reported in STORET (U.S. EPA 2014n); these data are not presented herein.

Table A-6. Summary of surface water quality data available from Ohio EPA

Stream	Site ID	Data year	Number of samples			
			Any	Metals	Organics	Pesticides
Shantee Creek (HUC 04100001 03 01)						
Shantee Creek	P11S96	2011	5	5	--	--
	P11S62	1987	1	1	--	--
	P11S60	1987	1	1	--	--
		1992	2	2	1	1
		1994	2	2	--	--
		2011	5	5	1	--
	P11S80	1992	2	2	1	1
		1994	2	2	--	--
Silver Creek	P11P30	1977	1	1	--	--
		1994	2	2	2	1
	P11S79	1992	2	2	1	--
		1994	2	2	--	--
		2011	5	5	--	--
	P11S99	1994	2	2	2	1
	301449	2011	5	5	--	--
	P11P31	1976	1	1	--	--
Halfway Creek (HUC 04100001 03 02)						
Halfway Creek	301448	2011	5	5	--	--

Source: Ohio EPA 2014d
Notes
Sites per stream are listed from top to bottom as headwaters to mouth.
HUC = hydrologic unit code.

Michigan DEQ (2004, 2006) collected surface water chemistry samples from one site each on Halfway and Indian creeks on September 13, 2000 and June 7, 2005. All four samples were evaluated for 7 transition metals[8], arsenic, and mercury. In 2000, only arsenic and zinc (one site) were detected. In 2005, arsenic, chromium (one site), copper, and zinc were detected. Michigan DEQ (2014d) also collected two samples from Halfway and Creek and one sample from Indian Creek on June 30, 2010; these samples were not evaluated for metals. A subset of the Michigan DEQ data was reported in STORET (U.S. EPA 2014n); these data are not presented herein.

The city of Toledo collected water chemistry samples from one site each on Silver and Shantee creeks from 1995 through 2013 (Toledo 2014a). The city typically collected 8-9 samples per year at both sites from 1995 through 2005 and 3-4 samples per year from2006-2013. The samples were evaluated for multiple parameters include eight transition metals[9] and mercury; samples were not evaluated for PAHs or PCBs. This is the largest dataset of metals water chemistry available for the project (Table A-7).

[8] The seven transition metals evaluated from the September 13, 2000 samples are: cadmium, chromium, copper, lead, selenium, silver, and zinc.
[9] The eight transition metals evaluated are: cadmium, chromium (hexavalent and total), copper, iron, lead, nickel, silver, and zinc.

Table A-7. Summary of surface water quality data from Toledo

Parameter [a]	Units	Data year(s)	Silver Creek (#20)			Shantee Creek (#21)		
			No. of samples [b]	No. of detects	Range of detects	No. of samples [b]	No. of detects	Range of detects
Cadmium	µg/L	1995-2013 [c]	104	2	1 - 29	102	1	2
Chromium (hexavalent)	mg/L	1997, 1999, 2004-2013	51	2	0.3 - 0.5	53	2	0.2 - 0.5
Chromium (total)	µg/L	1995-2013 [d]	65	21	1 - 480	71	26	15 - 648
Copper	µg/L	1995-2013 [c]	101	17	2 - 43	101	21	3 - 80
Lead	µg/L	1995-2013 [c]	102	9	1 - 15	101	13	0.8 - 44
Mercury	µg/L	1995-2013	113	19	0.2 - 6.2	112	22	0.2 - 304
Nickel	µg/L	1995-1997, 1999, 2004-2013	67	20	0.01 - 12	73	28	0.02 - 120
Silver	µg/L	2004-2010	24	0	--	24	0	--
Zinc	mg/L	1995-2013 [c]	92	77	0.01 - 243	93	76	0.01 - 230

Based upon: Toledo 2014a
Notes
mg/L = milligrams per liter; µg/L = micrograms per liter.
a. Parameters are reported as either total or dissolved and the data were combined for this table.
b. The number of samples includes samples that were not evaluated due to holding time exceedances.
c. No samples were evaluated for these parameters at either site in 1999.
d. No samples were evaluated for chromium (total) in 1998 and 2001-2002 at site #20 and 2000 and 2002 at site #21.

NWIS reports two sites sampled for surface water quality in Michigan NWIS (Table A-10); no sites are reported in Ohio (USGS 2014b). The samples collected in Michigan were not evaluated for metals, PAHs, or PCBs.

Table A-8. Summary of surface water quality data available in NWIS

Site ID	Site name	No. of samples	Data year(s)
04176662	Halfway Creek at Piehl Rd nr Whiteford Center, MI	1	1972
04176680	Halfway Creek at Smith Road near Lambertville, MI	9	1970-1973, 1990, 1991

Source: USGS 2014a

Ohio EPA also provided water chemistry data collected by students at Whitmer Senior High School, which is part of the Washington Local School District. Data were collected[10] at Silver Creek at Clegg Drive from 1992 through 2011 but do not include any toxic pollutants.

[10] The dataset contains the following parameters: biological oxygen demand, dissolved oxygen, fecal coliform, nitrates, pH, total phosphorus, total solids, turbidity, and water temperature.

A-1.6 Groundwater

Groundwater chemistry and water levels data were downloaded from NWIS. Seven wells are reported in NWIS within the HSSCA project area (Table A-9).The two wells in Ohio have data for one sample each collected on June 23, 1987 that was evaluated for metals (iron, manganese, strontium, and aluminum), nutrients, and major cations and anions (USGS 2014b). Similar data are available for the wells in Michigan, though more metals are available (USGS 2014a).[11]

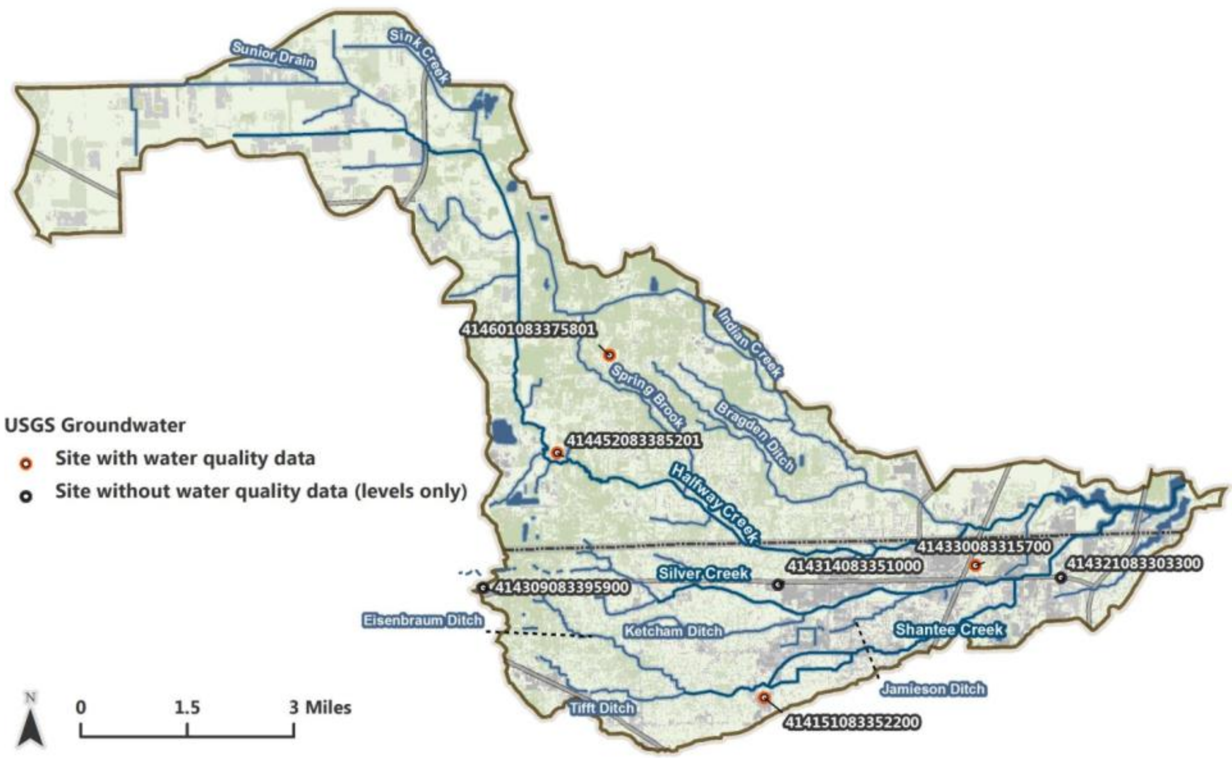

Figure A-8. Groundwater sampling sites in the HSSCA project area.

[11] Data for the following metals are available for one of the two samples each at the wells in Michigan: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lea, manganese, molybdenum, nickel, silver, strontium, vanadium, zinc.

Table A-9. Summary of groundwater chemistry data available in NWIS

Well name	Well ID	Water quality		Water level	
		No. of samples	Data year	No. of levels	Data year(s)
Shantee Creek (HUC 04100001 03 01)					
Dupont at Toledo, OH (LU-174-T)	414151083352200	1	1987	4	1986, 1987
LU-205-SY11 at Sylvania, OH (LU-205-SY11)	41430908339590	0	--	1	1975
LU-173-T	414314083351000	0	--	3	1986, 1987
LU-130-T	414321083303300	0	--	5	1986, 1987
Lucas Asphalt at Toledo, OH (LU-194-T)	414330083315700	1	1987	4	1986, 1987, 1990
Halfway Creek (HUC 04100001 03 02)					
08S 07E 31BBB Monroe Co. (Well G-29)	414452083385201	2	1991	149	1991-2010
08S 07E 19 DCA01 Monroe Co. (Well G-30)	414601083375801	2	1991, 1992	145	1991-2010

Source: USGS 2014a,b

A-1.7 Flow

Flow data were downloaded from NWIS. No continuously recording flow gages are operated by USGS in the HSSCA project area. Ten sites with instantaneous flow data are reported by NWIS in the HSSCA project area (Figure A-9 and Table A-10). Seven sites are in Michigan (USGS 2014a), and three sites are in Ohio but no data are available for them (USGS 2014b).

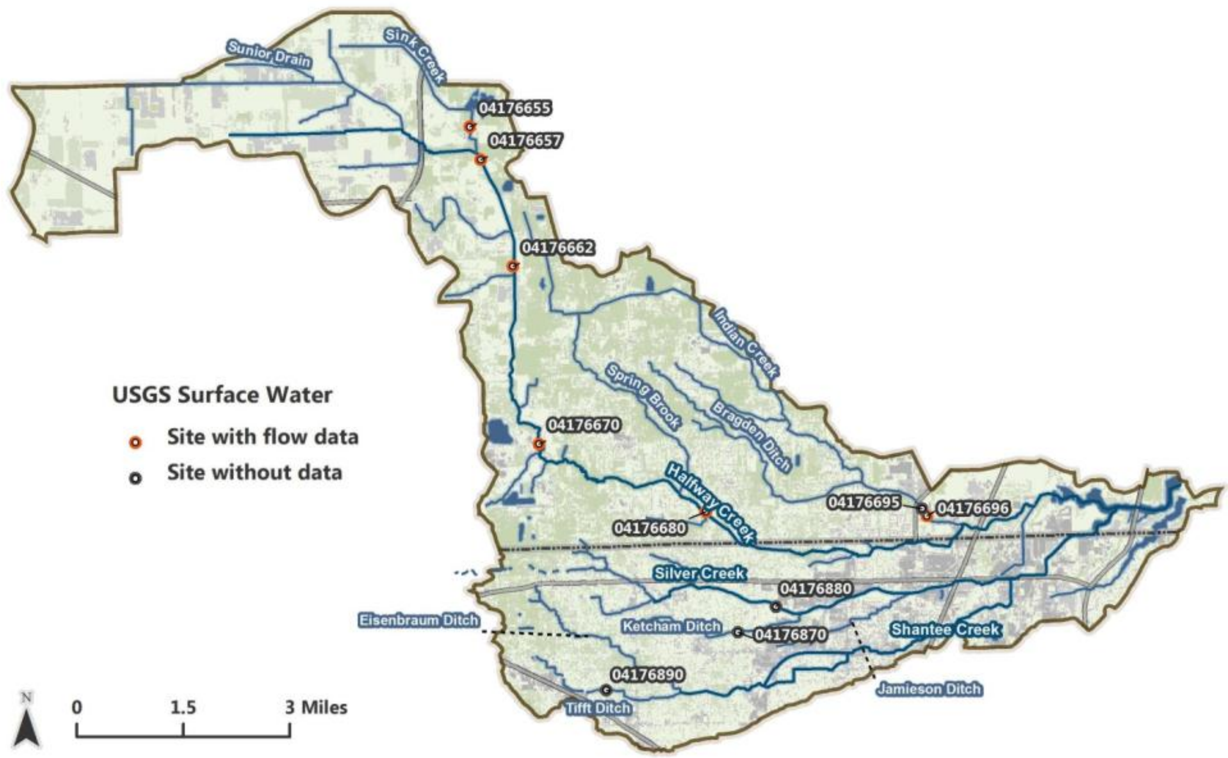

Figure A-9. Flow monitoring sites in the HSSCA project area.

Table A-10. Summary of flow data available in NWIS

Site ID	Site name	No. of flows	Data year(s)
Shantee Creek (HUC 04100001 03 01)			
04176870	Ketcham Ditch on Rowland Road at Toledo, OH	n/a	--
04176880	Silver Creek on Jackman Road at Toledo, OH	n/a	--
04176890	Tift Ditch on Fox Glove Road at Toledo, OH	n/a	--
Halfway Creek (HUC 04100001 03 02)			
04176655	Hoegel Drain at School Road near Samaria, MI	2	1971, 1972
04176657	Halfway Creek at Samaria Road near Samaria, MI	2 [a]	1971, 1972
04176662	Halfway Creek at Piehl Rd nr Whiteford Center, MI	1	1972
04176670	Halfway Creek at Sterns Road near Lambertville, MI	1	2003
04176680	Halfway Creek at Smith Road near Lambertville, MI	10	1967-1991
04176695	Indian Creek at Lavoy Road near Temperance, MI	n/a	--
04176696	Trib to Indian Creek near Temperance, MI	1 [a]	2003

Sources: USGS 2014a,b
Notes
n/a = not available
a. These records show no surficial flow (i.e., dry streams).

A-2. Facilities and Spills Data

Facilities that discharge to the environment are permitted by federal and state government agencies. U.S. EPA, Ohio EPA, and Michigan DEQ permit facilities and entities to discharge to surface waters through the National Pollutant Discharge Elimination System (NPDES). These agencies maintain databases of these facilities and databases of the monitoring data required of the facilities in the NPDES permits.

Additionally, facilities with the potential for unpermitted discharges to the environment are regulated by federal and state government agencies. U.S. EPA maintains databases for such facilities. Much of the data were obtained through U.S. EPA's Envirofacts[12] websites. The following is a summary of 290 records obtained through EnviroMapper and using GIS to identify facilities in the HSSCA project area (U.S. EPA 2014a):

- Air Facility System (22 sites)
- Cleanup and Redevelopment Exchange System (1 site)
- Hazardous Waste Report (13 sites)
- Comprehensive Environmental Response, Compensation, and Liability Information System (5 sites)
- Greenhouse Gas Reporting Program (2 sites)
- Permit Compliance System and Integrated Compliance Information System (8 sites)
- Radiation Information (no sites)
- Resource Conservation and Recovery Act Information (268 sites)
- Toxic Release Inventory (21 sites)
- Toxic Substances Control Act (2 sites)

A-2.1 Facility Registry System

U.S. EPA maintains the Facility Registry System (FRS) that is a database of all facilities subject to various federal environmental regulations (U.S. EPA 2006). The FRS database includes location and contact information along with facility type information (i.e., Standard Industrial Classification, North American Industry Classification System).

FRS tabular and spatial data were obtained from publically accessible Envirofacts websites maintained by U.S. EPA (U.S. EPA 2013a, 2014a). Over 76,000 FRS facilities are in Ohio and 488 are in the HSSCA project area (Figure A-10). Data for individual facilities were not downloaded; such data can be obtained later, as necessary.

FRS data are also searchable through FlexViewer. Flex Viewer is online, interactive mapping software used for interagency response to environmental threats (U.S. EPA 2014c). Tetra Tech is able to access a restricted version of the Flex View software for contractors. FlexViewer includes FRS as a spatial data layer and the attribute information include links to U.S. EPA websites for FRS data.

[12] Envirofacts (http://www.epa.gov/envirofw/) is an online, mappable, and searchable database maintained by U.S. EPA. Searches can be performed within specific databases or across all databases.

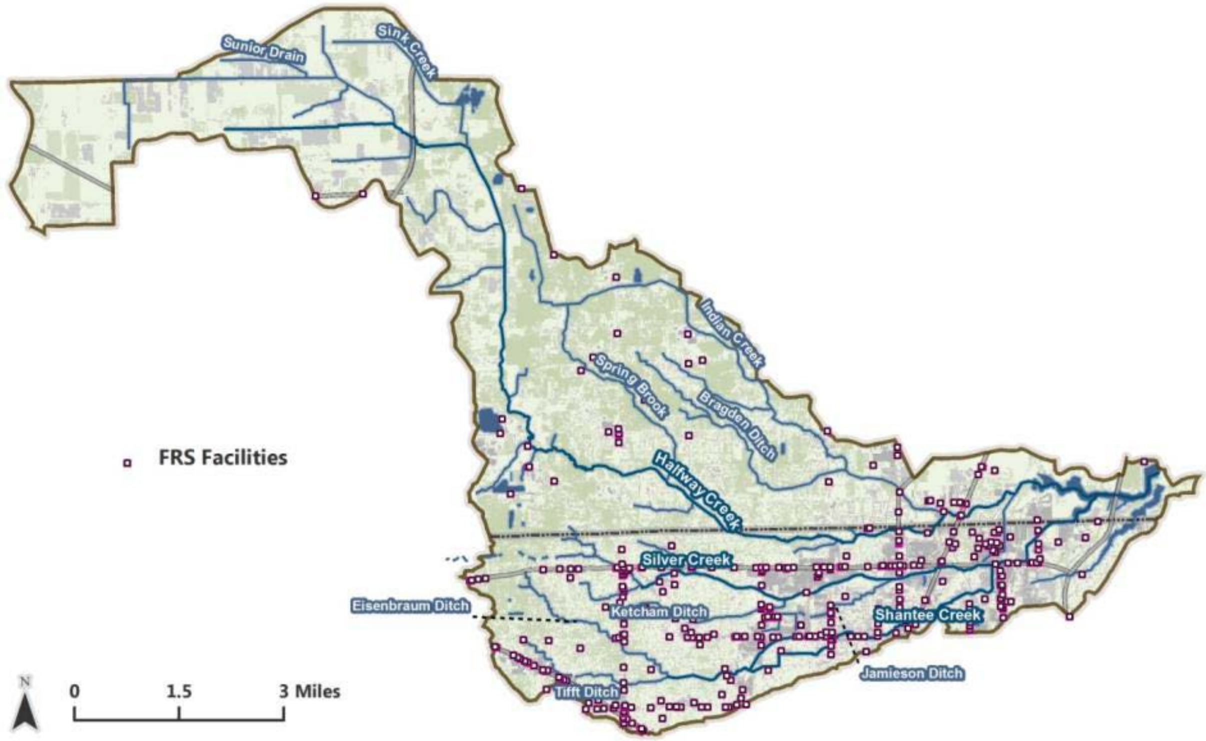

Figure A-10. FRS facilities in the HSSCA project area.

A-2.2 NPDES Permittees

Six facilities are covered by individual and general NPDES permits for non-stormwater discharges. Eight facilities are or were covered by individual NPDES permits for stormwater discharges, while numerous industrial facilities and construction sites are or were covered by general NPDES permits for stormwater discharges. The city of Toledo is covered by an individual NPDES permit for stormwater from a municipal separate storm sewer system (MS4), while five additional communities are covered by general NPDES permits for MS4 stormwater.

There are no confined animal feeding operations, confined animal feeding facilities[13], and biosolid application fields (i.e., land application of sewage sludge to agricultural fields) in the HSSCA project area. While the city of Toledo is a combined sewer overflow (CSO) community; no CSO outfalls discharge to streams in the HSSCA project area.

A-2.2.1 Non-Stormwater

Six facilities (non-stormwater) are permitted through NPDES (Figure A-11, Table A-11). No facilities in Ohio have general NPDES permits (non-stormwater) and one facility in Michigan has a general permit (non-stormwater). DMR data were provided by Michigan DEQ (2014c)[14], Ohio EPA (2014f), and U.S. EPA (2014e).

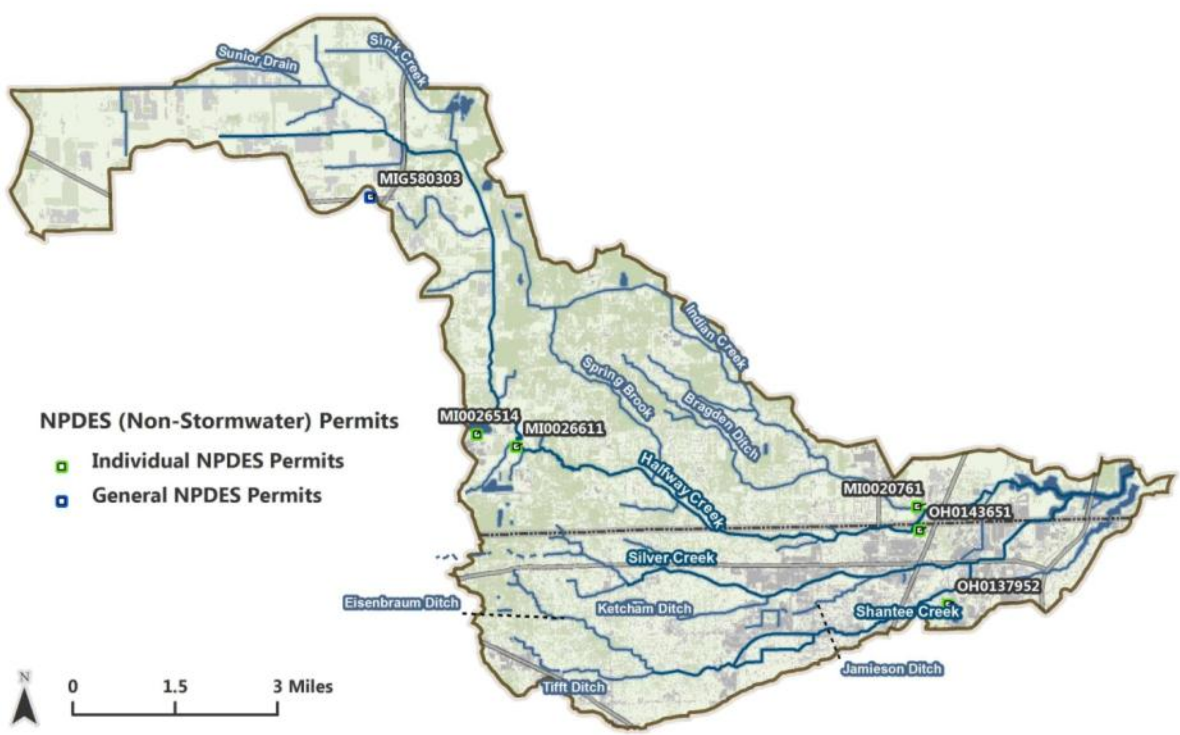

Figure A-11. Individual and general NPDES permits (non-stormwater) in the HSSCA project area.

[13] Confined Animal Feeding Facilities are permitted by the Ohio Department of Agriculture, Division of Livestock Environmental Permitting. Permits to install and permits to operate are issued by the Division under the authority of the Ohio Revised Code.

[14] Michigan DEQ only retains records for 15 years per Michigan's records retention policy. After 15 years, records are destroyed. DMR data are included within this policy.

Table A-11. Facilities with NPDES permits (non-stormwater)

NPDES ID	Ohio EPA ID	Facility name	Design flow (mgd)	DMR years
MI0020761	--	Bedford Township WWTP	6.0	2003-2013
MI0026514	--	Stoneco Inc. - Ottawa Lake	8.0	2003-2013
MI0026611	--	Bedford Meadows WWTP [a]	0.03	2003-2013
MIG580303	--	Pilot Travel Center 26-Monroe	n/a	2008, 2010, 2012
OH0137952	2PR00218	Grimes, Inc	0.003	2005-2013
OH0143651	2IN00244	Northwest Bioenergy LLC	sludge[b]	n/a [c]

Sources: Michigan DEQ 2012, 2014c*;* Ohio EPA 2011a, 2012, 2014f; U.S. EPA 2014e

Notes

DMR = discharge monitoring report; LLC = limited liability company; mgd = million gallons per day; n/a = not applicable; NPDES = National Pollutant Discharge Elimination System; WWTP = wastewater treatment plant.

a. Bedford Meadows WWTP is also known as Stoney Trails Apartments.

b. Northwest Bioenergy LLC is only permitted to land-apply, landfill, or transfer sludge and biosolids; the facility is not permitted to discharge to surface waters.

c. Sludge and biosolid monitoring data are not applicable to this study; therefore, DMR data were not obtained.

The Bedford Township WWTP is a major sanitary sewer treatment facility (Michigan DEQ 2012); it is required to monitor numerous parameters, including metals and PAHs. Reports and data submissions associated with additional monitoring requirements, including toxicity reports, for Bedford Township WWTP were obtained from Michigan DEQ (2014c). Stoneco Inc's Ottawa Lake is a major discharged that is permitted to discharge limestone mine dewatering water and stonewash water (Michigan DEQ 2012b); the facility is not required to monitor or permitted to discharge metals, PAHs, and PCBs. . Reports and data submissions associated with additional monitoring requirements, including toxicity reports, for Stoneco were obtained from Michigan DEQ (2014c).

The Bedford Meadows WWTP (formerly known as Stoney Trails Aparments) is a small, sanitary package treatment plant for an apartment complex; the facility is not required to monitor or permitted to discharge metals, PAHs, and PCBs (Michigan DEQ 2013a). The Pilot Travel Center has a general NPDES permit for a wastewater stabilization lagoon that discharges seasonally.

Grimes Inc. is a small sanitary wastewater treatment facility (Ohio EPA 2010a); the facility is not required to monitor or permitted to discharge metals, PAHs, and PCBs. Northwest Bioenergy LLC is only permitted to land apply Class B biosolids, landfill sewage sludge or biosolids, and transfer sewage sludge or biosolids to another NPDES permittee (Ohio EPA 2012).

A-2.2.2 Facilities with NPDES Permits for Stormwater

Construction sites and industrial facilities have individual or general NPDES permits for stormwater in the HSSCA project area (Figure A-12). No marinas are permitted for industrial stormwater in the project area. Permitee facility or site and ownership information was obtained from publicly available websites maintained by Ohio EPA DSW or directly from Michigan DEQ. DMR data were obtained directly from Ohio EPA DSW (Ohio EPA 2014e,g).

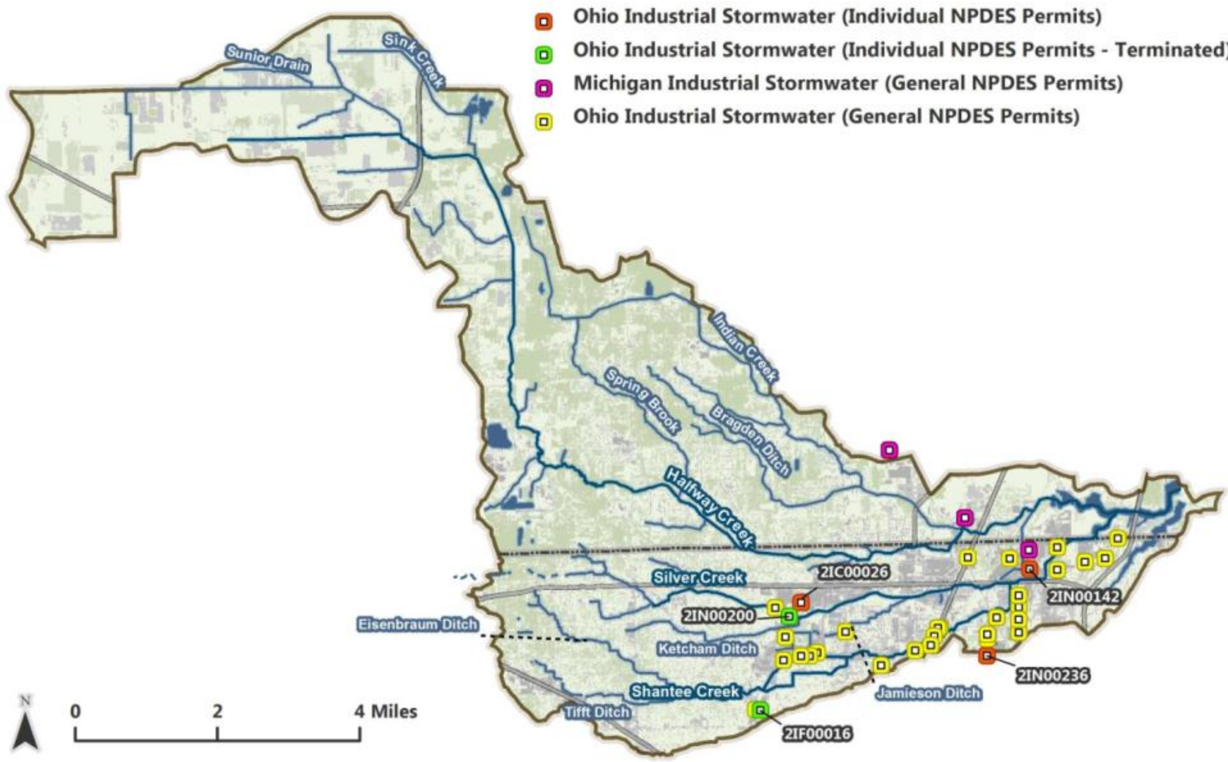

Figure A-12. Individual and general NPDES permittees for industrial activities stormwater.

In Ohio, three facilities currently have individual NPDES permit coverage for industrial stormwater and two additional facilities formerly had permit coverage (Table A-12). None of the facilities monitor metals, PAHs, or PCBs; all of the facilities report flow and oil and grease concentration.

Table A-12. Facilities with NPDES permits for industrial stormwater

NPDES ID	Ohio EPA ID	Facility name	Design flow (mgd)	DMR years
OH000534	2IF00016	E.I. DuPont De Nemours & Company, Inc [a]	terminated	1995-2010
OH0002640	2IC00026	General Motors LLC	--	1995-2013
OH0116181	2IN00142	Lucas County Landfill LLC	--	2010-2013
OH0130516	2IN00200	Racer Trust [b]	terminated	2003-2013
OH0142042	2IN00236	All Ohio Ready Mix Stickney	--	2010-2013

Sources: Ohio EPA 2005, 2008, 2010a,b, 2014e,g
Note: DMR = discharge monitoring report; LLC = limited liability company; mgd = million gallons per day; NPDES = National Pollutant Discharge Elimination System.
a. E.I. DuPont De Nemours & Company, Inc is also known as Axalta Coating Systems LLC - Toledo Plant.
b. Racer Trust is also known as Remediation and Liability Management.

In Lucas County, there are 571 general permittees for stormwater associated with large and small construction sites (OHC000004), 91 general permittees for stormwater associated with industrial activities (OHR000005), and 58 facilities maintain no exposure certification (Ohio EPA 2014p). Due to limited spatial information, the number of construction site permitees in the HSSCA project area was not determined.[15] Approximately 17 industrial facility permitees are in the HSSCA project area.[16] The number of no exposure permittees in the HSSCA project are was not determined due to limited spatial information.[17] As the objective of this document is to identify potential datasets for future analyses, additional effort was not expended to properly plot all general NPDES stormwater permittees.

Three industrial facilities have general NPDES permits for stormwater in the Michigan portion of the HSSCA project area (Michigan DEQ 2014e):

- Heidtman Steel Products (MIS210202)
- Vienna Junction Landfill (MIS210973)
- Fischer Tool & Die Corp (MIS210990)

A-2.2.3 Regulated MS4s

Six communities have individual or general NPDES permits for stormwater associated with regulated municipal separate storm sewer systems (MS4s; Table A-13). The city of Toledo is the only Phase I MS4 in the HSSCA project area. Three Phase II MS4s are in southeast Monroe County in the greater Toledo area (Michigan DEQ 2014e). Lucas County and Others is the one of the five Phase II MS4s in the HSSCA project area and Sylvania and Washington townships are co-permitees with Lucas County. The Ohio Department of Transportation (ODOT) is a non-traditional Phase II MS4; ODOT is responsible for stormwater associated with interstate route 75 and state route 184 in northern Lucas County (ODOT 2005, 2012).

[15] Construction site addresses from construction sites, lots, and co-permitees were geocoded and plotted in GIS. Numerous locations could not be plotted due to a variety of issues (e.g., site address was not reported, nearby road intersection was reported as the site address, the owner address outside of Lucas County was reported as the site address).
[16] Industrial facility addresses were geocoded and plotted in GIS. Only 78 of the 91 permitees plotted in Lucas County. Seventeen of the 78 industrial facilities plotted in the HSSCA project area. Nine of the 13 facilities that did not plot are identified as being in Toledo and could be in the HSSCA project area.
[17] No exposure certifications were geocoded and plotted in GIS. For reasons unknown, geocoding was only successful for 12 of the 58 facilities in Lucas County; of those 12, three facilities plotted in the HSSCA project area.

Table A-13. Communities with NPDES permits for regulated MS4 stormwater

NPDES ID	Ohio EPA ID	Permitee name	Permit type	DMR years
MIS040018	--	Bedford Township MS4-Monroe	Phase II MS4	--
MIS040033	--	Erie Township MS4-Monroe	Phase II MS4	--
MIS040044	--	Monroe County Drain Commission MS4	Phase II MS4	--
--	2GQ00006	Lucas County & Others	Phase II MS4 [a]	--
OH0111635	2PI00003	city of Toledo	Phase I MS4	--
OHQ000002	4GQ00000	ODOT	Phase II MS4 [a]	--

Sources: Michigan DEQ 2014e*;* Ohio EPA 2014p
Notes
DMR = discharge monitoring report; NPDES = National Pollutant Discharge Elimination System; ODOT: Ohio Department of Transportation.
a. Ohio EPA permits Phase II MS4s as *Small MS4s*.

A-2.3 Part 201 Sites

Properties in Michigan that are contaminated above certain thresholds, from a source other than regulated USTs, may be investigated and remediated under the Environmental Remediation Program of Michigan DEQ's Remediation and Redevelopment Division. The Environmental Remediation Program will provide state funding for remediation of 201 sites[18] without responsible parties and will provide technical guidance for sampling, monitoring, well installation, modeling, and investigations (Michigan DEQ 2013b). Five 201 sites are in the Michigan portion of the Halfway Creek watershed (Michigan DEQ 2014b). All five 201 sites are in Monroe County, Michigan (Figure A-13, Table A-14). Additional data are available for the following three sites: Erie Coatings, Stevens Landfill, and Cooper Industries Lambertville (Michigan DEQ 2014g; U.S. EPA 2014f).

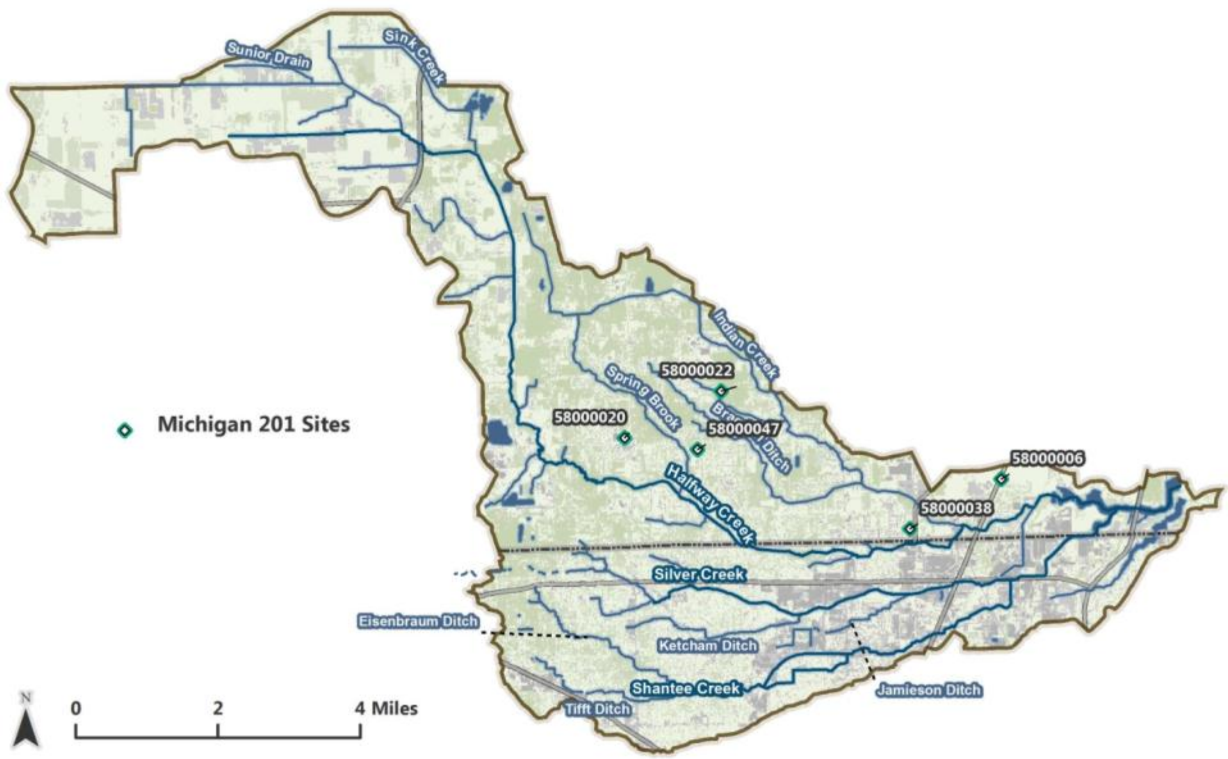

Figure A-13. 201 sites in the HSSCA project area.

Table A-14. 201 site records in Michigan

Site ID	Site name	County
58000006	Erie Coatings	Monroe
58000020	Secor and Stern Roads well	Monroe
58000022	Stevens Landfill	Monroe
58000038	Town Meadows North Mobile Home Park	Monroe
58000047	Cooper Industries Lambertville	Monroe

Source: Michigan DEQ 2014b

[18] The "201" in "201 sites" refers to Part 201 of the Michigan Natural Resources and Environmental Protection Act (NREPA), which is Act 451 of 1994.

A-2.4 Resource Conservation and Recovery Act Information

The Resouce Conservation and Recovery Act Information (RCRAInfo) database is a publically available database of hazardous waste transportation. U.S. EPA maintains the database to track hazardous waste generators, handlers, treaters, storers, and disposers (U.S. EPA 2013b).

The online RCRAInfo was queried through Envirofacts using 11 zip codes[19] that compose most of the HSSCA project area (U.S. EPA 2014a,k). Of the 623 facilities in these 12 codes, 266 facilities[20] are in the HSSCA project area (Figure A-14). Data for individual facilities were not downloaded; such data can be obtained later, as necessary.

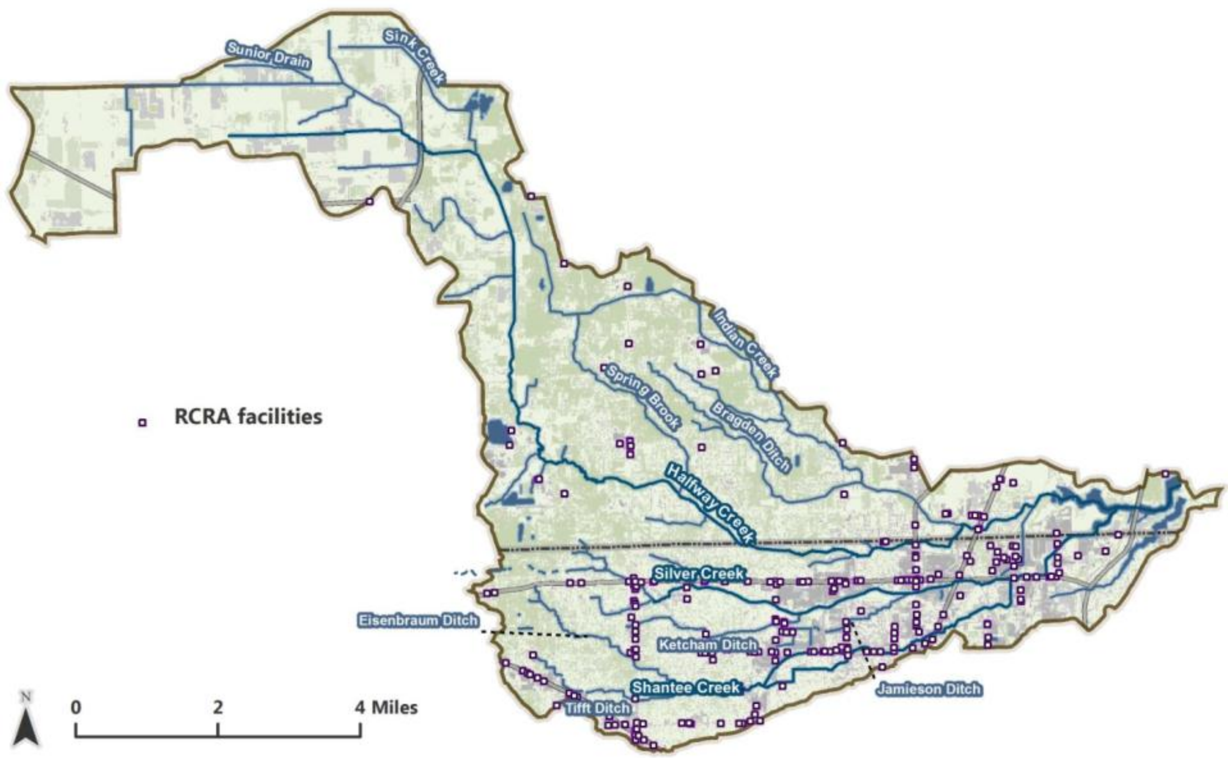

Figure A-14. RCRA facilities in the HSSCA project area.

[19] The 11 zip codes that compose most of the project area are 43611, 43612, 43613, and 43623 in northern Lucas County, OH and 43560, 48133, 48144, 48182, 49228, 49267, and 49276 in southeast Michigan.

[20] The query of RCRA sites through the RCRAInfo search in Envirofacts (U.S. EPA 2014k) yielded 266 results. A search for all regulated facilities through EnviroMapper for Envirofacts yielded 268 RCRA records (U.S. EPA 2014a). The discrepancy may be the result of errors with the zip code or geographic coordinates in the facilities' records. The discrepancies were not further investigated but could be investigated, if necessary, later in the project.

A-2.5 Spills Reports

Spills, releases, and other unpermitted discharges to the environment are illegal. Federal, state, and municipal government regulatory agencies respond to and investigate reported spills and releases. Such agencies are also involved in remediation efforts.

The government regulatory agencies maintain databases of spills reports that include pertinent information associated with the investigated spills. In the HSSCA project area, the following four agencies investigate spills and maintain records of the spills: U.S. EPA, Ohio EPA, the city of Toledo, and Michigan DEQ.

It is also noteworthy that the Toledo Blade typically reports upon significant spills in the HSSCA project area. Using the Google News™ archive of scanned issues and electronic versions of more recent articles, it appears that a considerable number of articles dating from the 1950s through present report upon spills throughout the HSSCA project area. Historic articles are available on microfilm at the Cleveland Public Library but would require considerable effort to query and obtain.

A-2.5.1 U.S. EPA

U.S. EPA maintains a website for on-scene coordinators (OSCs) to share information associated with spills and releases of pollutants to the environment. The online OSC website for Region 5 was queried using the six municipalities[21] that compose most of the HSSCA project area (U.S. EPA 2014g). Of the 30 records in these six municipalities, six records are for spills in the HSSCA project area (Figure A-15, Table A-15). Pollution reports were downloaded for each site as well as images, contact lists, documents, links, and kml files, when available.

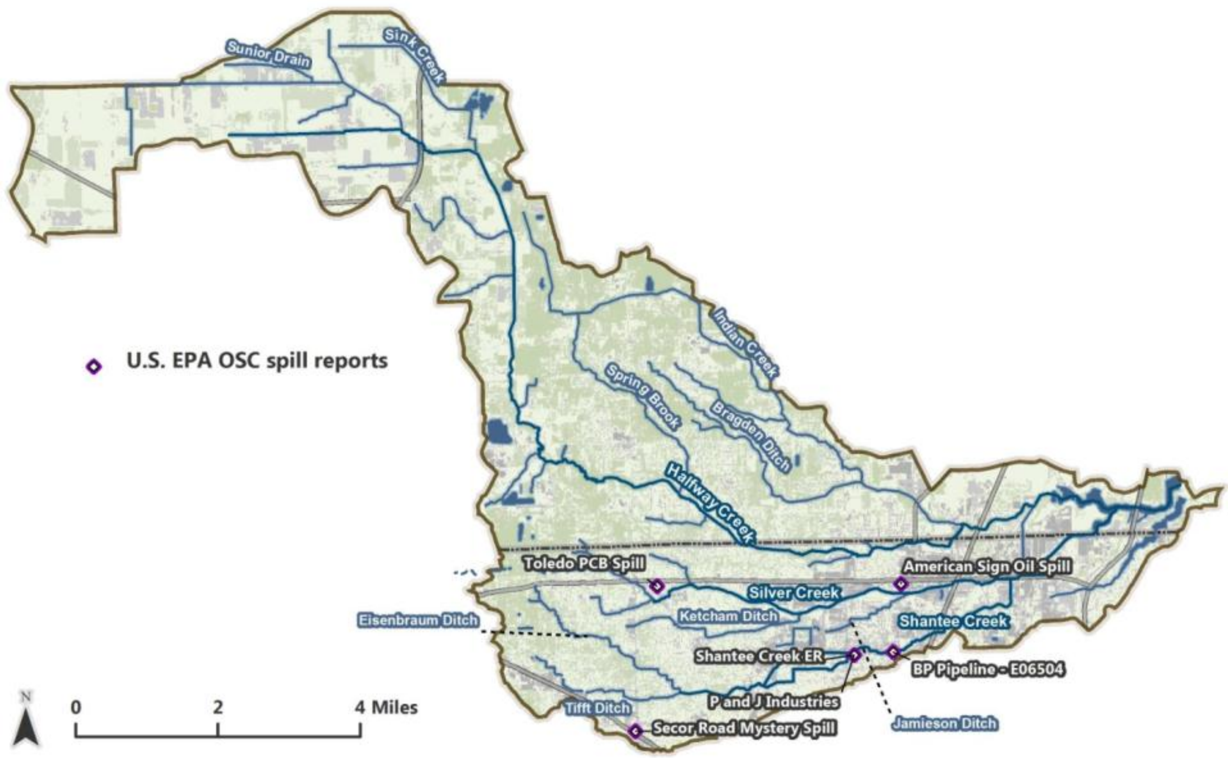

Figure A-15. Spills reported by U.S. EPA Region 5 OSCs.

Table A-15. Summary of spills records obtained from U.S. EPA Region 5 OSCs

Spill name	Spill date	FPN	Site ID	Pollutant
American Sign Oil Spill	3/9/2010	E10511		oil
BP Pipeline - E06504	3/23/2006	E06504	Z5FJ	gasoline
P and J Industries	8/26/2011		C568	*none* [a]
Secor Road Mystery Spill	5/13/2010	E10522	E10522	kerosene (assumed)
Shantee Creek ER	8/17/2011		C567	cyanide
Toledo PCB Spill	11/12/2003		559	oil

Notes
BP = British Petroleum; ER = Emergency Response; FPN = Federal Project Number; PCB = polychlorinated biphenyl.
a. No pollutant was released into the environment.

[21] The six municipalities that compose most of the HSSCA project area are: the city of Toledo and Sylvania and Washington townships of Lucas County, OH and Bedford, Erie, and Whiteford townships of Monroe County, MI.

The six OSC reports for these spills are summarized in the following subsections (U.S. EPA 2014g). Each OSC spill report includes information about the responsible party, a narrative of the spill and response, and U.S. EPA's response and future actions. In most cases, government regulatory agencies (e.g., U.S. EPA or Ohio EPA OSCs, city of Toledo staff) and contractors of responsible parties collected ambient environmental samples to evaluate the extent of the spills and progress of clean-up and remediation. Chemistry results are typically not reported quantitatively in the spills reports (Table A-16). Such data are not readily available for inclusion in the HSSCA.

Table A-16. Summary of the content of U.S. EPA Region 5 OSC spills records

Spill name	No. of pollution reports	Discussion of		
		Environmental samples	Environmental sample results	Materials removed
American Sign Oil Spill	1	None	--	Quantitative
BP Pipeline - E06504	5	Air, soil, unknown media	None	Quantitative
P and J Industries	1	None	--	Quantitative
Secor Road Mystery Spill	3	Soil, stormwater	Qualitative	Quantitative
Shantee Creek ER	3	Air, water column, sediment, stormwater	Qualitative	Quantitative
Toledo PCB Spill	1	Unknown media	Qualitative	Qualitative

Note: BP = British Petroleum; ER = Emergency Response; PCB = polychlorinated biphenyl.

2.5.1.1 American Sign Oil

The city of Toledo responded to a complaint of oil discharging from storm sewers into Silver Creek on March 9, 2010. The oil spill was traced to the American Sign Company building that consists of multiple bays, managed by different companies. Spills from the bays flow into a trench and into the city of Toledo's storm sewer system. Initially American Sign Company's contractor then U.S. EPA cleaned up the spills and had contaminated soils and water removed from the catch basins, trench, and storm sewers.

2.5.1.2 BP Pipeline

A BP 6-inche pipeline leaked oil into a two mile long segment of Shantee Creek on March 23, 2006. BP and its contractor initially responded to the spill; U.S. EPA and other federal, state, and municipal government regulatory agencies later responded. A second smaller leak was identified on March 25, 2006. Air, water, and soil samples were collected and contamination was present in soil and water samples. Nearby residents complained of odors and a sanitary sewer manhole was found to contain gasoline vapors. Remediation and recovery proceeded for two months after the emergency response. Contaminated soils from both leaks and contaminated water in Shantee Creek were removed.

2.5.1.3 P and J Industries

P&J Industries was investigated as part of the Shantee Creek Emergency Response (Section 2.5.1.5) as a potential source of cyanide contamination in Shantee Creek due to its history of metal coating and plating operations. U.S. EPA determined that P&J Industries was not a source of the cyanide contamination.

During the course of the investigation, U.S. EPA determined that hazardous materials were present on the property, which was in bankruptcy, in violation of storage requirements. U.S. EPA documented the facility owner and its contractor during the removal of the hazardous waste. Additional information about this investigation is available in the Superfund records (U.S. EPA 2014i,j; Section A-2.6.3 and Section A-2.6.4).

2.5.1.4 Secor Road Mystery Spill

An unknown product, initially believed to be kerosene and later determined to be gasoline, was identified in storm sewers when the city of Toledo was replacing old terra cotta storm sewers at the intersection of Secor Road and West Sylvania Avenue. The city of Toledo Division of Environmental Services (DES) responded and the city's Division of Engineering Services and U.S. EPA responded during subsequent days as the investigation continued. U.S. EPA conducted soil borings to characterize the contamination and oversaw the excavation and removal of contaminated soils from the site. U.S. EPA concluded that the contamination was historic and turned the case over to Bureau of Underground Storage Tanks Regulation (BUSTR) for further investigation and potential enforcement.

2.5.1.5 Shantee Creek ER

An orange discoloration of Shantee Creek and dead fish were reported to DES on August 15, 2011 and were due to a cyanide spill. U.S. EPA, Ohio EPA, ODNR, and DES investigated, which included the collection of air, sediment, and water samples; the agencies determined the location of contaminated sediments at an industrial property. Additional information about this spill is available in the Superfund records (U.S. EPA 2014i,j; Section A-2.6.4).

2.5.1.6 Toledo PCB Spill

Pole-mounted transformers leaked oil into storm sewers that drain to Silver Creek when the pole fell during a storm in November 2003. U.S. EPA, Ohio EPA, and DES responded. The electrical company hired a contractor to contain and clean-up the spill, including the storm sewers and Silver Creek. Additional information about this spill is available in the Superfund records (U.S. EPA 2014i; Section A-2.6.5).

A-2.5.2 Ohio EPA DERR

Spills and releases are reported to the Ohio EPA Division of Environmental Response and Revitalization (DERR). DERR maintains databases of spills from 1990 through present. The databases do not include georeferenced data. All spills records include the street address and geographic coordinates (degrees minutes seconds). Watersheds are not recorded in spills records. An impacted waterways field is sometimes populated; however, often times storm sewers are the listed waterway. Thus, DERR has no means to search the databases for the waterbodies specific to the HSSCA that would capture all applicable spills reports.

Ohio EPA DERR in the Central Office provided a list of 1,000 spills in Lucas County from 1990 through 2013 (Ohio EPA 2014i). Tetra Tech geocoded the 1,000 spills records and determined that 146 records were for spills in the HSSCA project area (Figure A-16).

The list of 146 spills records was further screened and reduced to 130 unique spills. The elimination of spills that did not discharge to a waterway (e.g., fully contained on-site, fumes) or were for substances outside the scope of the HSSCA (e.g., sewage, algae) results in 93 unique spills. DERR provided a Microsoft Access database that contains the narrative information for the 93 spills records in the HSSCA project area (Ohio EPA 2014a). Specific additional spill reports for spills that did not discharge to a waterway were requested when spills to waterways occurred at the same facility or near a group of spills to waterways (Ohio EPA 2014o).

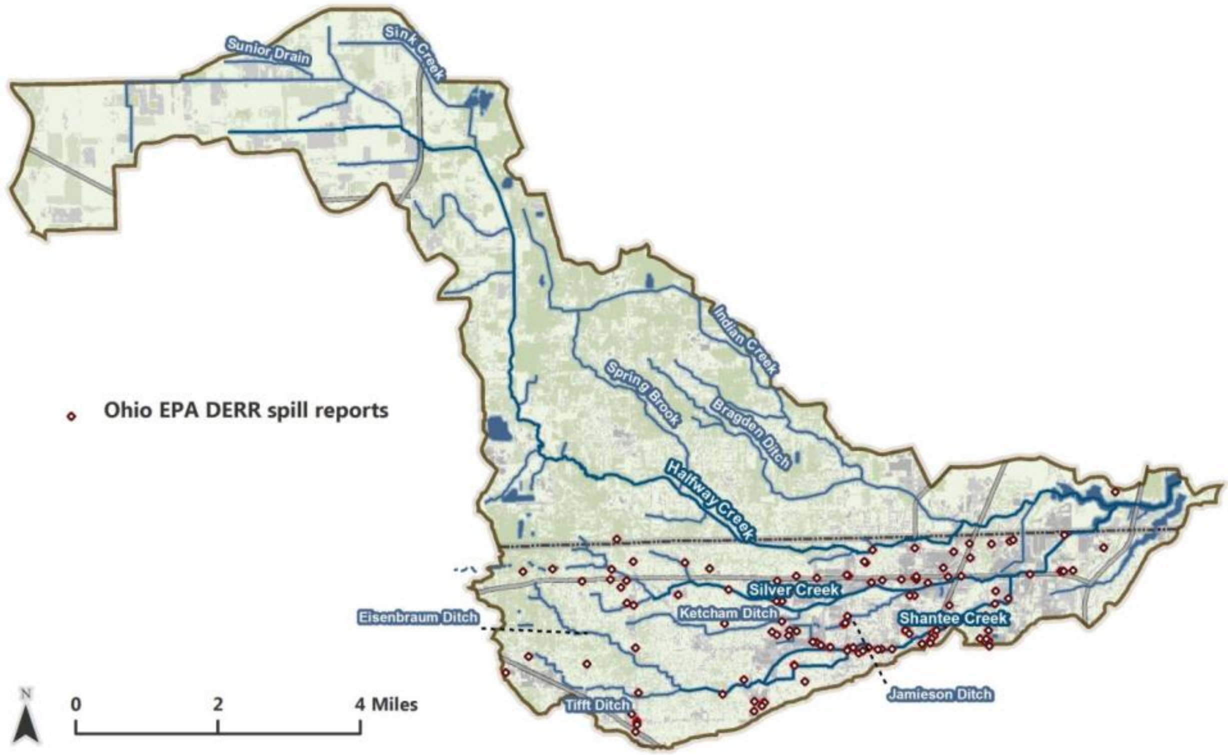

Figure A-16. Spills reported by Ohio EPA DERR.

A-2.5.3 City of Toledo

The city of Toledo Department of Public Utilities Division of Environmental Services responds to spills throughout the city of Toledo and adjacent municipalities. The Division of Environmental Services compiles spills reports (often from citizen complaints) and reports and violations associated with industrial pre-treatment facilities. Spills records are not georeferenced and do not include geographic coordinates; many records include a street address, nearby intersection, or business or neighborhood name.

Tetra Tech staff reviewed hardcopies of spills reports at the Division of Environmental Services on March 20, 2014 and selected approximately 200 spills reports to be scanned and electronically mailed to Tetra Tech (Toledo 2014f). Many spills reports were eliminated from further consideration as they were not relevant to the HSSCA; such insignificant records included citizen complaints of:

- green colored water (due to green dye for storm sewer mapping)
- trash, furniture, mattresses, and such
- brown or white colored water (due to water main, sanitary sewer, or storm sewer maintenance, replacement, or leaks)
- various colored water from organic debris (e.g., leaves) or algae
- sounds or smells not associated with PAHs, PCBs, or metals (e.g., sanitary sewer leak)

A-2.5.4 Michigan DEQ

Michigan DEQ maintains multiple databases for spills records. Various databases are maintained at the Central Office and field offices. Electronic and hardcopy spills records for Monroe County, MI are maintained at Michigan DEQ JFO; such records were formerly maintained at the Southeast Michigan field office. Similar to Ohio EPA DERR, watersheds and receiving waterbodies are not included as searchable fields in the spills databases and spills records are not georeferenced. Spills records contain street addresses or street intersections. Additionally, some records are hand-written. Finally, due to Michigan DEQ record retention policy, spills records from prior to 1997 were not retained and are no longer available for review.

Nine spills were reported in the Michigan portion of the HSSCA project area from 1997 through 2013 (Michigan DEQ 2014f). The spills records are summarized in Table A-17.

Table A-17. Summary of spills records provided by Michigan DEQ

Date	PEAS ID	Spilled substance	Source
11/20/1997	JO49-97	latex- and oil-based paint	business in Ohio
3/10/1998	--	diesel fuel	traffic accident
4/5/1999	J-99.58007	heating oil #2	LUST to storm sewers
2/25/2000	--	grinding fluid	trash container
5/3/2001	J-01.58008	55-gallong drum (not leaking)	n/a
7/30/2002	J-02.58014	diesel fuel	overturned semi-trailer truck
7/30/2006	598-06	unknown	unknown
5/20/2010	--	hydraulic oil	business in Ohio
11/16/2011	--	fuel oil	city of Toledo storm sewers

Source: Michigan DEQ 2014f
Note: LUST = leaking underground storage tank; n/a = not available; PEAS = Pollution Emergency Alerting System.

A-2.6 Superfund

U.S. EPA maintains the Superfund program to address sites contaminated with hazardous waste. The Agency's National Priorities List identifies known or potential releases of hazardous wastes and is used to help the Agency decide which sites to address.

The online Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)[22] was queried for Superfund sites in the 11 zip codes[23] that compose most of the HSSCA project area (U.S. EPA 2014l). Of the 15 records identified in CERCLIS for the 11 zip codes, five records are for Superfund sites in the HSSCA project area (Figure A-17; Table A-18).

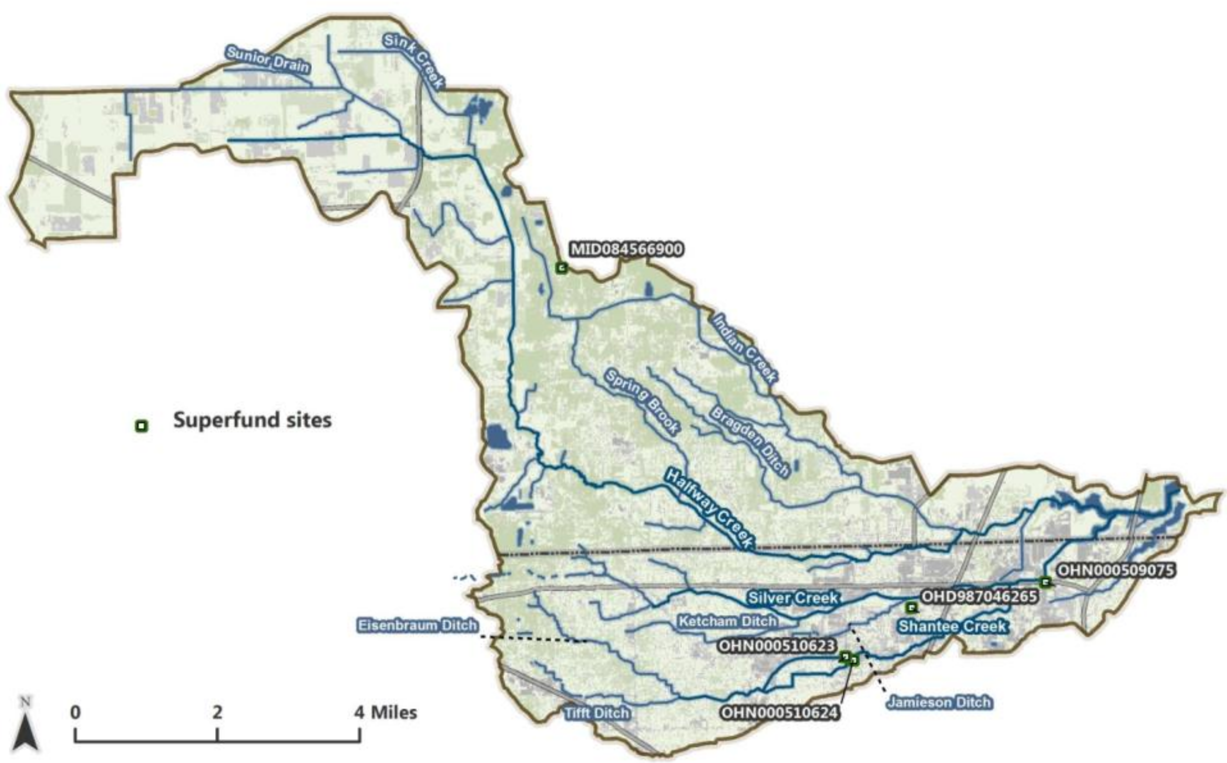

Figure A-17. Superfund sites in the HSSCA project area.

Table A-18. Superfund sites in the HSSCA project area.

U.S. EPA Superfund ID	Site name	Street address	City and state
MID084566900	Novaco Industries	9411 Summerfield Road	Temperance, MI
OHD987046265	Impact Stamping Site	5511 Telegraph Road	Toledo, OH
OHN000510624	P and J Industries	4934 Lewis Avenue	Toledo, OH
OHN000510623	Shantee Creek ER	Intersection of Laskey and Lewis Avenues	Toledo, OH
OHN000509075	Toledo PCB ER	3049 West Alexis Street	Toledo, OH

Sources: U.S. EPA 2014b,l

[22] According to the CERCLIS website (U.S. EPA 2014l), CERCLIS is to be replaced by the Superfund Enterprise Management System (SEMS) in early 2014. U.S. EPA stopped updating CERCLIS on November 12, 2013.
[23] The 11 zip codes that compose most of the project area are 43611, 43612, 43613, and 43623 in northern Lucas County, OH and 43560, 48133, 48144, 48182, 49228, 49267, and 49276 in southeast Michigan.

Records from the Superfund Enterprise Management System (SEMS) for the 11 zip codes that compose most of the HSSCA project area were provided by U.S. EPA Region 5 (U.S. EPA 2014b): 22 records were for sites in Ohio and eight records were for sites in Michigan. The SEMS queries cannot export street addresses or geographic coordinates; ergo, the records cannot be geocoded or plotted in GIS to determine which sites are in the HSSCA project area. Location information can be provided by U.S. EPA Region 5, on a site-by-site basis.

The five sites in the HSSCA project area with Superfund records are presented in Table A-18. Information on Novaco Industries was obtained from U.S. EPA's Superfund Information System websites (U.S.EPA 2014p), while information for the four Ohio facilities were obtained directly from U.S. EPA Region 5 (U.S. EPA 2014h,i,j). A summary of each Superfund site and the available data are presented in the following subsections.

A-2.6.1 Novaco Industries (MID084566900)

Chromic acid leaked from an underground storage tank (UST) at Novaco Industries in 1979 and subsequent sampling from 1970 through 1985 identified chromium contamination in on-site and off-site wells, including off-site residential wells. In 1986, U.S. EPA ordered groundwater pumping and treatment. In 1991, U.S. EPA issued an amended record of decision because chromium levels began decreasing in 1998 and the agency believed that there was no longer a contaminant plume. The records of decisions, as amended, are available from U.S. EPA's Superfund website (U.S. EPA 2014p).

A-2.6.2 Impact Stamping Site (OHD987046265)

Impact Stamping was a metals stamping facility that was abandoned by 1991 after at least 40 years of operation (U.S. EPA 2014g). U.S. EPA, Ohio EPA, U.S. EPA contractors, and the city of Toledo's fire department conducted site assessments and determine that hazardous and toxic substances were present (e.g., two USTs with gasoline solvents, pits with oil and water, floors contaminated with PCBs). In 1994, contractors removed the hazardous and toxic materials in the drums, pits, USTs, and contaminated flooring for treatment, recycling, and such. U.S. EPA (2014h) provided site assessments and reports of removal actions written by U.S. EPA OSCs, their contractors, and the Toledo fire department.

A-2.6.3 P and J Industries (OHN000510624)

P&J Industries was investigated as part of the Shantee Creek Emergency Response (Section 2.5.1.5) but was not found to be a potential source of cyanide contamination in Shantee Creek; refer to Section 2.5.1.3 for a brief description of the OSC spill report. U.S. EPA (2014i) provided an OSC report, which is also available from the U.S. EPA Region 5 OSC website (U.S. EPA 2014h).

A-2.6.4 Shantee Creek ER (OHN000510623)

A cyanide spill occurred in Shantee Creek in August 2011; refer to Section 2.5.1.5 for a brief description of the OSC spill reports. U.S. EPA (2014j) provided a compact disc with 18 files, which included OSC reports (also available from U.S. EPA 2014j), site photographs, maps with water quality sample results, laboratory reports, and memoranda describing the clean-up activities.

A-2.6.5 Toledo PCB ER (OHN000509075)

Transformers leaked oil into storm sewers that drain to Silver Creek in November 2003; refer to Section 2.5.1.6 for a brief description of the OSC spill report. U.S. EPA (2014i) provided an OSC report, which is also available from the U.S. EPA Region 5 OSC website (U.S. EPA 2014i).

A-2.7 Toxic Release Inventory

The Toxic Release Inventory (TRI) is a publically available database, which is maintained by U.S. EPA, of industrial facilities that dispose of or release toxic chemicals. The database contains information about on-site releases and disposal of toxic chemicals and off-site transfers of toxic chemicals (U.S. EPA 2011).

The online TRI database was queried through Envirofacts using 11 zip codes[24] that compose most of the HSSCA project area (U.S. EPA 2014a,m). Of the 37 records in these 11 zip codes, 21 records are for facilities in the HSSCA project area (Figure A-18). Reports identifying the regulated chemicals for each of the 21 facilities were downloaded; available data through 2012 are summarized in Table A-19.

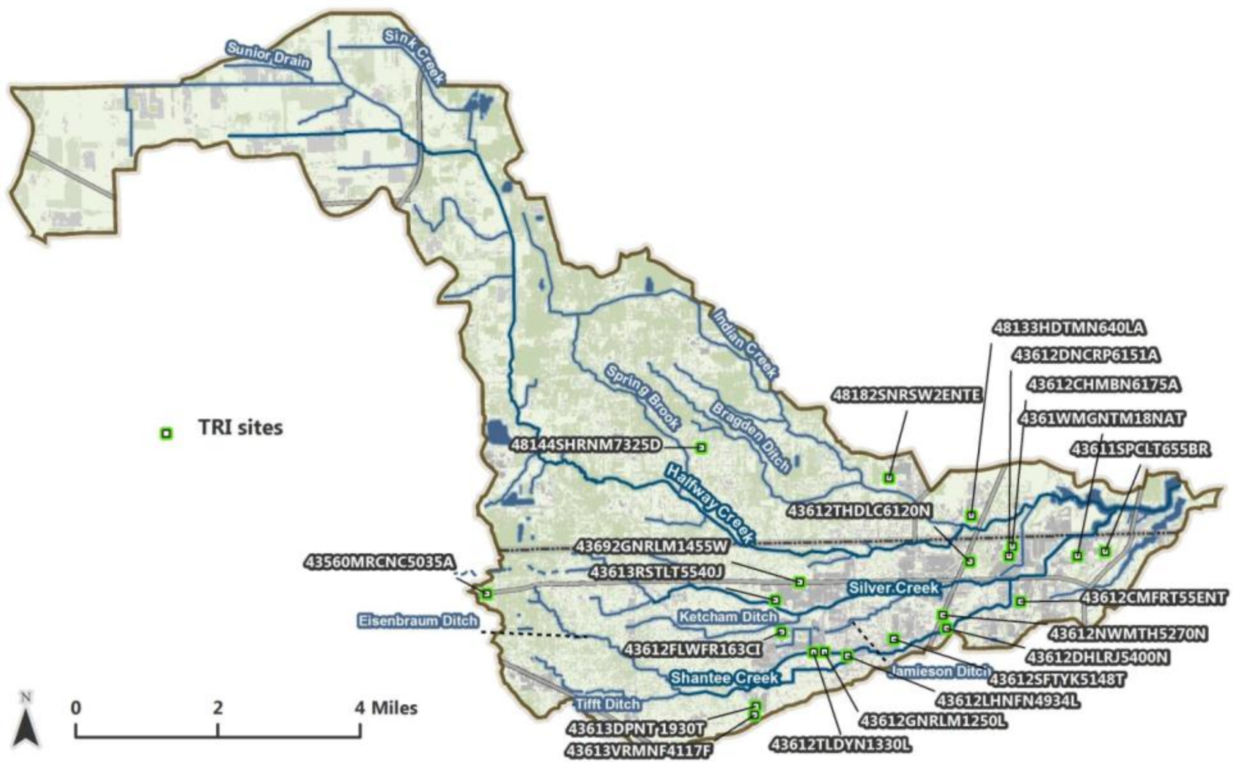

Figure A-18. TRI facilities in the HSSCA project area.

[24] The 11 zip codes that compose most of the project area are 43611, 43612, 43613, and 43623 in northern Lucas County, OH and 43560, 48133, 48144, 48182, 49228, 49267, and 49276 in southeast Michigan.

Table A-19. Facilities listed with the TRI

TRI site ID	Facility name	Toxic materials
43560MRCNC5035A	Bobbart Industries Inc	acetone (1987-1992), styrene (1987-1992, 1994-1999)
4361WMGNTM18NAT	Magna Team Systems	chromium compounds (2012), styrene (2012)
43611SPCLT655BR	Specialty Gases of America Inc	chloromethane (2010-2012), propylene (2009-2012)
43612CHMBN6175A	Arclin USA LLC	ammonia (1995, 1996, 2004-2008), biphenyl (2012), diethanolamine (2004-2008), ethylene glycol (1990, 2005-2012), formaldehyde (1989-2012), certain glycol ethers (2004-2012), 4,4-isopropylidenediphenol (2004-2006), methanol (1989-2012), phenol (1989-2012), triethyleamine (1995-2003)
43612CMFRT55ENT	Comfort Line Ltd	styrene (2006-2012)
43612DHLRJ5400N	Doehler-Jarvis Toledo Inc	aluminum oxide (fibrous forms) (1987-1988, 1990, 1992-1998), chlorine (1987-1998), copper (1987-1988, 1990-1998), ethylene glycol (1987-1989), manganese compounds (1992-1998), sodium hydroxide (solution) (1987), sulfuric acid (1990-1994), zinc compound (1990)
43612DNCRP6151A	Dana Corp	*none reported*
43612FLWFR163CI	Maclean Flowform LLC	zinc compounds (2001-2008)
43612GNRLM1250L	Smucker Bakery Manufacturing Inc	ammonia (2003-2005), benzo(g,h,i)perylene (2000-2002, 2006-2007), chromium (2005), certain glycol ethers (2003-2005), lead (2005), methanol (2004), n-methyl-2-pyrrolidone (2004), peracetic acid (2003-2005), polycyclic aromatic compounds (2000-2002, 2006-2007)
43612LHNFN4934L	P&J Industries Inc	ammonia (1987-1992), butyl benzyl phthalate (1989-1993), chlorophenols (1990-1992, 1994-1995), 1,4-dichlorobenzene (1989-1990), diethanolamine (1989-1993), ethylene glycol (1987-1995), certain glycol ethers (1987-1995), hydrochloric acid (1987-1994), nickel compounds (2001-2011), 2-phenylphenol (1987-1995), phosphoric acid (1989-1995), sodium dimethyldithiocarbamate (2001, 2003-2006), zinc compounds (1990-1993)
43612NWMTH5270N	New Mather Metals Inc	manganese (1998-2010)
43612SFTYK5148T	Safety-Kleen Systems	benzo(g,h,i)perylene (2009-2012), ethylene glycol (1998-2012), lead (2001-2012), polycyclic aromatic compounds (2000-2012)
43612TLDYN1330L	Toledyne Ryan Aeronautical	acetone (1990), ammonia (1997), methanol (1990), methyl ethyl ketone (1990), polychlorinated biphenyls (1990), toluene (1990), 1,1,1,-trichloroethane (1987-1988, 1990), xylene (mixed isomers) (1990)
43612THDLC6120N	Dial Corp	ammonia (1987-1988), chlorine (1987-1988), sodium hydroxide (solution) (1987-1988), sodium sulfate (solution) (1987)
43613DPNT 1930T	Axalta Coating Systems LLC – Toledo Plant	antimony compounds (1987-1988), barium compounds (1987, 1998, 1991, 1992), butyl acrylate (1987, 1988, 1990-1994, 1997-1999, 2002-2004, 2007-2009, 2012), n-butyl alcohol (1987-1992, 1995-1999, 2002-2012), chlorophenols (1987), chromium compounds (1987-1988), ethylene glycol (1987-1988), certain glycol ethers (1987-1993), lead compounds (1987-1988), methanol (1987-2000), methyl

TRI site ID	Facility name	Toxic materials
		acrylate (1987-2012), methyl ethyl ketone (1987-1992), methyl isobutyl ketone (1987-1992), methyl methacrylate (1987-2012), phthalic anhydride (1987-1990), styrene (1987-2012), toluene (1987-2012), xylene (mixed isomers) (1987-2010), zinc (fume or dust) (1987-1990)
43613RSTLT5540J	Erie Steel Ltd	ammonia (1989-2012)
43613VRMNF4117F	Frostbite	ammonia (1990-2004, 2006-2008, 2010-2012), nitrate compounds (2004, 2010-2012), nitric acid (2000-2001, 2003-2006, 2009-2012), phosphoric acid (1988-1990, 1993-1998), sodium hydroxide (solution) (1988)
43692GNRLM1455W	General Motors LLC – Toledo Plant	ammonia (1987-1988), aluminum (fume or dust) (1987-1991), chromium (1988-1995, 2010-2012), copper (1988, 1993-2012), copper compounds (1987-1992), diethanolamine (1987-1999), ethylene glycol (1987, 1989, 2005), certain glycol ethers (1988-1989), lead (1988-1991, 1993-1994, 1997-2012), manganese (1993-2007, 2010-2012), nickel (1988-2008, 2010-2012), nitrate compounds (1995), polychlorinated alkanes (1995-2001), sodium hydroxide (solution) (1987-1988), sulfuric acid (1987-1993), zinc compounds (1988, 1993-1994)
48133HDTMN640LA	HS Processing LP	hydrochloric acid (1987-1995), sodium hydroxide solution (1987-1988)
48144SHRNM7325D	Sharon Manufacturing Co	aluminum oxide (fibrous forms) (1987-1988)
48182SNRSW2ENTE	Sunrise Windows Ltd	diisocyanates (2004-2012)

Source: U.S. EPA 2014m

A-2.8 Toxic Substance Control Act

U.S. EPA can regulate the sale and distribution of commercial chemicals through authority granted to the Agency by the Toxic Substance Control Act (TSCA). Data are collected on new and existing chemicals and U.S. EPA evaluates the potential risk of their manufacturing, processing, and use (U.S. EPA 2012). An inventory of chemicals subject to regulation is maintained by the Agency.

The online TSCA database was queried through Envirofacts using 11 zip codes[25] that compose most of the HSSCA project area (U.S. EPA 2014a,n). Of the three records in these 11 zip codes, two[26] are for facilities in the HSSCA project area (**Error! Reference source not found.**). Data for each facility were not downloaded; such data can be obtained later, as necessary.

[25] The 11 zip codes that compose most of the project area are 43611, 43612, 43613, and 43623 in northern Lucas County, OH and 43560, 48133, 48144, 48182, 49228, 49267, and 49276 in southeast Michigan.

[26] The query of TSCA sites through the TSCA search in Envirofacts (U.S. EPA 2014n) yielded 0 results. A search for all regulated facilities through EnviroMapper for Envirofacts yielded two TSCA records (U.S. EPA 2014a). The reason for this discrepancy was not investigated.

A-2.9 Underground Storage Tanks

In Ohio, BUSTR regulates USTs, including leaking underground storage tanks (LUSTs). In Michigan, DEQ and the Department of Licensing and Regulatory Affairs (LARA) regulate and permit USTs[27].

A-2.9.1 Underground Storage Tanks

In Ohio, all USTs are permitted and entered into the Ohio Tank Tracking and Environmental Regulations (OTTER) database, which is available through BUSTR's website (BUSTR 2014a). OTTER records are not georeferenced and geographic coordinates are not available. There are 385 records for permitted USTs in the four zip codes in Ohio that the HSSCA project area is within. The 385 records were geocoded; 243 records for USTs 174 unique street addresses were identified in the HSSCA project area (Figure A-19).

Michigan DEQ and LARA jointly operate the Storage Tank Information Center and maintain the publicly accessible Storage Tank Information Database, which has georeferenced UST records (Michigan DEQ and LARA 2014). Eighteen active and 57 inactive UST records are in the HSSCA project area (Figure A-19):

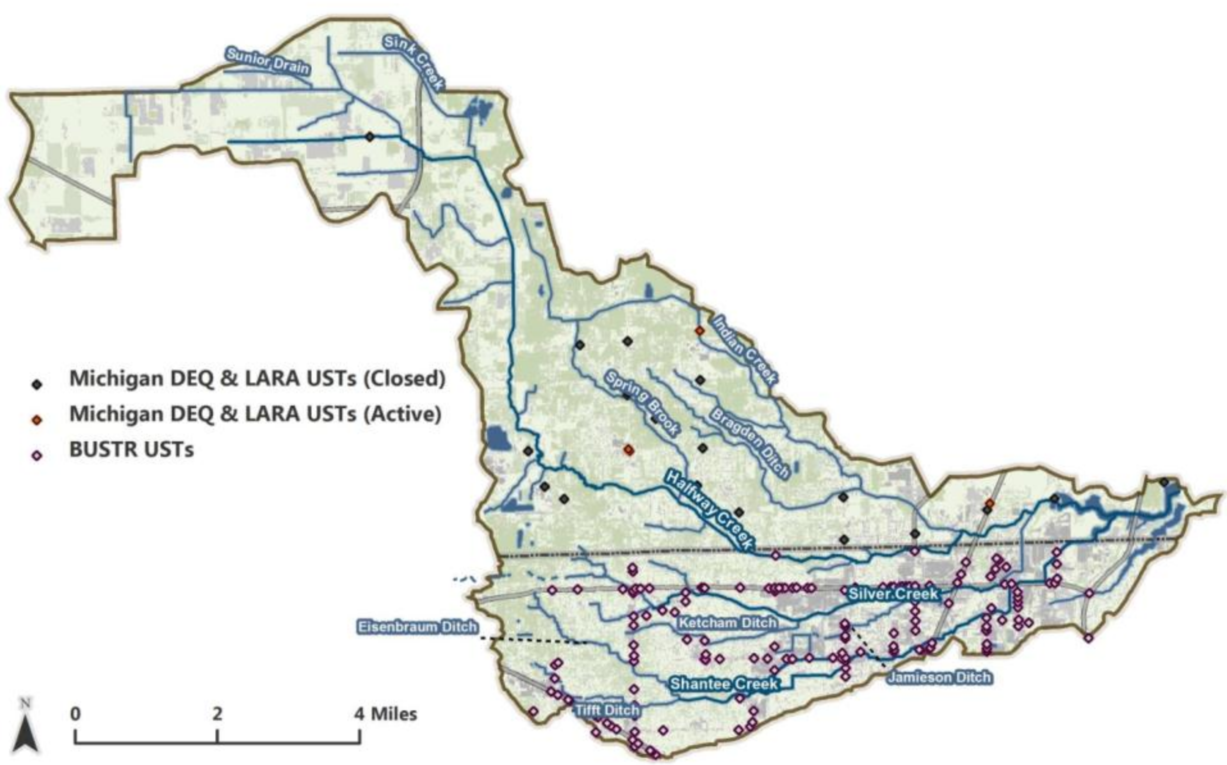

Figure A-19. USTs in the HSSCA project area.

[27] USTs are regulated under Part 211 ("211 sites") and LUSTS are regulated under Part 213 ("213 sites") 201 of the Michigan Natural Resources and Environmental Protection Act (NREPA), which is Act 451 of 1994.

A-2.9.1 Leaking Underground Storage Tanks

BUSTR also maintains a database of current and past LUSTs that is on a publicly accessible website (BUSTR 2014b). Similar to the OTTER database, the data are not georeferenced and lack geographic coordinates. There are 332 LUST records for the four counties that the HSSCA project area is within, and 200 records for LUSTs at 137 unique street addresses were identified in the HSSCA project area (Figure A-20). Of the BUSTR LUSTs records, 17 records are active at a total of 12 unique street addresses.

In Michigan, the Storage Tank Information Database also includes georeferenced LUST records. Six open and 17 close LUST records are in the HSSCA project area (Figure A-20). Additional USTs and LUSTs are also located just outside of the watershed boundaries.

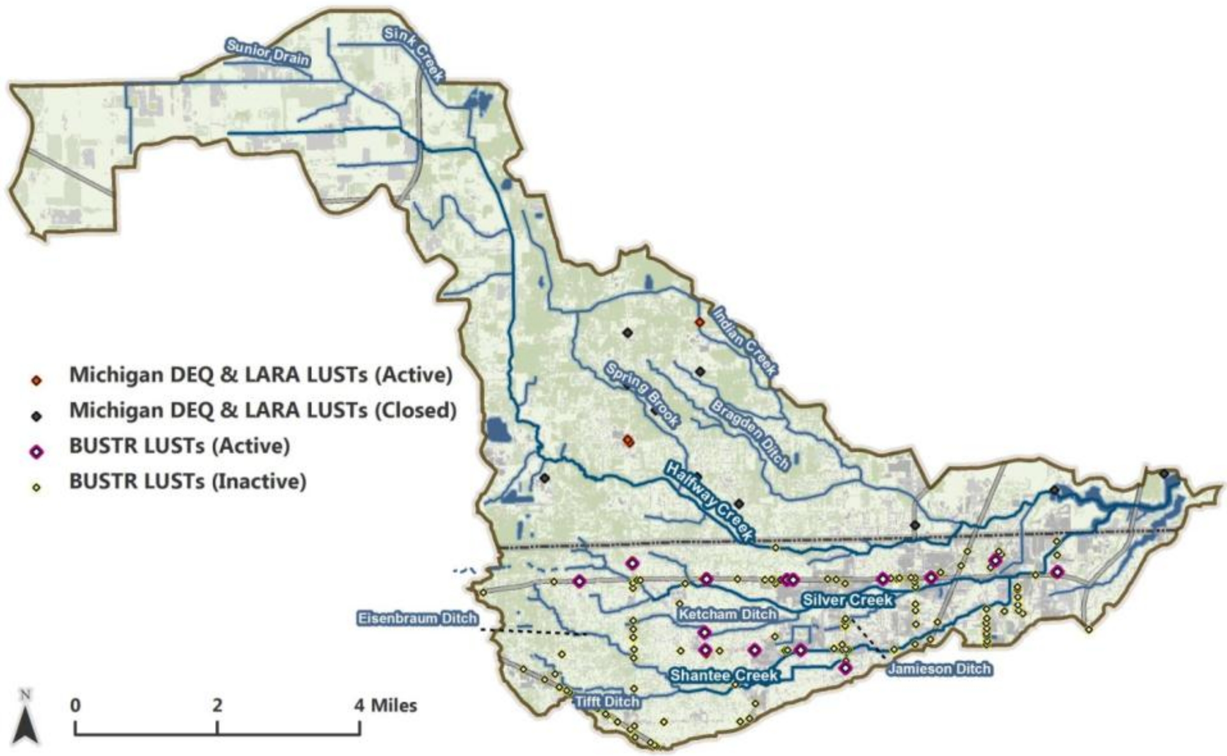

Figure A-20. LUSTs in the HSSCA project area.

A-2.10 Volunteer Action Program Projects

Owners of property in Ohio can investigate and cleanup their property with the assistance Ohio EPA DERR through the Volunteer Action Program (VAP). The owners that follow VAP's cleanup requirements may then obtain a covenant not to sue to protect their property from responsibility from future investigation and remediation (Ohio EPA 2014q).

Only one VAP project is within the HSSCA project area: Naval Weapons Industrial Reserve Plant (11NFA412) that was issued a covenant not to sue on May 2, 2011 (Ohio EPA 2014j,k). VAP requires paper hardcopy submission of all required documentation for the No Further Action Letter and Covenant Not To Sue (i.e., electronic data are not available). Ohio EPA DERR at NWDO has 22 bound reports and five files for this facility from 2001 through 2007 in their remedial records and 17 bound reports and six files in their VAP records for this facility from 2009 through early 2014.

A-3. Georeferenced Spatial Data

Georeferenced spatial data layers were obtained from multiple federal, state, and local government agencies. Data were primarily obtained from publicly available websites maintained by government agencies. This section provides summaries spatial data layers that Tetra Tech obtained; spatial data created by Tetra Tech using other datasets (e.g., coordinates of QHEI monitoring sites included within the QHEI datasheets) are not presented in this section.

A-3.1 Physical Spatial Data

The following types of data were downloaded from publicly available websites maintained by government agencies or obtained directly from local government agencies: aerial imagery (Table A-20), land cover and land use data (Table A-21), physical (Table A-22), surface water (Table A-23) and groundwater (Table A-24) hydrography and hydrology. Additional physical spatial data are available at the Michigan Geographic Data Library (Michigan Department of Technology, Management, and Budget [DTMB] 2014) and the GIMS (GIS) Program (ODNR 2014).

Table A-20. Aerial imagery spatial data

Layer	Data year(s)	Areal extent	Source
Air photos	2006	Lucas County	Lucas County (2012b)
	2010	Lucas County	Lucas County (2012a)
GoogleEarth™	1993, 1999, 2000, 2003-2006, 2008-2011	Earth	Google Inc. (2013)
National Agriculture Imagery Program air photos	2005, 2012	Lenawee County	NRCS (2013)
	2004, 2013	Lucas County	
	2005, 2012	Monroe County	

Note: NRCS = Natural Resources Conservation Service.

Table A-21. Land use and land cover spatial data

Layer	Data year(s)	Areal extent	Source
Coastal wetlands	n/a	Lake Erie	UM (2014)
Land cover/use	1991	Michigan	Michigan DTMB (2014)
Land cover - Lucas County	1986	Lucas County	ODNR (1987)
Land cover - Lucas County	1994	Lucas County	ODNR (1997)
Land use	1995	LEB: MI & OH	UM (2014)
Land use	2000	LEB: MI & OH	UM (2014)
Land use change	1995-2000	LEB: OH, PA, NY	UM (2014)
NLCD 1992 - land cover	ca. 1990s	United States	Vogelmann (2001)
NLCD 2001 (version 2.0) - land cover	ca. 2001	United States	Homer et al. (2007)
NLCD 2001 (version 2.0) - percent developed imperiousness	ca. 2001	United States	Homer et al. (2007)
NLCD 2001 (version 1.0) - percent tree canopy	ca. 2001	United States	Homer et al. (2007)
NLCD 2006 - land cover	ca. 2006	United States	Fry et al. (2006).
NLCD 2006 - percent developed imperiousness	ca. 2006	United States	Fry et al. (2006).
Ohio Wetland Inventory - Lucas County	1980/1985	Lucas County	ODNR (1991b)

Note: ca. = circa; Michigan DTMB = Michigan Department of Technology, Management, and Budget; LEB = Lake Erie basin; NLCD = National Land Cover Dataset; ODNR = Ohio Department of Natural Resources; UM = University of Michigan.

Table A-22. Physical spatial data

Layer	Data year(s)	Areal extent	Source
Ecoregions (level III and level IV)	2012	OH, IN	Woods et al. (2012)
Elevation	2011	Lucas County	Lucas County (2012b)
	2013	Lucas County	NRCS (2013)
Soils	2011	Lucas County	NRCS (2013)
	2013	Lenawee County	
	2013	Monroe County	

Note: NRCS = Natural Resources Conservation Service.

Table A-23. Surface water hydrography and hydrology spatial data

Layer	Data year(s)	Areal extent	Source
12-digit HUCs	2013	Michigan	Michigan DTMB (2014)
Channel cross-sections	2012	Lucas County	Lucas County (2012b)
Ditches	2012	Lucas County	Lucas County (2012b)
Floodplains	2012	Lucas County	Lucas County (2012b)
NHD (high)	2013	OH, MI	USGS (2013)
Streams and ditches	2013	Lenawee County	Michigan DTMB (2014)
	2013	Monroe County	Michigan DTMB (2014)
	2013	Toledo	Toledo (2014d)
Use designations	2009	OH	Ohio EPA (2010d)
Watershed assessment units	2010	OH	Ohio EPA (2010c)
	2014	OH	Ohio EPA (2014l)

Note: HUC = hydrologic unit code; Michigan DTMB = Michigan Department of Technology, Management, and Budget; NHD = National Hydrology Dataset; USGS = U.S. Geological Survey.

Table A-24. Groundwater hydrography and hydrology spatial data

Layer	Data year(s)	Areal extent	Source
DRASTIC Model	2010	Lucas County	ODNR (2010)
Ground-Water Resources - Lucas County	1986	Lucas County	ODNR (1991a)
Potentiometric Surface of the Consolidated Aquifers in Lucas County	2011	Lucas County	ODNR (2011a)
Potentiometric Surface Map of the Unconsolidated Aquifers in Lucas County	2011	Lucas County	ODNR (2011b)

Note: ODNR = Ohio Department of Natural Resources.

Flex Viewer is online, interactive mapping software used for interagency response to environmental threats (U.S. EPA 2014a). Tetra Tech is able to access a restricted version of the Flex View software for contractors. The following georeferenced spatial data layers are available and pertinent to the evaluation of environmental data:

- National Hydrography Dataset (from USGS)
- Shoreline boundaries (from ODNR)
- Topographic Quadrangles
- Wetlands (from the U.S. Fish and Wildlife Service)

A-3.2 Political

The boundaries of political subdivisions of the states of Michigan and Ohio were obtained from Michigan DTMB (2014) and Lucas County (2012a) and are presented in Table A-25.

Table A-25. Political boundaries spatial data

Layer	Data year(s)	Areal extent	Source
County boundaries	2013	Michigan	Michigan DTMB (2014)
Maumee AOC boundary	2013	Northwest Ohio	Ohio EPA (2014n)
Municipal boundaries	2012	Lucas County	Lucas County (2012a)
	2013	Michigan	Michigan DTMB (2014)
Parcels (e.g., ownership, addresses)	2012	Lucas County	Lucas County (2012a)
Townships (i.e., minor civil divisions)	2013	Michigan	Michigan DTMB (2014)

Note: AOC = area of concern; Michigan DTMB = Michigan Department of Technology, Management, and Budget.

A-3.3 Facilities, Infrastructure, and Spills

Georeferenced spatial data are limited for most spills data while many facilities and infrastructure datasets do include georeferenced spatial data or geographic coordinates. In Ohio, geographic coordinates are included for individual NPDES permittees, whereas as general NPDES permittees only include street addresses. Spills records maintained by Ohio EPA typically include geographic coordinates while UST and LUST records maintained by BUSTR only include street addresses.

In Michigan, geographic coordinates were also included for individual NPDES permitees and some general NPDES permitees. Michigan DEQ's spills records contained limited spatial information, UST and LUST data were georeferenced.

The Inland Sensitivity Atlas (U.S. EPA 2008) includes infrastructure and facilities data pertinent to the HSSCA (Table A-26 and Table A-27). For example, dozens of pipelines cross the HSSCA project area, including a 6-inche pipeline owned by BP Pipelines North America (identified as PL4). Additional datasets are pertinent to the Maumee AOC (e.g., marinas, navigation locks & dams, above ground storage tanks) are available but are not within the HSSCA project area.

Table A-26. Infrastructure spatial data

Layer	Data year(s)	Areal extent	Source
Pipelines	n/a	Ohio	U.S. EPA (2008)
Road centerlines	2012	Lucas County	Lucas County (2012b)
	2013	Michigan	Michigan DTMB (2014)
Road infrastructure (e.g., bridges, culverts)	2012	Lucas County	Lucas County (2012b)
Sanitary sewer infrastructure	2012	Lucas County	Lucas County (2012b)
Surface water intakes	n/a	Ohio	U.S. EPA (2008)
Storm sewer infrastructure	2011	Lucas County	Ohio EPA (2014m)
	2012		Lucas County (2012b)
	2008, 2013	Ohio	ODOT (2008, 2013)
	2010	Toledo	Ohio EPA (2014m)
	2013	Toledo	Toledo (2014d)
Water distribution infrastructure	2012	Lucas County	Lucas County (2012b)

Note: Michigan DTMB = Michigan Department of Technology, Management, and Budget; n/a = not available (i.e., the year of the data is not identified); ODOT = Ohio Department of Transportation; U.S. Environmental Protection Agency.

Table A-27. Facilities and spills spatial data

Layer	Data year(s)	Areal extent	Source
201 sites	2014	Michigan	Michigan DEQ (2014b)
FRS	2014	United States	U.S. EPA (2014d)
LUSTs (open and closed)	ca. 1987 - 2013	Michigan	Michigan DEQ and LARA (2014)
OSC spills reports		Region 5	U.S. EPA (2014f)
USTs (active and closed facilities)	ca. 1987 - 2013	Michigan	Michigan DEQ and LARA (2014)
VAP projects	2008-2012	Ohio	Ohio EPA (2014k)

Note: AST = above ground storage tank; FRS = Facility Registry System; LUST = leaking underground storage tank; Michigan DEQ and LARA = Michigan Department of Environmental Quality and Department of Licensing and Regulatory Affairs; Ohio EPA = Ohio Environmental Protection Agency; OSC = on-scene coordinator (U.S. EPA); UST = underground storage tank; U.S. EPA = U.S. Environmental Protection Agency; VAP = Volunteer Action Program.

Flex Viewer (U.S. EPA 2014a) also includes georeferenced sptatial data layers that are pertinent to the evaluation of facilities, infrastructure, and spills: Census population data (form the U.S. Census Bureau)

- Educational facilities
- Energy facilities and infrastructure
- Facilities and routes of interest to U.S. EPA
- Floodplain boundaries (from the Federal Emergency Management Agency)
- Hazardous Materials (HAZMAT) facilities
- Inland Sensitivity Atlas
- Oil and gas wells (from ODNR)
- Public health facilities
- Transportation facilities and infrastructure

A-3.4 Important Resources

Georeferenced spatial data were obtained from the University of Michigan (UM 2014; Table A-28) and are available in the Insland Sensitivity Atlas (U.S. EPA 2008) and Flex Viewer (U.S. EPA 2014a).

Table A-28. Ecological spatial data

Layer	Data year(s)	Areal extent	Source
Amphibians	1981-1998	Western LEB	UM (2014)
Aquatic insects	n/a	Western LEB	UM (2014)
Fish	1863-2002	Michigan	UM (2014)
Mussels	n/a	Michigan	UM (2014)
Mussels	n/a	Western LEB	UM (2014)
Reptiles	n/a	Michigan	UM (2014)
Snails	1981-1995	Michigan	UM (2014)

Notes: LEB = Lake Erie basin; UM = University of Michigan.

Along the Ohio-Michigan state border, two locations are identified with threatened vegetation in the Inland Sensitivity Atlas (U.S. EPA 2008) in the Halfway Creek watershed in Ohio: aquatic/riparian plant (#395) and terrestrial/upland plant (#951). Georeferenced spatial data layers within the Inland Sensitivity Atlas that are pertinent to the Maumee AOC but not specifically in the HSSCA project area include:

- Managed Areas
- Other environmentally sensitive areas
- Special Designated Areas

Flex Viewer (U.S. EPA 2014a) also includes georeferenced spatial data layers that are pertinent to the evaluation of important resources:

- Inland Sensitivity Atlas
- Wetlands (from the U.S. Fish and Wildlife Service)

A-4. Non-Georeferenced Spatial Data

Electronic copies of maps and engineering plans were obtained from publicly available websites and the city of Toledo. The maps and site plans are not georeferenced and cannot be input into GIS. Generally, the engineering plans are scans of old hardcopy documents from the 1960s. The engineering plans do include information about stream culverts and stream segments that are piped underground. Non-georeferenced maps are presented in Table A-29 and non-georeferenced plans are presented in Table A-30.

Table A-29. Maps without georeferenced spatial data

Map	Map year(s)	Areal extent	Type	Source
15’ Quadrangle	1900	Toledo	Electronic (*.jpg)	mytopo (2014)
Bedrock-surface topography of the Toledo area	1996	NW Ohio	Electronic (*.pdf)	Shideler et al. (1996)
ODOT District 1 and 2 MS4 map	2012	NW Ohio	Electronic (*.pdf)	ODOT (2012)
Potentiometric Surface of the Consolidated Aquifers in Lucas County	2011	Lucas County	Electronic (*.pdf)	ODNR (2011b)
Potentiometric Surface Map of the Unconsolidated Aquifers in Lucas County	2011	Lucas County	Electronic (*.pdf)	ODNR (2011d)
Potentiometric-surface map of the Carbonate Aquifer in Silurian and Devonian rocks, Lucas, Sandusky, and Wood Counties	1986	NW Ohio	Electronic (*.pdf)	Breen (1989)

Note: MS4 = municipal separate storm sewer system; NW = northwest; ODNR = Ohio Department of Natural Resources; ODOT = Ohio Department of Transportation; USGS = U.S. Geological Survey.

Table A-30. Engineering plans without georeferenced spatial data

Map	Map year(s)	Areal extent	Type	Source
Halfway Creek (ditch 067; 3 plans)	1937, 1967	segment	Electronic (*.tif)	Toledo (2014e)
Homeville Ditch (ditch 573; 3 plans)	1965	segment	Electronic (*.tif)	Toledo (2014e)
Shantee Creek (ditch 068; 7 plans)	1965	segment	Electronic (*.tif)	Toledo (2014e)
Shantee Creek (lower; 1 plan)	1969	segment	Electronic (*.tif)	Toledo (2014e)
Silver Creek (ditch 064a; 16 plans)	1967	segment	Electronic (*.tif)	Toledo (2014e)
Silver Creek (lower) re-route (2 pages)	1970	segment	Electronic (*.tif)	Toledo (2014e)
Tifft Ditch (ditch 393; 1 plan)	1965	segment	Electronic (*.tif)	Toledo (2014e)

A-5. Project Area Studies

Project area studies were obtained from publically available websites maintained by federal and state government agencies and associated organizations. The previous studies that may contain useful information include studies with regional background information (Table A-31) and studies of regional groundwater resources (Table A-32). A summary of available studies about stream and ditch re-routing and channelization are presented in Section A-5.1 and a summary of a Tetra Tech study of scrapyards is presented in Section A-5.3.

The city of Toledo was awarded a Great Lakes Restoration grant for green infrastructure retrofitting along a road segment without curbs and gutters in a low-density residential neighborhood in the Silver Creek watershed. This retrofit project was recommended through an ongoing study that the city of Toledo and the National Oceanic and Atmospheric Administration are conducting. If the NOAA study is completed during the course of the HSSCA project, its results will be included in the HSSCA summary report.

Finally, Tetra Tech was unable to locate or obtain additional studies regarding seiches, lacustrine effects, and hydrodynamics (Section A-5.2).

Table A-31. Background and general information

Title	Areal extent	Source
Fish Tissue Study of the Ottawa River	Ottawa River	Ohio EPA (1999)
Fish Tissue, Bottom Sediment, Surface Water Organic and Metal Chemical Evaluation, Ottawa River / Tenmile Creek, Toledo, Ohio	Ottawa River	Ohio EPA (1991)
The History of Lake Erie	Lake Erie basin	Hansen (1989)
Maumee Area of Concern Stage 2 Watershed Restoration Plan	Maumee AOC	Maumee RAP (2006)
Ottawa River TSD	Ottawa River	n/a [a]
TMACOG Areawide Water Quality Management Plant	Northwest Ohio	TMACOG (2013)
2011 Study Plan for the Tenmile Ottawa Watershed (Fulton and Lucas Counties, OH)	Northwest Ohio	Ohio EPA (2011b)

Notes
AOC = area of concern; n/a = not available; TMACOG = Toledo Metropolitan Area Council of Governments; TSD = technical support document.
a. Ohio EPA sampled the Ottawa River basin, including the HSSCA project area, in 2011 and will use these data to develop a TSD.

Table A-32. Geology and groundwater

Title	Areal extent	Source
Geohydrology and quality of water in aquifers in Lucas, Sandusky, and Wood counties, northwestern Ohio	Northwest Ohio	USGS (1991)
Ground Water for Planning in Northwest Ohio: A Study of the Carbonate Rock Aquifers	Northwest Ohio	ODNR (1970)
Ground Water Pollution Potential of Lucas County	Lucas County	Sprowls (2010)
Structure Contour Map on the Precambrian Unconformity Surface in Ohio and Related Basement Features	Ohio	Baranoski (2013)

Note: ODNR = Ohio Department of Natural Resources; USGS = U.S. Geological Survey.

A-5.1 Hydrography and Hydrology

The city of Toledo commissioned the *Comprehensive Plan for Main Ditch Improvements* in 1971, and it was updated in 1984 and 1985 (Finkbeiner et al. 1971, 1984, 1985; see Table A-33). No electronic copies of these documents are available. Paper hardcopies are available for review at the Division of Engineering Services office at the city of Toledo's Department of Public Utilities. Tetra Tech obtained scans of selected pages of the 1971 and 1985 documents and a hardcopy of the 1984 document. The city of Toledo has also commissioned studies for stormwater improvement in more recent years in the Shantee Creek (Finkbeiner et al. 2002) and Silver Creek (URS 2009) watersheds.

Table A-33. Hydrography and Hydrology

Title	Areal extent	Source
Comprehensive Plan for Main Ditch Improvements	city of Toledo	Finkbeiner et al. (1971)
Flood Insurance Study. City of Toledo, Ohio. Lucas County	city of Toledo	FEMA (1979)
Flood Insurance Study for Toledo, Ohio	city of Toledo	USACE (1971)
Master Plan for Storm Sewers in Old Washington Township, Reynolds Road Area, Byrne Road Area	portions of the city of Toledo	Finkbeiner et al. (1985)
Review of Comprehensive Plan for Main Ditch Improvements - 1971 and Storm Drainage Study in Old Orchard, Southwest of Colony Nopper Gardens, Beverly West Toledo	portions of the city of Toledo	Finkbeiner et al. (1984)
Shantee Creek Improvements, Phases 3 and 4, Preliminary Design Report	Shantee Creek watershed	Finkbeiner et al. (2002)
Silver Creek Drainage Basin Improvement Plan. Final Plan	Silver Creek watershed	URS (2009)

Note: FEMA = Federal Emergency Management Agency; USACE = United States Army Corps of Engineers.

USGS provided information regarding the 2002 re-routing of Shantee Creek along the Conrail Railroad lines in its report about HEC-RAS modeling for Lucas County (Toledo 2014c). The new channel flows along the Conrail Railroad lines, while the old channel flowed through residential areas. During peak flows, water flows through both the old and new channels. Information regarding culverts, water elevations, and channel hydrography are presented by USGS for 30 streams in Lucas County (Toledo 2014c). Old flood insurance studies are also available for review, in hardcopy only, at the Division of Engineering Services (Table A-33).

A-5.2 Seiches, Lacustuaries, and Hydrodynamics

No studies regarding Lake Erie seiches and the extent of backwater flow up into the HSSCA tributaries are available. Anecdotal information was provided by various government employees; lacustrine boundaries are dynamic and can vary considerably by year and by storm events. Seiches may flow up old, lower Shantee Creek to RM 1.57 to RM 1.76, with wetland areas just east of I-75, along the residential developments[28]. Along Halfway Creek, seiches may flow up to RM 3.29[29]. The lacustuary along Silver Creek extends above Hagman Road at RM 1.13 to the vicinity of RM 1.25[30]. Tetra Tech staff observed backwater flow at Hagman Road on March 21, 2014.

[28] Bryon McIntosh (Washington Township), Brian Miller (Lucas County Engineer's Office), and Dennis Mishne (Ohio EPA), personal communications, January 21, 2014 and February 28, 2014.
[29] Dennis Mishne (Ohio EPA), personal communication, February 28, 2014.
[30] Brian Miller (Lucas County Engineer's Office) and Dennis Mishne (Ohio EPA), personal communications, February 28, 2014.

Lucas County has contracted with USGS to delineated floodplain and floodplain boundaries for 30 streams in Lucas County (Toledo 2014c).USGS developed develop one-dimensional HEC-RAS models of streams in the County (Toledo 2014c) and used the models with flow estimations (based upon StreamStats [Koltun et al. 2006]) as part of a Flood Insurance Study. USGS has revised the models and project results based upon review of the *Comprehensive Ditch Plan*. In early 2014, the project results were being reviewed by the Federal Emergency Management Agency to revise floodplain maps.

A-5.3 Scrapyards

The city of Toledo contracted with Tetra Tech to study scrap yards in the Ottawa River 10-digit HUC (Tetra Tech 2013). The objectives of the study were to identify sources of stormwater contaminants from scrapyards and to work with the scrap yards to control stormwater runoff and limit contamination. Tetra Tech staff used GIS to develop a list of scrap yards, and 13 scrap yards and salvage operations participated in the pollution prevention study, which included a few scrap yards in the HSSCA project area. The facilities were inspected in 2011 and three facilities implemented new BMPs that were evaluated in 2012; none of these three facilities are in the HSSCA project area. Tetra Tech found that low-intensity bioretetion reduces stormwater contaminant loads and may be more effective than oil-water separators, except for oil spills. Additionally, Tetra Tech identified a need for more education and outreach for scrap yard owners and operators.

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Appendix B.

Watershed Characterization

Tables

Note: References are presented on page B-12.

Figures

Abbreviations and Acronyms

HSSCA	Halfway, Silver, and Shantee Creeks Analysis
HSG	hydrologic soil group
HUC	hydrologic unit code
NCDC	National Climactic Data Center
NLCD	National Land Cover Dataset

Table B-1. Drainage areas and peak flows of certain tributaries in the HSSCA project area

Stream	Drainage area (square miles)	Estimated 100-year recurrence interval peak flow (cubic feet per second)
Silver Creek	15.94	2,050
Jamieson Ditch	0.88	203
Ketcham Ditch	1.16	272
North Ketcham Ditch	0.46	150
South Silver Creek	0.35	95
Wing Ditch	0.60	125
Shantee Creek	7.96	965
Barnum Ditch	0.41	119
Eisenbraum	2.13	417
Tifft Ditch	4.14	650

Source: Lucas County 2014.

Table B-2. Land use and land cover in Shantee and Silver creeks

Land cover class	Shantee Creek 12-digit HUC[a]		Silver Creek (w/o Shantee Creek) [b]		Silver Creek Cutoff [b]		Shantee Creek [b]		Shantee Creek Cutoff [b,c]	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Open Water	12	<1 %	10	<1 %	0	--	9	<1 %	53	6%
Developed, open space	1,809	18 %	892	17 %	36	18 %	1,016	20 %	250	28%
Developed, low intensity	4,887	48 %	2,395	45 %	81	41 %	2,587	50 %	371	41%
Developed, medium intensity	1,551	15 %	879	16 %	46	23 %	767	15 %	145	16%
Developed, high intensity	1,166	12 %	733	14 %	30	16%	563	11 %	51	6%
Barren land	--	--	--	--	--	--	--	--	1	<1 %
Deciduous forest	516	5 %	277	5 %	--	--	204	4 %	6	<1 %
Evergreen forest	--	--	--	--	--	--	--	--	--	--
Mixed forest	--	--	--	--	--	--	--	--	--	--
Shrub/scrub	--	--	--	--	--	--	--	--	--	--
Grassland/herbaceous	7	<1 %	5	<1 %	--	--	1	<1 %	--	--
Pasture/hay	123	1 %	104	2 %	--	--	19	<1 %	--	--
Cultivated crops	16	<1 %	79	2 %	--	--	--	--	8	<1 %
Woody wetlands	12	<1 %	2	<1 %	3	2%	--	--	7	<1 %
Emergent herbaceous wetlands	2	<1 %	7	<1 %	--	--	1	<1 %	13	2 %
Total	**10,101**	**100 %**	**5,383**	**100 %**	**197**	**100 %**	**5,168**	**100 %**	**905**	**100 %**

Source: 2006 NLCD (Fry et al. 2011).
Notes
Acreages and percentages were rounded to the nearest integer and do not sum to 100 percent due to rounding.
A double dash ("--") indicates that a land cover was not present.
a. The Shantee Creek 12-digit HUC is 04100001 03 01; it does not include the Shantee Creek cutoff, which is in HUC 04100001 03 09.
b. These subwatersheds were delineated for this project and are not exactly consistent with the 12-digit HUC boundaries. Therefore, the areas of these subwatersheds do not sum to the area of the 12-digit HUC.
c. The Shantee Creek cutoff is the small, northern portion of HUC 04100001 03 09.

Table B-3. Land use and land cover in Halfway and Indian creeks

Land cover class	Halfway Creek 12-digit HUC[a]		Halfway Creek (w/o Indian Creek) [b]		Indian Creek [b]	
	Acres	Percent	Acres	Percent	Acres	Percent
Open Water	265	1 %	238	1 %	30	<1 %
Developed, open space	5,078	21 %	3,055	17 %	1,912	33 %
Developed, low intensity	3,847	16 %	2,589	14 %	1,127	20 %
Developed, medium intensity	797	3 %	576	3 %	157	3 %
Developed, high intensity	417	2 %	244	1 %	70	1 %
Barren land	43	<1 %	40	<1 %	2	<1 %
Deciduous forest	3,654	15 %	1,911	11 %	1,758	30 %
Evergreen forest	52	<1 %	18	<1 %	33	<1 %
Mixed forest	21	<1 %	21	<1 %	0	--
Shrub/scrub	8	<1 %	8	<1 %	0	--
Grassland/herbaceous	185	1 %	126	<1 %	60	1 %
Pasture/hay	1,025	4 %	880	5 %	140	2 %
Cultivated crops	8,680	36 %	8,115	45 %	482	8 %
Woody wetlands	186	1 %	187	1 %	5	<1 %
Emergent herbaceous wetlands	82	<1 %	76	<1 %	0	--
Total	**24,340**	**100 %**	**18,084**	**100 %**	**5,776**	**100 %**

Source: 2006 NLCD (Fry et al. 2011).

Notes

Acreages and percentages were rounded to the nearest integer and do not sum to 100 percent due to rounding.

A double dash (“--“) indicates that a land cover was not present.

a. The Halfway Creek WAU is the 12-digit HUC 04100001 03 02; it does not include the Shantee Creek cutoff, which is in HUC 04100001 03 09.

b. These subwatersheds were delineated for this project and are not exactly consistent with the 12-digit HUC boundaries. Therefore, the areas of these subwatersheds do not sum to the area of the 12-digit HUC.

Table B-4. Level IV ecoregion physiography and geology in the project area

Ecoregion	Physiography	Geology
Maumee Lake Plains (57a)	Glaciated. Nearly level to depressional glacial lake plain with paleobeach ridges, limestone ridges, and end moraines. Sluggish, low gradient streams, many with high loads of suspended clay. Channelized streams and ditches with clayey channels are common.	Fine, poorly drained, water-worked glacial till and lacustrine sediment; also coarser end moraine and beach ridge deposits. Occasional outcrops of underlying Silurian and Devonian limestone and dolomite occur.
Oak Openings (57b)	Glaciated. Low, relict sand dunes, paleobeach ridges, sand sheets, and intervening pans occur.	Late-Wisconsinan sand dunes, sandy beach ridges, clayey glacial till, and fine lacustrine material overlie Devonian and Mississippian carbonates and shale.

Source: Woods et al. 2011

Table B-5. Level IV ecoregion soils in the HSSCA project area

Ecoregion	Common soil series
Maumee Lake Plains (57a)	On water-worked glacial till: Hoytville, Nappanee, Blount, Miamian. On clayey to very clayey lake deposits: Toledo, Latty. On coarser sediments above lacustrine material: Mermill.
Oak Openings (57b)	On sandy sediments: mostly Ottokee, Granby, and Tedrow. In scattered loamy areas: Colwood, Mermill.

Source: Woods et al. 2011

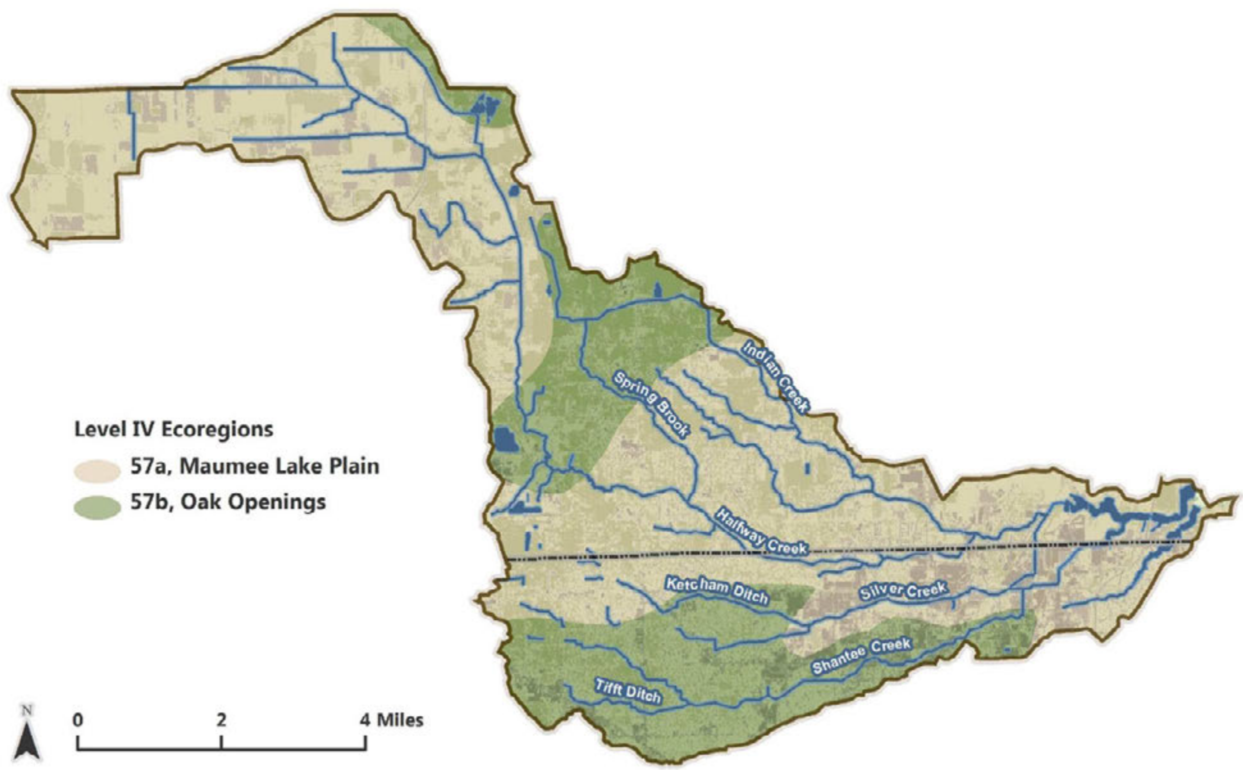


Figure B-1. Level IV ecoregions in the HSSCA project area.

Table B-6. HSG descriptions

HSG	Group description
A	Sand, loamy sand or sandy loam types of soils. Low runoff potential and high infiltration rates even when thoroughly wetted. Consist chiefly of deep, well- to excessively drained sands or gravels with a high rate of water transmission.
B	Silt loam or loam. Moderate infiltration rates when thoroughly wetted. Consist chiefly or moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures.
C	Soils are sandy clay loam. Low infiltration rates when thoroughly wetted. Consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	Soils are clay loam, silty clay loam, sandy clay, silty clay or clay. Group D has the highest runoff potential. Low infiltration rates when thoroughly wetted. Consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.
A/D B/D C/D	Dual HSGs. Certain wet soils are placed in group D solely on the basis of the presence of a water table within 24 inches of the surface even though the saturated hydraulic conductivity might be favorable for water transmission. If these soils can be adequately drained, they are assigned to dual HSGs (A/D, B/D, and C/D) according to their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the un-drained condition.

Source: Soil Data Viewer 6.0 (NRCS 2011).

Table B-7. HSG distribution in the HSSCA project area

Watersheds	A	B	C	D	A/D	B/D	C/D	NR
HSSCA project area	16%	19%	5.8%	1.2%	9.4%	17%	17%	15%
Shantee Creek (04100001 03 01)								
Shantee Creek	5.9%	27%	--	--	6.1%	25%	2.0%	34%
Silver Creek (without Shantee Creek)	11%	12%	3.7%	0.1%	11%	8.9%	9.9%	43%
Silver Creek cutoff	--	7.4%	14%	3.0%	--	8.2%	29%	39%
Halfway Creek (04100001 03 09)								
Halfway Creek (without Indian Creek)	17%	18%	7.0%	2.0%	8.6%	17%	26%	4.1%
Indian Creek	30%	24%	9.2%	1.2%	15%	16%	2.1%	1.9%
Detwiler Ditch-Frontal Lake Erie (04100001 03 09)								
Shantee Creek cutoff	--	4.2%	2.9%	--	--	13%	38%	42%

Notes
Percentages are rounded to two significant digits and do not sum to 100 percent due to rounding.
A double dash ("--") indicates that a hydrologic soil group was not present.

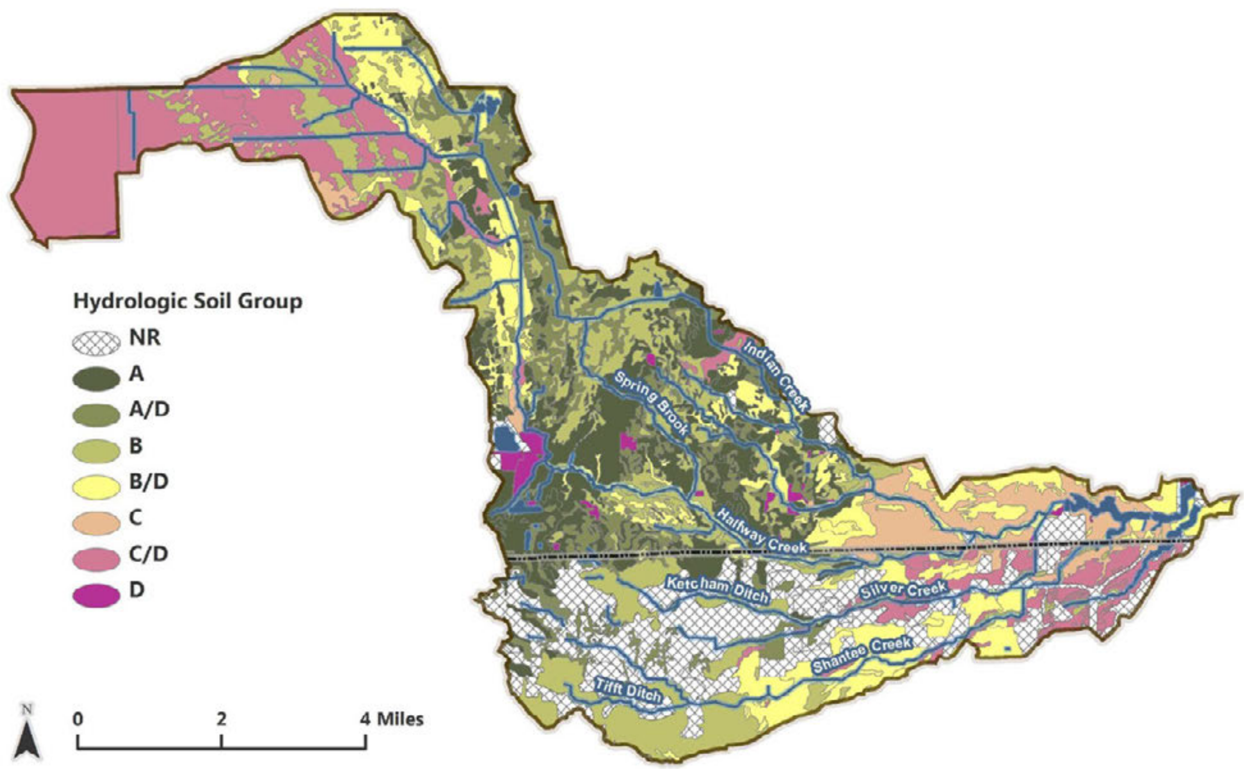


Figure B-2. HSGs in the HSSCA project area.

Table B-8. Climate data summary for Toledo, OH (National Climactic Data Center [NCDC] station 94830)

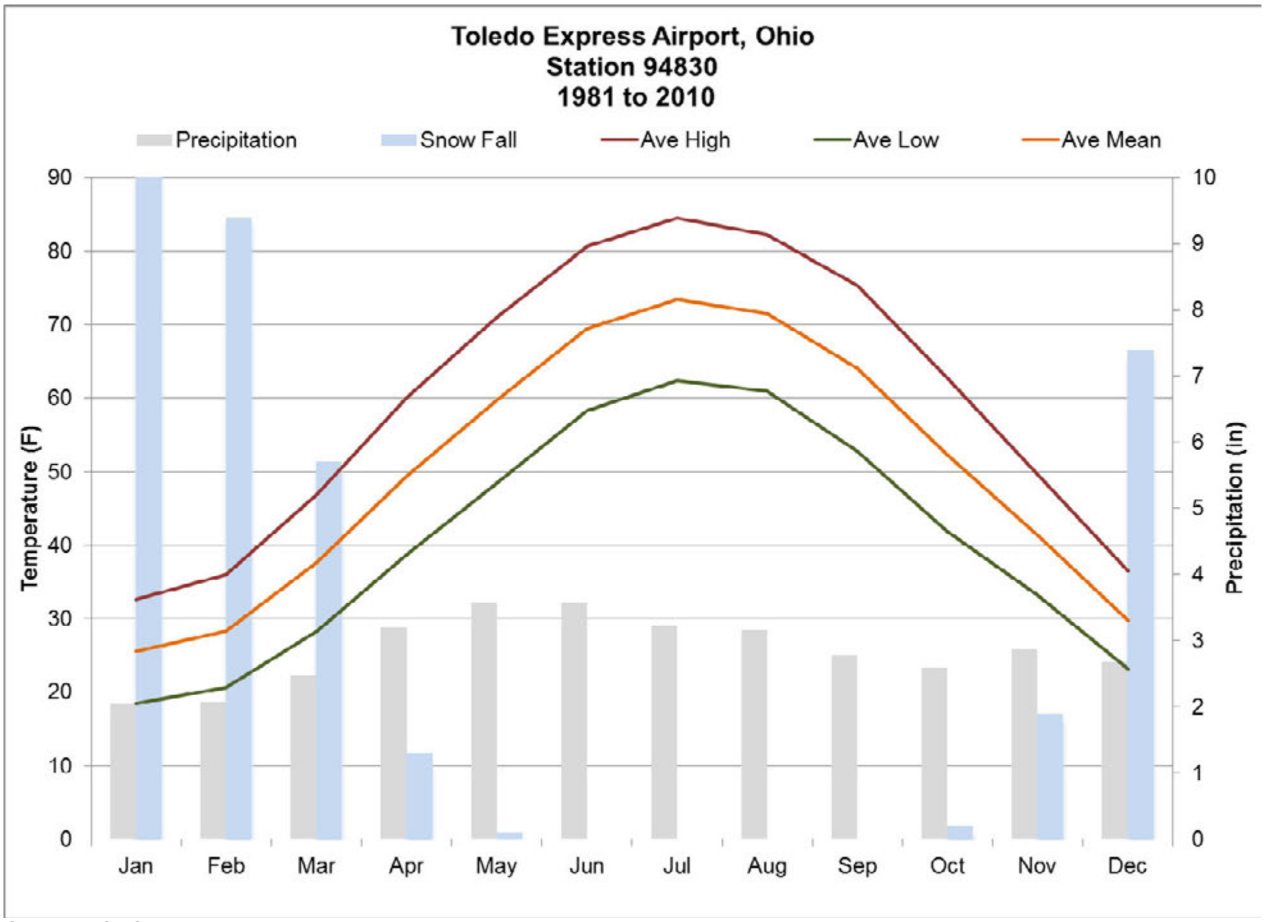
Parameter[a]	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	32.6	36.0	46.9	60.1	71.0	80.7	84.5	82.2	75.4	62.8	49.7	36.4
Low	18.4	20.6	28.3	38.7	48.5	58.3	62.4	60.9	52.8	41.8	33.2	23.1
Mean	25.5	28.3	37.6	49.4	59.8	69.5	73.5	71.5	64.1	52.3	41.4	29.7
Precipitation	2.05	2.07	2.48	3.19	3.58	3.57	3.23	3.15	2.78	2.6	2.86	2.68
Snowfall	11.6	9.4	5.7	1.3	0.1	0	0	0	0	0.2	1.9	7.4

Source: NCDC 2014.

Notes

Summary of data collected at Toledo, OH (Toledo Express Airport) NCDC station 94830 from 1981 through 2010.

a. All five parameters are monthly averages. high, low, and mean are in degrees Fahrenheit. Average precipitation is in inches water equivalent. Average snowfall is in inches of snow.



Source: NCDC 2014.

Figure B-3. Temperature and precipitation summary at the Toledo Express Airport (NCDC station 94830).

Table B-9. StreamStats in Ohio results for Silver Creek near Hagman Road

Statistic	Flow (cfs)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
Peak flow [a]					
2 years	342	37	2.1	180	650
5 years	525	35	3.3	287	961
10 years	644	34	4.4	352	1,180
25 years	785	35	5.9	422	1,460
50 years	885	37	6.8	465	1,680
100 years	982	38	7.5	503	1,920
500 years	1,190	42	8.6	569	2,490
Low-flow (10-year) [b]					
80 percent exceedance [c]	1.04	29	--	--	--
1-day	0.19	53	--	--	--
7-day	0.24	40	--	--	--
30-day	0.36	36	--	--	--
90-day	0.53	30	--	--	--
Mean and Percentile					
Mean annual	6.43	--	--	--	--
Harmonic mean annual	1.12	--	--	--	--
25^{th} percentile	1.31	--	--	--	--
50^{th} percentile	2.80	--	--	--	--
75^{th} percentile	7.01	--	--	--	--

Source: Koltun et al. 2006
Notes
cfs = cubic feet per second.
A double dash ("--") indicates that the value was not calculated.
a. Each row represents the peak flow at the specified recurrence interval.
b. Each row represents the specified consecutive day low-flow at a 10 year recurrence interval.
c. The flow that is exceeded 80 percent of the time.

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Appendix C.

Water Column Metals Results

Tables

Abbreviations and Acronyms

Michigan DEQ	Michigan Department of Environmental Quality
Ohio EPA	Ohio Environmental Protection Agency
OMZA	outside mixing zone average
OMZM	outside mixing zone minimum
Toledo DES	Toledo Division of Environmental Services (Department of Public Utilities)
WQS	water quality standard

Table C-1. Ohio and Michigan water quality standards

Constituent	Ohio EPA				Michigan DEQ			
	Agriculture (OMZA) [a]	Aquatic Life (IMZM) [b]	Aquatic Life (OMZA) [b]	Aquatic Life (OMZM) [b]	HNV non-drink [d]	FCV [e]	AMV [e]	FAV [e]
Arsenic	100	680	340	150	280	150	340	680
Cadmium	50	9.0 - 43 [c]	4.5 - 22 [c]	2.5 - 7.3 [c]	130	2 - 6 [c,f]	4 - 19 [c,f]	9 - 38 [c,f]
Chromium (hexavalent)	--	31	16	11	9,400	11 [d]	16 [d]	32 [d]
Chromium	100	3,600 - 11,000 [c]	1,800 - 5,600 [b]	86 - 270 [c]	9,400	74 - 231 [c,f]	570 - 1,773 [c,f]	1,140 - 3,537 [c,f]
Copper	500	28 - 100 [c]	14 - 52 [c]	9.3 - 30 [c]	38,000	9 - 29 [c,f]	13 - 50 [c,f]	27 - 99 [c,f]
Iron	5,000	--	--	--	--	--	--	--
Lead	100	240 - 1,400 [c]	120 - 710 [c]	6.4 - 37 [c]	190	21 - 61 [c,f]	100 - 291 [c,f]	399 - 1,166
Manganese	--		--	--	59,000	1,966 - 6,644 [c]	4,242 - 14,334 [c]	8,483 - 28,667
Mercury	10	3.4	1.7	0.91	0.0018	0.77 [f]	1.4 [f]	2.8 [f]
Nickel	200	940 - 3,000 [c]	470 - 1,500 [c]	52 - 170 [c]	210,000	52 - 167 [c,f]	468 - 1,513 [c,f]	937 - 3,026 [c,f]
Selenium	50	--	--	5.0	2,700	5	62	120
Silver	--	--	--	--	11,000	0.06	0.54	1.1
Zinc	25,000	240 - 780 [c]	120 - 390 [c]	120 - 390 [c]	16,000	118 - 382 [c,f]	117 - 379 [c,f]	234 - 759 [c,f]

Notes
Results are reported in micrograms per liter.
A double dash ("--") indicates that no WQS were promulgated for the constituent indicated.
AMV = aquatic maximum value; FAV = final acute value; FCV = final chronic value; HNV = human non-carcinogen value; OMZA = outside mixing zone average; OMZM = outside mixing zone maximum; WQS = water quality standards.
a. Ohio metals WQS for the protection of agricultural use are expressed as total recoverable (Table 7-12 of *OAC-3745-01-07*).
b. Ohio metals WQS for the protection of aquatic life are expressed as total recoverable (Table 7-1 and Table 7-9 of *OAC-3745-01-07*).
c. These metals WQS are dependent upon hardness (Table 7-9 of *OAC-3745-01-07* and *MAC 323.1057*). The displayed ranges are for 100 and 400 milligrams per liter calcium carbonate hardness.
d. Michigan metals WQS for the protection of human life are for non-drinking water uses and are expressed as total.
e. Michigan metals WQS for the protection of aquatic life are expressed as total unless indicated otherwise.
f. Michigan metals WQS for the protection of aquatic life that are expressed as dissolved.

Table C-2. Water column metals results for Shantee Creek

Constituent	WQS [a]		P11S96	P11S62	P11S60				#21	P11S80	
			Ohio EPA	Ohio EPA	Ohio EPA				Toledo DES	Ohio EPA	
			2011	1987	1987	1992	1994	2011	1995 - 2013 [b]	1992	1994
	OMZM	OMZA	n=5	n=1	n=1	n=2	n=2	n=5	24 < n < 112 [b]	n=2	n=2
Aluminum	--	--	<200 - 323	--	--	384 - 6,620	537 - 1,780	285 - 542	--	332 - 4,700	242 - 1,880
Arsenic	340	150	2.3 - 5.3	2	<2	<2 - 3	3	2.5 - 5.4	--	2	2 - 4
Cadmium [c]	4.5 - 22	2.5 - 7.3	<0.20	<0.20	<0.20	<0.2 - 1.3	<0.2 - 0.2	<0.20	<0.2 - 2	<0.2 - 0.7	<0.2 - 0.3
Chromium (hexavalent) [d]	16	11	--	--	--	--	--	--	<0.2 - 0.5	--	--
Chromium [c]	1,800 - 5,600	86 - 270	<2.0	<30	<30	<30	<30	<2.0 - 2.0	<1 - **648**	<30	<30
Copper [c]	14 - 52	9.3 - 30	2.7 - 6.8	<10	<10	<10 - **74**	**<10**, <10	5.8 - 9.6	<10 - **80**	<10 - **26**	**<10**, <10
Iron	--	--	601 - 1,230	640	440	629 - 11,280	550 - 2,930	622 - 1,280	<10 - 6,700	643 - 7,450	267 - 3,280
Lead [c]	120 - 710	6.4 - 37	<2.0 - 4.4	8	2	4 - **107**	<2 - **17**	3.6 - 5.6	<10 - **44**	2 - **53**	<2 - **18**
Manganese	--	--	88 - 879	--	--	--	--	139 - 268	--	--	--
Mercury	1.7	0.91	--	--	--	<0.2 - 0.34	<0.2	--	<0.2 - 0.304	<0.2	<0.2
Nickel [c]	470 - 1,500	52 - 170	2.1 - 4.7	<40	<40	<40	<40	3.5 - 7.0	<10 - 120	<40	<40
Selenium	--	5.0	<2.0	--	--	<2.0	<2.0	<2.0	--	<2.0	<2.0
Silver			--	--	--	--	--	--	<10	--	--
Zinc [c]	120 - 390	120 - 390	<10 - 41	20	15	34 - **316**	14 - 34	18 - 39	<10 - **1,240**	12 - 152	13 - 44

Notes
Sites are listed from left to right as headwaters to mouth.
Results are reported in micrograms per liter.
A double dash (“--“) indicates that no WQS were promulgated for the constituent indicated (WQS fields) or that the sample was not evaluated for the indicated constituent (samples fields).
OMZA = outside mixing zone average; OMZM = outside mixing zone maximum; WQS = water quality standards.
Shaded orange cells indicate results greater than the reporting or detection limit.
Bolded values exceed WQS: **bolded green** for exceeding the OMZA and **bolded red** for exceeding both the OMZA and OMZM.
a. Ohio water quality standards for the protection of aquatic life (Table 7-1 and Table 7-9 of *OAC-3745-01-07*). Metals standards are in micrograms per liter as total recoverable.
b. The number of samples and sample dates vary by parameter; additional information is provided in Section A-1.1 of Appendix A.
c. These metals water quality criteria are dependent upon hardness (Table 7-9 of *OAC-3745-01-07*). The displayed ranges are for 100 and 400 milligrams per liter calcium carbonate hardness.

Table C-3. Water column metals results for Silver Creek

	WQS a		P11P30		P11S79			#20	P11S99	301449	P11P31
			Ohio EPA				Ohio EPA	Toledo DES	Ohio EPA	Ohio EPA	Ohio EPA
			1977 [b]	1994	1992	1994	2011	1995 - 2013 [c]	1994	2011	1976 [b]
Constituent	OMZM	OMZA	n=1	n=2	n=2	n=2	n=5	24 < n < 113 [c]	n=2	n=5	n=1
Aluminum	--	--	--	501 - 1,150	<200 - 1,540	237 - 844	<200 - 417	--	<200 - 1,040	260 - 511	<10
Arsenic	340	150	--	<2 - 3	<2 - 3	3	2.9 - 5.5	--	<2 - 4	2.6 - 5.3	--
Cadmium [d]	4.5 - 22	2.5 - 7.3	<5	<0.20	<0.20 - 0.20	<0.20	<0.20	<0.2 - 1	<0.20	<0.20	<5
Chromium (hexavalent) [e]	16	11	<30	--	--	--	--	<0.5 - 0.5	--	--	<30
Chromium (total) [d]	1,800 - 5,600	86 - 270	<30	<30	<30	<30	<2.0	<0.1 - **480**	<30	<2.0 - 3.8	50
Copper [d]	14 - 52	9.3 - 30	<30	**<10**, <10	**<10**, <10	**<10**, <10	4.1 - 8.3	<0.5 - **43**	**<10**, <10	6.2 - 10	<30
Iron	--	--	--	772 - 1,400	430 - 2,320	478 - 1,330	391 - 959	<100 - 5,500	162 - 1,800	597 - 1,270	--
Lead [d]	120 - 710	6.4 - 37	219	4 - 5	<2 - 14	<2 - 8	<2 - 3.4	<1 - **14**	<2	2.5 - 6.8	9 - 21
Manganese	--	--	--	--	--	--	110 - 406	--	--	100 - 588	--
Mercury	1.7	0.91	--	<0.2	<0.2	<0.2	--	<0.1 - **6.2**	<0.2	--	<0.5
Nickel [d]	470 - 1,500	52 - 170	--	<40	<40	<40	2.7 - 4.4	<10 - 12	<40	4.0 - 6.9	<100
Selenium	--	5.0	--	<2.0	<2.0	--	<2.0	--	--	<2.0	--
Silver	--	--	--	--	--	<2.0	--	<10	<2.0	--	<30
Zinc [d]	120 - 390	120 - 390	120	<10 - 10	<10 - 46	<10 - 20	<10 - 65	<10 - 243	13 - 22	14 - 54	200

Notes
Sites are listed from left to right as headwaters to mouth.
Results are reported in micrograms per liter.
A double dash ("--") indicates that no WQS were promulgated for the constituent indicated (WQS fields) or that the sample was not evaluated for the indicated constituent (samples fields).
OMZA = outside mixing zone average; OMZM = outside mixing zone maximum; WQS = water quality standards.
Shaded orange cells indicate results greater than the reporting or detection limit.
Bolded values exceed WQS: **bolded green** for exceeding the OMZA and **bolded red** for exceeding both the OMZA and OMZM.
a. Ohio water quality standards for the protection of aquatic life (Table 7-1 and Table 7-9 of *OAC-3745-01-07*). Metals standards are in micrograms per liter as total recoverable.
b. Hardness data are not reported with the P11P30 samples from 1977 and the P11P31 sample from 1976. These data were not evaluated with the WQS.
c. The number of samples and sample dates vary by parameter; additional information is provided in Section A-1.1 of Appendix A.
d. These metals water quality criteria are dependent upon hardness (Table 7-9 of *OAC-3745-01-07*). The displayed ranges are for 100 and 400 milligrams per liter calcium carbonate hardness.
e. The hexavalent chromium water quality criterion is for dissolved.

Table C-4. Water column metals results for Halfway Creek

Constituent	WQS				301448	580450	
	Ohio [a]		Michigan [b]		Ohio EPA	Michigan DEQ	
	Aquatic Life OMZM	Aquatic Life OMZA	FCV	AMV	2011 n=5	2000 n=1	2005 n=1
Aluminum	--	--	--	--	<200 - 531	--	--
Arsenic	340	150	150	340	<2.0	2.7	2
Cadmium [c,d]	4.5 - 22	2.5 - 7.3	2 - 6	4 - 19	<0.20	<0.2	<0.2 [c]
Chromium [c,d]	1,800 - 5,600	86 - 270	74 - 231	570 - 1,773	<2.0	<1.0	<1.0 [c]
Copper [c,d]	14 - 52	9.3 - 30	9 - 29	13 - 50	<2.0 - 2.9	3.7	2.5
Iron	--	--	--	--	229 - 898	--	--
Lead [c,d]	120 - 710	6.4 - 37	21 - 61	100 - 291	<2.0	<1.0	<1.0 [c]
Manganese [c,d]	--	--	1,966 - 6,644	4,242 - 14,334	36 - 82	--	--
Mercury [d]	1.7	0.91	0.77	1.4	--	<0.2	<0.2 [c]
Nickel [c,d]	470 - 1,500	52 - 170	52 - 167	468 - 1,513	4.0 - 6.1	10	--
Selenium	--	5.0	5	62	<2.0	<1.0	<1.0 [c]
Silver	--	--	0.06	0.54	--	<0.5	<0.5 [c]
Zinc [c,d]	120 - 390	120 - 390	118 - 382	117 - 379	<10 - 14	17	16

Notes
Sites are listed from left to right as headwaters to mouth.
Results are reported in micrograms per liter.
A double dash ("--") indicates that no WQS were promulgated for the constituent indicated.
AMV = aquatic maximum value; FCV = final chronic value; OMZA = outside mixing zone average; OMZM = outside mixing zone maximum; WQS = water quality standards.
Shaded orange cells indicate results greater than the reporting or detection limit.
a. Ohio WQS for the protection of aquatic life (Table 7-1 and Table 7-9 of *OAC-3745-01-07*). Metals standards are in micrograms per liter as total recoverable.
b. Michigan WQS for the protection of aquatic life (*MAC 323.1057*). Metals standards are in micrograms power liter as total, unless indicated otherwise.
c. These metals water quality criteria are dependent upon hardness (Table 7-9 of *OAC-3745-01-07* and *MAC 323.1057*). The displayed ranges are for 100 and 400 milligrams per liter calcium carbonate hardness.
d. Michigan metals WQS for the protection of aquatic life that are expressed as dissolved.
e. Detection limits were not reported with Michigan DEQ's 2005 data. In this table, the detection limits for the 2005 data are assumed to be equivalent to the detection limits of the 2000 data.

Table C-5. Water column metals results for Indian Creek

	WQS [b]		580449	
			Michigan DEQ	
			2000	2005
Constituent	FCV	AMV	n=1	n=1
Arsenic	150	340	3.6	3
Cadmium [b,c]	2 - 6	4 - 19	<0.2	<0.2 [d]
Chromium [b,c]	74 - 231	570 - 1,773	<1.0	<1.0 [d]
Copper [b,c]	9 - 29	13 - 50	2.1	2.2
Lead [b,c]	21 - 61	100 - 291	<1.0	<1.0 [d]
Mercury [c]	0.77	1.4	<0.2	<0.2 [d]
Nickel [b]	52 - 167	468 - 1,513	10	--
Selenium	5	62	<1.0	<1.0 [d]
Silver	0.06	0.54	<0.5	<0.5 [d]
Zinc [b,c]	118 - 382	117 - 379	<10	<10 [d]

Notes
Results are reported in micrograms per liter.
A double dash (“--“) indicates that no WQS were promulgated for the constituent indicated.
AMV = aquatic maximum value; FCV = final chronic value; WQS = water quality standards.
Shaded orange cells indicate results greater than the reporting or detection limit.
a. Michigan WQS for the protection of aquatic life (*MAC 323.1057*). Metals standards are in micrograms power liter as total, unless indicated otherwise.
b. These metals water quality criteria are dependent upon hardness (*MAC 323.1057*). The displayed ranges are for 100 and 400 milligrams per liter calcium carbonate hardness.
c. Michigan metals WQS for the protection of aquatic life that are expressed as dissolved.
d. Detection limits were not reported with Michigan DEQ’s 2005 data. In this table, the detection limits for the 2005 data are assumed to be equivalent to the detection limits of the 2000 data.

Appendix D.

Subwatersheds

Tables

Figure

Abbreviations and Acronyms

FRS	Federal Registry System
HUC	hydrologic unit code
LUST	leaking underground storage tank
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
Ohio EPA DERR	Ohio Environmental Protection Agency Division of Environmental Response and Revitalization
PDI	percent developed impervious
PTC	percent tree canopy
RCRA	Resource Conservation and Recovery Act
TRI	Toxic Release Inventory
UST	underground storage tank
U.S. EPA R5	U.S. Environmental Protection Agency, Region 5
VAP	Ohio's Volunteer Action Program

Table D-1. Delineated subwatersheds

Subwatershed name	Hydrography description	Downstream subwatershed	Critical area	Critical area name
Shantee Creek (HUC 04100001 03 01)				
Tifft Ditch (upper)	Tifft Ditch from headwaters to Franklin Park Mall	Tifft Ditch (lower)	No	--
Tifft Ditch (lower)	Tifft Ditch from Franklin Park Mall to mouth on Shantee Creek	Shantee Creek (upper)	Yes	Secor Road, West Sylvania Avenue, & Monroe Street
Eisenbraum Ditch (upper)	Eisenbraum Ditch from headwaters to West Laskey Road	Eisenbraum Ditch (lower)	No	--
Eisenbraum Ditch (lower)	Eisenbraum Ditch from West Laskey Road to mouth on Shantee Creek	Shantee Creek (upper)	No	--
Shantee Creek (upper)	Shantee Creek from the confluence of Tifft Ditch and Eisenbraum Ditch to split west of Jackman Road (along railroad lines adjacent to Bowman Park)	Shantee Creek (West Laskey Road)	No	--
Shantee Creek (West Sylvania Avenue)	South of Shantee Creek along southern HSSCA boundary	Shantee Creek (West Laskey Road)	No	--
Shantee Creek (West Laskey Road)	Shantee Creek from split west of Jackman Road to Bennett Park	Shantee Creek (Telegraph Road)	Yes	West Laskey Road
Shantee Creek (Telegraph Road)	Shantee Creek from Bennet Park to railroad	Shantee Creek (Stickney Avenue)	Yes	Telgraph Road, North Deroit Avenue, & West Laskey Avenue
Shantee Creek (Stickney Avenue)	Shantee Creek between railroad lines	Shantee Creek (lower)	Yes	Stickney Avenue
Shantee Creek (lower)	Shantee Creek from railroad to mouth on Silver Creek	Silver Creek (lower)	No	--
Silver Creek (upper)	North and South branches of Silver Creek	Silver Creek (Jackman Road)	No	--
Silver Creek (Jackman Road)	Confluence of North and South branches of Silver Creek to Jackman Road	Silver Creek (General Motors)	No	--
Ketcham Ditch (upper)	Ketcham Ditch headwaters to Wernerts Field	Ketcham Ditch (middle)	No	--
Ketcham Ditch (West Laskey Road)	Storm sewer drainage to Ketcham Ditch at Wernerts Field	Ketcham Ditch (middle)	No	--
Ketcham Ditch (middle)	Ketcham Ditch from Wernerts Field to Jackman Road	Ketcham Ditch (lower)	No	--
Ketcham Ditch (lower)	Ketcham Ditch from Jackman Road to mouth on Silver Creek	Silver Creek (General Motors)	Yes	Jackman Road, Coining Drive, & Prosperity Road
Silver Creek (General Motors)	Silver Creek from Jackman Road to Lewis Avenue	Silver Creek (North Town Square)	Yes	West Alexis Road
Jamieson Ditch (upper)	Jamieson Ditch from headwaters to Jackman Road	Jamieson Ditch (middle)	No	--
Jamieson Ditch (middle)	Jamieson Ditch from Jackman Road to Lewis Avenue	Jamieson Ditch (lower)	Yes	Jamieson Ditch
Jamieson Ditch (lower)	Jamieson Ditch from Lewis Avenue to the mouth on Silver Creek	Silver Creek (North Town Square)	No	--

Subwatershed name	Hydrography description	Downstream subwatershed	Critical area	Critical area name
Silver Creek (North Towne Square)	Silver Creek from Lewis Avenue to Enterprise Boulevard	Silver Creek (RR crossing)	Yes	West Alexis Road
Silver Creek (RR crossing)	Silver Creek from railroad intersection to Raintree Parkway	Silver Creek (lower)	No	--
Silver Creek Cutoff	Silver Creek cutoff from East Alexis Road to mouth on Halfway Creek	Halfway Creek (Erie Township)	Yes	Benore Road
Silver Creek (lower)	Silver Creek from Raintree Parkway to the mouth on Halfway Creek	Halfway Creek (lower)	Yes	East Aexis Road, Enterprise Boulevard, & Hagman Road
Halfway Creek (HUC 04100001 03 02)				
Sunior Drain	Sunior Drain and other agricultural ditches	Halfway Creek (headwaters)	No	--
Sink Creek	Sink Creek	Halfway Creek (Whiteford Township)	No	--
Halfway Creek (headwaters)	Halfway Creek headwater to confluence with Sink Creek, Labadie Drain, & McMeekian Drain	Halfway Creek (Whiteford Township)	No	--
Halfway Creek (Whiteford Township)	Halfway Creek from Sink Creek to Clegg Road	Halfway Creek (Lambertville)	No	--
Halfway Creek (Lambertville)	Halfway Creek from Clegg Road to North Ridgewood Lane	Halfway Creek (golf courses)	No	--
Spring Brook	Spring Brook	Halfway Creek (golf courses)	No	--
Halfway Creek (golf courses)	Halfway Creek from North Ridgewood Lane to Lewis Avenue	Halfway Creek (State Line Road)	No	--
Halfway Creek (State Line Road)	Halfway Creek from Lewis Avenue to motor home park	Halfway Creek (North Towne Square)	No	--
Halfway Creek (North Towne Square)	Halfway Creek from motor home park to Indian Creek	Halfway Creek (Bedford Township)	Yes	--
Bragden Ditch	Bragden Ditch	Indian Creek	No	--
Indian Creek	Indian Creek excluding Bragden Ditch	Halfway Creek (Bedford Township)	No	--
Halfway Creek (Bedford Township)	Halfway Creek from Indian Creek to Silver Creek cutoff	Halfway Creek (Erie Township)	No	--
Halfway Creek (Erie Township)	Halfway Creek from Silver Creek cutoff to Silver Creek	Halfway Creek (lower)	No	--
Halfway Creek (lower)	Halfway Creek from Silver Creek to mouth on North Maumee Bay	n/a	No	--
Detwiler Ditch-Frontal Lake Erie (HUC 04100001 03 09)				
Shantee Creek Cutoff (upper)	Shantee Creek cutoff from the racetrack to East Alexis Road	Shantee Creek cutoff (lower)	No	--
Shantee Creek Cutoff (lower)	Shantee Creek cutoff from East Alexis Road to mouth on North Maumee Bay	n/a	No	--

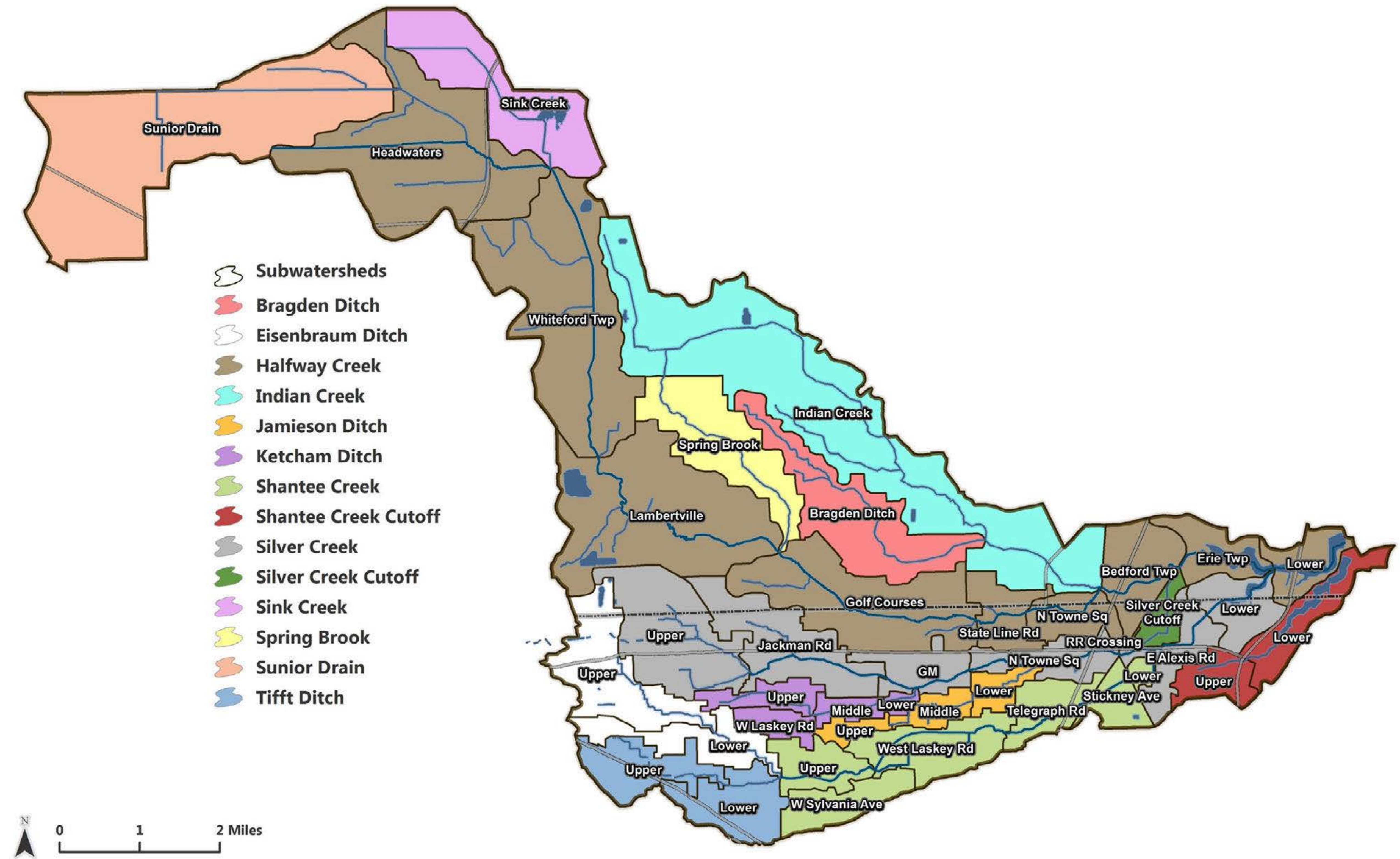

Figure D-1. Subwatershed map.

Table D-2. Land cover and land use in the delineated subwatersheds

Subwatershed name	Area (acres)	PDI (percent)	PTC (percent)	Agriculture (percent)	Developed L, M, H (percent)	Developed - open (percent)	Forest (percent)	Water & Wetland (percent)	Other (percent)
Shantee Creek (HUC 04100001 03 01)									
Tifft Ditch (upper)	593	48%	21%	--	86%	14%	0.4%	--	--
Tifft Ditch (lower)	628	51%	16%	--	92%	8%	1%	--	--
Eisenbraum Ditch (upper)	1,022	20%	47%	2%	47%	37%	13%	1%	0.1%
Eisenbraum Ditch (lower)	570	31%	36%	--	73%	27%	0.02%	--	--
Shantee Creek (upper)	404	35%	27%	--	79%	21%	--	--	--
Shantee Creek (West Sylvania Avenue)	456	47%	18%	--	94%	6%	--	--	--
Shantee Creek (West Laskey Road)	732	49%	9%	--	92%	8%	--	--	--
Shantee Creek (Telegraph Road)	408	53%	3%	--	84%	15%	1%	--	--
Shantee Creek (Stickney Avenue)	279	28%	20%	--	39%	41%	19%	0.1%	--
Shantee Creek (lower)	76	43%	15%	--	75%	13%	11%	1%	--
Silver Creek (upper)	1,245	28%	25%	11%	61%	17%	10%	0.1%	0.3%
Silver Creek (Jackman Road)	1,041	33%	22%	--	74%	20%	7%	--	--
Ketcham Ditch (upper)	284	39%	19%	--	89%	11%	--	--	--
Ketcham Ditch (West Laskey Road)	219	44%	13%	--	87%	13%	--	--	--
Ketcham Ditch (middle)	162	37%	21%	--	90%	8%	2%	--	--
Ketcham Ditch (lower)	60	53%	18%	--	74%	7%	19%	--	--
Silver Creek (General Motors)	409	56%	5%	--	77%	20%	2%	0.3%	--
Jamieson Ditch (upper)	126	57%	13%	--	94%	6%	--	--	--
Jamieson Ditch (middle)	221	56%	12%	--	76%	11%	12%	1%	--
Jamieson Ditch (lower)	212	41%	7%	--	91%	6%	3%	--	--
Silver Creek (North Towne Square)	453	52%	5%	--	77%	19%	4%	--	--
Silver Creek (RR crossing)	52	47%	10%	--	92%	8%	--	--	--
Silver Creek Cutoff	197	37%	8%	--	80%	18%	0.05%	2%	--
Silver Creek (East Alexis Road)	422	49%	7%	--	81%	17%	1%	1%	--
Silver Creek (lower)	477	30%	2%	9%	66%	23%	--	3%	0.3%

Subwatershed name	Area (acres)	PDI (percent)	PTC (percent)	Agriculture (percent)	Developed L, M, H (percent)	Developed - open (percent)	Forest (percent)	Water & Wetland (percent)	Other (percent)
Halfway Creek (HUC 04100001 03 02)									
Sunior Drain	3,784	1%	1%	91%	2%	5%	0.4%	1%	0.2%
Sink Creek	1,443	1%	14%	71%	2%	6%	14%	6%	1%
Halfway Creek (headwaters)	2,632	2%	6%	77%	4%	10%	5%	2%	1%
Halfway Creek (Whiteford Township)	2,661	3%	14%	62%	4%	16%	16%	1%	1%
Halfway Creek (Lambertville)	2,447	13%	23%	20%	26%	29%	19%	3%	2%
Spring Brook	1,146	15%	36%	--	37%	32%	30%	0.1%	--
Halfway Creek (golf courses)	1,677	21%	20%	--	44%	42%	13%	0.2%	0.2%
Halfway Creek (State Line Road)	414	37%	14%	--	74%	15%	7%	--	3%
Halfway Creek (North Towne Square)	380	42%	10%	--	66%	25%	7%	3%	--
Bragden Ditch	1,378	17%	28%	--	39%	37%	23%	< 0.1%	1%
Indian Creek	4,397	10%	31%	14%	19%	32%	33%	1%	1%
Halfway Creek (Bedford Township)	734	23%	17%	11%	61%	13%	5%	8%	3%
Halfway Creek (Erie Township)	443	10%	3%	48%	30%	4%	--	15%	3%
Halfway Creek (lower)	408	20%	12%	9%	54%	6%	11%	18%	2%
Detwiler Ditch-Frontal Lake Erie (HUC 04100001 03 09)									
Shantee Creek Cutoff (upper)	343	34%	2%	--	55%	45%	0.5%	--	0.3%
Shantee Creek Cutoff (lower)	562	28%	4%	1%	68%	17%	1%	13%	--

Notes
A double dash indicates that the land use was not present in the subwatershed.
a. PDI is NLCD 2006 Percent Developed Impervious.
b. PTC is NLCD 2006 Percent Tree Canopy.
c. Agriculture is NLCD 2006 Land Cover categories Cultivated Crops (#81) and Pasture/Hay (#82).
d. Developed L, M, H is NLCD 2006 Land Cover categories Developed, Low Intensity (#22), Developed, Medium Intensity (#23), and Developed, High Intensity (#24).
e. Developed - open is NLCD 2006 Land Cover category Developed, Open (#21).
f. Forest is NLCD 2006 Land Cover categories Deciduous Forest (#41), Evergreen Forest (#42), and Mixed Forest (#423).
g. Water & Wetland is NLCD 2006 Land Cover categories Open Water (#10), Woody Wetlands (#90), and Emergent Herbaceous Wetlands (#95).
h. Other is NLCD 2006 Land Cover categories Barren Land (Rock/Sand/Clay) (#31), Shrub/Scrub (#52), and Grassland/Herbaceous (#71).

Table D-3. Regulated facilities and spills in the delineated subwatersheds

	Federal programs				NPDES					Ohio programs				Michigan programs					Spills	
					Individual		General													
Subwatershed name	FRS	RCRA	Superfund	TRI	Non-stormwater	Industrial stormwater	Non-stormwater	Industrial stormwater	Stormwater non-exposure	UST	LUST (active)	LUST (inactive)	VAP Project	UST (active)	UST (closed)	LUST (open)	LUST (closed)	Part 201 Site	Ohio EPA DERR	U.S. EPA R5
Shantee Creek (HUC 04100001 03 01)																				
Tifft Ditch (upper)	21	12	--	--	--	--	--	--	--	21	--	8	--	--	--	--	--	--	2	--
Tifft Ditch (lower)	35	19		--	--	--	--	--	--	19	--	20	--	--	--	--	--	--	6	1
Eisenbraum Ditch (upper)	6	2	--	1	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1	--
Eisenbraum Ditch (lower)	12	7	--	--	--	--	--	--	--	12	--	13	--	--	--	--	--	--	2	--
Shantee Creek (upper)	3	2	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	2	--
Shantee Creek (West Sylvania Avenue)	17	10	--	2	--	1*	--	1	--	5	--	4	--	--	--	--	--	--	5	--
Shantee Creek (West Laskey Road)	30	16	2	1	--	--	--	--	--	24	3	11	1	--	--	--	--	--	12	1
Shantee Creek (Telegraph Road)	26	19	--	3	--	--	--	5	1	12	--	9	--	--	--	--	--	--	21	2
Shantee Creek (Stickney Avenue)	10	4	--	--	1	1	--	--	1	9	--	9	--	--	--	--	--	--	8	--
Shantee Creek (lower)	--	--	--	--	--	--	--	--	--	1	--	0	--	--	--	--	--	--	3	--
Silver Creek (upper)	22	13	--	--	--	--	--	--	--	11	1	8	--	--	--	--	--	--	9	--
Silver Creek (Jackman Road)	16	8	--	--	--	--	--	--	--	17	2	16	--	--	--	--	--	--	6	1
Ketcham Ditch (upper)	6	3	--	--	--	--	--	1	--	3	1	2	--	--	--	--	--	--	--	--
Ketcham Ditch (West Laskey Road)	8	4	--	--	--	--	--	--	--	12	1	6	--	--	--	--	--	--	--	--
Ketcham Ditch (middle)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--
Ketcham Ditch (lower)	13	12	--	1	--	--	--	3	--	--	--	--	--	--	--	--	--	--	4	--
Silver Creek (General Motors)	20	14	--	2	--	2*	--	--	--	13	2	12	--	--	--	--	--	--	5	--
Jamieson Ditch (upper)	6	3	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--
Jamieson Ditch (middle)	6	7	--	2	--	--	--	--	--	3	3	9	--	--	--	--	--	--	9	--
Jamieson Ditch (lower)	1	1	--	--	--	--	--	--	--	--	0	0	--	--	--	--	--	--	--	--
Silver Creek (North Towne Square)	19	17	1	--	1	--	--	1	1	19	2	14	--	--	--	--	--	--	13	1
Silver Creek (RR crossing)	2	1	--	--	--	--	--	--	--	2	--	2	--	--	--	--	--	--	--	--
Silver Creek cutoff	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Silver Creek (Enterprise)	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--

Subwatershed name	Federal programs				NPDES					Ohio programs				Michigan programs					Spills	
					Individual		General													
	FRS	RCRA	Superfund	TRI	Non-stormwater	Industrial stormwater	Non-stormwater	Industrial stormwater	Stormwater non-exposure	UST	LUST (active)	LUST (inactive)	VAP Project	UST (active)	UST (closed)	LUST (open)	LUST (closed)	Part 201 Site	Ohio EPA DERR	U.S. EPA R5
Silver Creek (lower)	5	6	--	2	--	--	--	--	--	4	--	4	--	--	--	--	--	--	3	--
Halfway Creek (HUC 04100001 03 02)																				
Sunior Drain	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sink Creek	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Halfway Creek (headwaters)	2	1	--	--	--	--	1	--	--	--	--	-	--	--	2	--	--	--	--	--
Halfway Creek (Whiteford Township)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Halfway Creek (Lambertville)	13	12	--	--	2	--	--	--	--	--	--	--	--	12	8	3	3	1	--	--
Spring Brook	3	1	--	--	--	--	--	--	--	--	--	--	--	--	18	--	3	1	--	--
Halfway Creek (golf courses)	7	5	--	--	--	--	--	--	--	7	--	5	--	--	--	--	--	--	2	--
Halfway Creek (State Line Road)	15	7	--	--	--	--	--	--	--	4	--	4	--	--	7	--	1	1	3	--
Halfway Creek (North Towne Square)	15	8	--	1	1	--	--	--	1	2	--	1	--	--	--	--	--	--	3	--
Bragden Ditch	2	2	--	1	--	--	--	--	--	--	--	--	--	--	10	--	3	--	--	--
Indian Creek	18	14	1	1	1	--	--	1	--	--	--	--	--	5	5	3	2	1	--	--
Halfway Creek (Bedford Township)	20	16	--	2	--	--	--	1	1	3	--	2	--	1	1	--	--	1	3	--
Halfway Creek (Erie Township)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	3	--	--	--
Halfway Creek (lower)	2	2	--	--	--	--	--	--	--	--	--	--	--	--	4	--	2	--	1	--
Detwiler Ditch-Frontal Lake Erie (HUC 04100001 03 09)																				
Shantee Creek cutoff (upper)	1	--	--	--	--	--	--	--	--	2	--	2	--	--	--	--	--	--	--	--
Shantee Creek cutoff (lower)	1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--

Notes
FRS = Federal Registry System; HUC = hydrologic unit code; LUST = leaking underground storage tank; NPDES = National Pollutant Discharge Elimination System; Ohio EPA DERR = Ohio Environmental Protection Agency, Division of Environmental Response and Revitalization; RCRA = Resource Conservation and Recovery Act; TRI = Toxic Release Inventory; U.S. EPA R5 = U.S. Environmental Protection Agency, Region 5; UST = underground storage tank; VAP = Volunteer Action Program.
* = A single individual NPDES permit for stormwater discharge in this delineated subwatershed was terminated.

Appendix E.

Recommendations for Future Sampling Efforts

Tables

Figures

Note: The full references of the materials cited in this appendix are presented in the main report.

Table E-1. Recommended sample sites

Subwatershed	CA	Station ID	Stream size [a]	Pri. [b]	Station description	Biology		Water		Flow	Sediment		Costs			
						F/M/H	FT	FP	M/O		M/O	PCBs	Labor [c]	Lab [d]	Total	
Tifft Ditch (upper)	No	TD-1	PHW	H	east of Tallmadge Road (downstream of storm sewer outlets)	--	--	X	--	--	X	--	$75	$400	$525	$600
		TD-3	PHW	L	east of Naomi Drive, south of Quinton Avenue	--	--	X	--	--	--	--	$25	--	$25	
		TD-2	PHW	M	Quinton Avenue at Harbor Drive, west end of Foxgrove Meadow Park	--	--	X	--	--	--	--	$25	--	$25	
		TD-4	PHW	L	Fox Grove Drive (west of Secor Road), behind medical complexes on Secor Road	--	--	X	--	--	--	--	$25	--	$25	
Tifft Ditch (lower)	Yes	P11S97	PHW	H	east of Secor Road	--	--	X	X	X	X	X	$225	$1,225	$1,300	$1,300
Eisenbraum Ditch (lower)	No	ED-1	PHW	M	at north side of school on Oak Grove Place	--	--	X	--	X	X	--	$175	$400	$525	$525
Shantee Creek (upper)	No	ShC-1	HW	L	east side of Douglas Road & Lambert Drive intersection	--	--	X	--	--	--	--	$25	--	$25	$50
		ShC-2	HW	L	Longfellow Elementary School, driveway fork	--	--	X	--	--	--	--	$25	--	$25	
Shantee Creek (West Laskey Road)	Yes	ShC-3	HW	H	Bowman Park, southern tip near RR right-of-way	X	--	X	X	X	X	X	$1,625	$1,725	$3,350	$5,025
		ShC-4	HW	M	across from Smucker's/Teledyne	--	--	X	--	X	--	--	$125	--	$125	
		ShC-5	HW	M	Larchmount Elementary School, south side	--	--	X	--	X	--	--	$125	--	$125	
		ShC-6	HW	L	just west of Lewis Avenue & West Laskey Road intersection	--	--	X	--	--	X	--	$75	$400	$475	
		ShC-7	HW	L	northwest corner of Lewis Avenue & Cribb Street	--	--	X	--	--	X	--	$75	$400	$475	
		ShC-8	HW	H	north of West Laskey Road & Burnham Avenue	--	--	X	--	--	X	--	$75	$400	$475	
Shantee Creek (Telegraph Road)	Yes	ShC-9	HW	H	West Laskey Road east of Tractor Road, east of vacant lot	--	--	X	--	X	X	X	$175	$600	$775	$5,075
		P11S62	HW	H	between Telegraph Road bridge and North Detroit Road bridge	--	--	X	--	--	X	--	$75	$400	$475	
		ShC-10	HW	M	just east of North Detroit Avenue bridge	--	--	X	--	--	X	X	$75	$600	$675	
		ShC-11	HW	H	just west of RR right-of-way (upstream of RR right-of-way)	X	--	X	X	X	X	--	$1,625	$1,525	$3,150	
Shantee Creek (Stickney Avenue)	Yes	P11S60	HW	H	just west of Stickney Avenue (upstream of storm sewer outlets)	X	X	X	--	--	X	--	$1,675	$2,400	$4,075	$5,525
		ShC-12	HW	H	just east of Stickney Avenue (downstream of storm sewer outlets)	--	--	X	X	X	X	X	$225	$1,225	$1,450	
Shantee Creek (lower)	No	ShC-13	HW	L	behind Walnut Lane (use field SE of Enterprise Blvd. & East Alexis Road)	--	--	X	--	X	--	--	$125	--	$125	$125
Silver Creek (General Motors)	Yes	SiC-1	HW	M	Silver Creek Road bridge	--	--	X	--	--	X	--	$75	$400	$475	$7,025
		P11P30	HW	H	just east of Jackman Road, southeast of intersection	X	--	X	X	X	X	--	$1,625	$1,525	$3,150	
		SiC-2	HW	L	along treeline at GM property or at service road crossing	--	--	X	--	--	--	--	$25	--	$25	
		SiC-3	HW	L	western edge of apartment complex on Lewis Avenue (west side)	--	--	X	--	--	--	--	$25	--	$25	
		P11S79	HW	H	east of Lewis Avenue bridge, just north of Heritage Baptist Church	X	--	X	X	X	X	X	$1,625	$1,725	$3,350	
Ketcham Ditch (lower)	Yes	P11A01	PHW	H	at Jackman Road, just north of Ketner Avenue	--	--	X	--	--	X	--	$75	$400	$475	$1,950
		KD-1	PHW	L	vicinity of 1604 Prosperity Drive (Ciralsky and Associates)	--	--	X	--	--	--	--	$25	--	$25	
		KD-2	PHW	H	near mouth, access through GM service road (dirt)	--	--	X	X	X	X	X	$225	$1,225	$1,450	
Jamieson Ditch (middle)	Yes	JD-1	PHW	M	behind 1520 West Laskey Road	--	--	X	--	--	X	--	$75	$400	$475	$1,625
		JD-2	PHW	M	Goody's Salvage Yard, open channel	--	--	X	--	--	X	--	$75	$400	$475	
		JD-3	PHW	H	Linda Drive, east of Lewis Avenue	--	--	X	--	--	X	X	$75	$600	$675	
Jamieson Ditch (lower)	No	JD-4	PHW	H	east of Silverdale Drive bridge, downstream of storm sewer outlets	--	--	X	X	X	X	X	$225	$1,225	$1,450	$1,450
Silver Creek (North Towne Square)	Yes	SiC-4	HW	L	east of Bennett Road, downstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	$3,875
		SiC-5	HW	H	Lewis Avenue (west side) upstream of storm sewer outlets	--	--	X	--	--	X	--	$75	$400	$475	
		SiC-6	HW	M	Lewis Avenue (east side), access through track's parking lot	--	--	X	--	--	--	--	$25	--	$25	
		SiC-7	HW	H	North Detroit Avenue bridge (east side), just south of East Alexis Road	X	--	X	X	X	X	X	$1,625	$1,725	$3,350	
Silver Creek (RR crossing)	No	SiC-8	HW	L	Stickney Avenue bridge, east side, downstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	$2,400
		P11S99	HW	H	East Alexis Road just upstream of Raintree Parkway	--	X	X	--	--	X	X	$275	$2,100	$2,375	

Subwatershed	CA	Station ID	Stream size [a]	Pri. [b]	Station description	Biology		Water		Flow	Sediment		Costs			
						F/M/H	FT	FP	M/O		M/O	PCBs	Labor [c]	Lab [d]	Total	
Silver Creek (East Alexis Road)	Yes	SiC-9	HW	L	East Alexis Road and Enterprise Boulevard, upstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	$3,900
		P11S80	HW	M	East Alexis Road and Enterprise Boulevard, downstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	
		301449	HW	H	Futura Drive	--	--	X	--	--	X	--	$75	$400	$475	
		SiC-10	HW	L	Menards eastern access bridge, downstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	
		P11P31	HW	H	Hagman Road bridge, east side, downstream of storm sewer outlets	X	--	X	X	X	X	X	$1,625	$1,725	$3,350	
Silver Creek Cutoff	Yes	P11S78	PHW	L	upstream of Benore Road	--	--	X	--	--	--	--	$25	--	$25	$1,500
		SCC-1	PHW	L	terminus of Heritage Court, upstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	
		SCC-2	PHW	M	American Road south of state line, downstream of storm sewer outlets	--	--	X	X	X	X	X	$225	$1,225	$1,450	
Halfway Creek (North Towne Mall)	Yes	HC-1	W	H	terminus of Mel Simmon Drive (west)	--	--	X	--	--	X	X	$75	$600	$675	$3,275
		HC-2	W	L	Telegraph Road bridge, east side, downstream of storm sewer outlets	--	--	X	--	--	--	--	$25	--	$25	
		301448	W	H	East State Line Road bridge, downstream of storm sewer outlets	X	--	X	X	X	X	X	$1,475	$1,100	$2,575	

Notes
Field headings: CA = critical area; Pri. = relative sampling priority; F/M/H = fish, macroinvertebrate, and habitat to be sampling and analysis; FT = fish tissue analysis; FP = field parameters to be monitored in the field with a meter; M/O = metals and organic constituents to be evaluated in a laboratory; PCBs = polychlorinated biphenyls to be evaluated in a laboratory
a. Stream size according to Ohio EPA. PHW = primary headwaters (less than 3 square miles drainage area); HW = headwaters (3 to 20 square miles drainage area); W = wading (20 to ~100 square miles drainage area).
b. Priority ranking for future sampling. L=low; M = medium; H=high.
c. Labor costs are limited to the time necessary for sampling. These costs exclude travel time and other costs such as lodging, vehicle or equipment rental, and per diem.
d. Laboratory costs are limited to the costs charged by a third party laboratory. The costs for shipping, ice, and such are excluded. Laboratory costs are for the full suites of parameters, not just the subsets of parameters discussed in Section 7.1 of the main report.

Table E-2. Water column organic constituents

Organic constituent [a]	Methods [b]		Organic constituent [a]	Methods [b]
Acenaphthene	625		Dibromomethane	624
Acenaphthylene	625		Di-n-butylphthalate	625
Anthracene	625		Dichlorodifluoromethane	624
Benzene	624		Diethylphthalate	625
n-Butylbenzene	624		2,4-Dimethylphenol	625
sec-Butylbenzene	624		Dimethylphthalate	625
tert-Butylbenzene	624		4,6-Dinitro-2-methylphenol	625
Benzo[a]anthracene	625		2,4-Dinitrophenol	625
Benzo[a]pyrene	625		2,4-Dinitrotoluene	625
Benzo[b]fluoranthene	625		2,6-Dinitrotoluene	625
Benzo[g,h,i]perylene	625		Di-n-octylphthalate	625
Benzo[k]fluoranthene	625		Ethylbenzene	624
bis(2-Chloroethoxy)methane	625		Fluoranthene	625
bis(2-Chloroethyl)ether	625		Fluorene	625
bis(2-Chloroisopropyl)ether	625		Hexachlorobenzene	625
bis(2-Ethylhexyl)phthalate	625		Hexachlorobutadiene	624 & 625
Bromobenzene	624		Hexachlorocyclopentadiene	625
Bromochloromethane	624		Hexachloroethane	625
Bromodichloromethane	624		Indeno[1,2,3-cd]pyrene	625
Bromoform	624		Isophorone	625
Bromomethane	624		Isopropylbenzene	624
4-Bromophenyl-phenyl-ether	625		4-Isopropyltoluene	624
Butylbenzylphthalate	625		Methylene chloride	624
Carbon tetrachloride	624		Naphthalene	624 & 625
4-Chloro-3-methylphenol	625		Nitrobenzene	625
Chloroethane	624		2-Nitrophenol	625
Chloroform	624		4-Nitrophenol	625
Chloromethane	624		n-Nitroso-di-n-propylamine	625
2-Chloronaphthalene	625		n-Nitrosodiphenylamine	625
2-Chlorophenol	625		Pentachlorophenol	625
4-Chlorophenyl-phenyl-ether	625		Phenanthrene	625
2-Chlorotoluene	624		Phenol	625
4-Chlorotoluene	624		n-Propylbenzene	624
Chrysene	625		Pyrene	625
1,2-Dibromo-3-chloropropane	624		Styrene	624
1,2-Dibromoethane	624		Tetrachloroethene	624
1,2-Dichlorobenzene	624 & 625		1,1,1,2-Tetrachloroethane	624
1,3-Dichlorobenzene	624 & 625		1,1,2,2-Tetrachloroethane	624
1,4-Dichlorobenzene	624 & 625		Toluene	624
1,1-Dichloroethane	624		1,2,3-Trichlorobenzene	624
1,2-Dichloroethane	624		1,2,4-Trichlorobenzene	624 & 625
cis-1,2-Dichloroethene	624		1,2,3-Trichloropropane	624
trans-1,2-Dichloroethene	624		1,1,1-Trichloroethane	624
2,4-Dichlorophenol	625		1,1,2-Trichloroethane	624
1,2-Dichloropropane	624		Trichloroethene	624
1,3-Dichloropropane	624		Trichlorofluoromethane	624
2,2-Dichloropropane	624		2,4,6-Trichlorophenol	625
1,1-Dichloropropene	624		1,2,4-Trimethylbenzene	624
cis-1,3-Dichloropropene	624		1,3,5-Trimethylbenzene	624
trans-1,3-Dichloropropene	624		o-Xylene	624
Dibenzo[a,h]anthracene	625		Total m&p-xylenes	624
Dibromochloromethane	624		Vinyl chloride	624

Notes
a. Organic constituents reported for the 2011 monitoring (Ohio EPA 2011)
b. U.S. EPA laboratory methods (U.S. EPA 2007a,b,c) that Ohio EPA uses (Ohio EPA 2010b).

Table E-3. Sediment organic constituents

Organic constituent [a]	Methods [b]		Organic constituent [a]	Methods [b]
Acenaphthene	8270		Fluorene	8270
Acenaphthylene	8270		Hexachlorobenzene	8270
Acetophenone	8270		Hexachlorobutadiene	8270
2-Acetylaminofluorene	8270		Hexachlorocyclopentadiene	8270
Aniline	8270		Hexachloroethane	8270
Anthracene	8270		Hexachloropropene	8270
Benz[a]anthracene	8270		Indeno[1,2,3-cd]pyrene	8270
Benzo[a]pyrene	8270		Isophorone	8270
Benzo[b]fluoranthene	8270		2-Methylnaphthalene	8270
Benzo[g,h,i]perylene	8270		3-Methylcholanthrene	8270
Benzo[k]fluoranthene	8270		2-Methylphenol	8270
Benzyl alcohol	8270		3&4-Methylphenol	8270
bis(2-Chloroethoxy)methane	8270		Methyl methanesulfonate	8270
bis(2-Chloroethyl)ether	8270		1,4-Naphthoquinone	8270
bis(2-Chloroisopropyl)ether	8270		Naphthalene	8270
bis(2-Ethylhexyl)phthalate	8270		2-Nitroaniline	8270
4-Bromophenyl-phenylether	8270		4-Nitroaniline	8270
Butylbenzylphthalate	8270		Nitrobenzene	8270
4-Chloro-3-methylphenol	8270		2-Nitrophenol	8270
2-Chloronaphthalene	8270		4-Nitrophenol	8270
2-Chlorophenol	8270		N-Nitroso-di-n-butylamine	8270
4-Chlorophenyl-phenylether	8270		N-Nitroso-di-n-propylamine	8270
Chrysene	8270		N-Nitrosomorpholine	8270
Dibenz[a,h]anthracene	8270		N-Nitrosopiperidine	8270
Dibenzofuran	8270		Nitrobenzene	8270
Di-n-butylphthalate	8270		PCB-1016	8082
1,2-Dichlorobenzene	8270		PCB-1221	8082
1,3-Dichlorobenzene	8270		PCB-1232	8082
1,4-Dichlorobenzene	8270		PCB-1242	8082
3,3'-Dichlorobenzidine	8270		PCB-1248	8082
2,4-Dichlorophenol	8270		PCB-1254	8082
2,6-Dichlorophenol	8270		PCB-1260	8082
Diethylphthalate	8270		Pentachlorobenzene	8270
p-Dimethylaminoazobenzene	8270		Pentachlorophenol	8270
7,12-Dimethylbenz[a]anthracene	8270		Phenacetin	8270
2,4-Dimethylphenol	8270		Phenanthrene	8270
Dimethylphthalate	8270		Phenol	8270
1,3-Dinitrobenzene	8270		2-Picoline	8270
4,6-Dinitro-2-methylphenol	8270		Pronamide	8270
2,4-Dinitrophenol	8270		Pyrene	8270
2,4-Dinitrotoluene	8270		Safrole	8270
2,6-Dinitrotoluene	8270		1,2,4,5-Tetrachlorobenzene	8270
Di-n-octylphthalate	8270		2,3,4,6-Tetrachlorophenol	8270
Diphenylamine	8270		1,2,4-Trichlorobenzene	8270
Ethyl methanesulfonate	8270		2,4,5-Trichlorophenol	8270
Fluoranthene	8270		2,4,6-Trichlorophenol	8270

Notes
a. Organic constituents reported for the 2011 monitoring (Ohio EPA 2011)
b. U.S. EPA laboratory methods (U.S. EPA 2007d,e) that Ohio EPA uses (Ohio EPA 2010b).

Figure E-1. Legend for the maps in Appendix E.

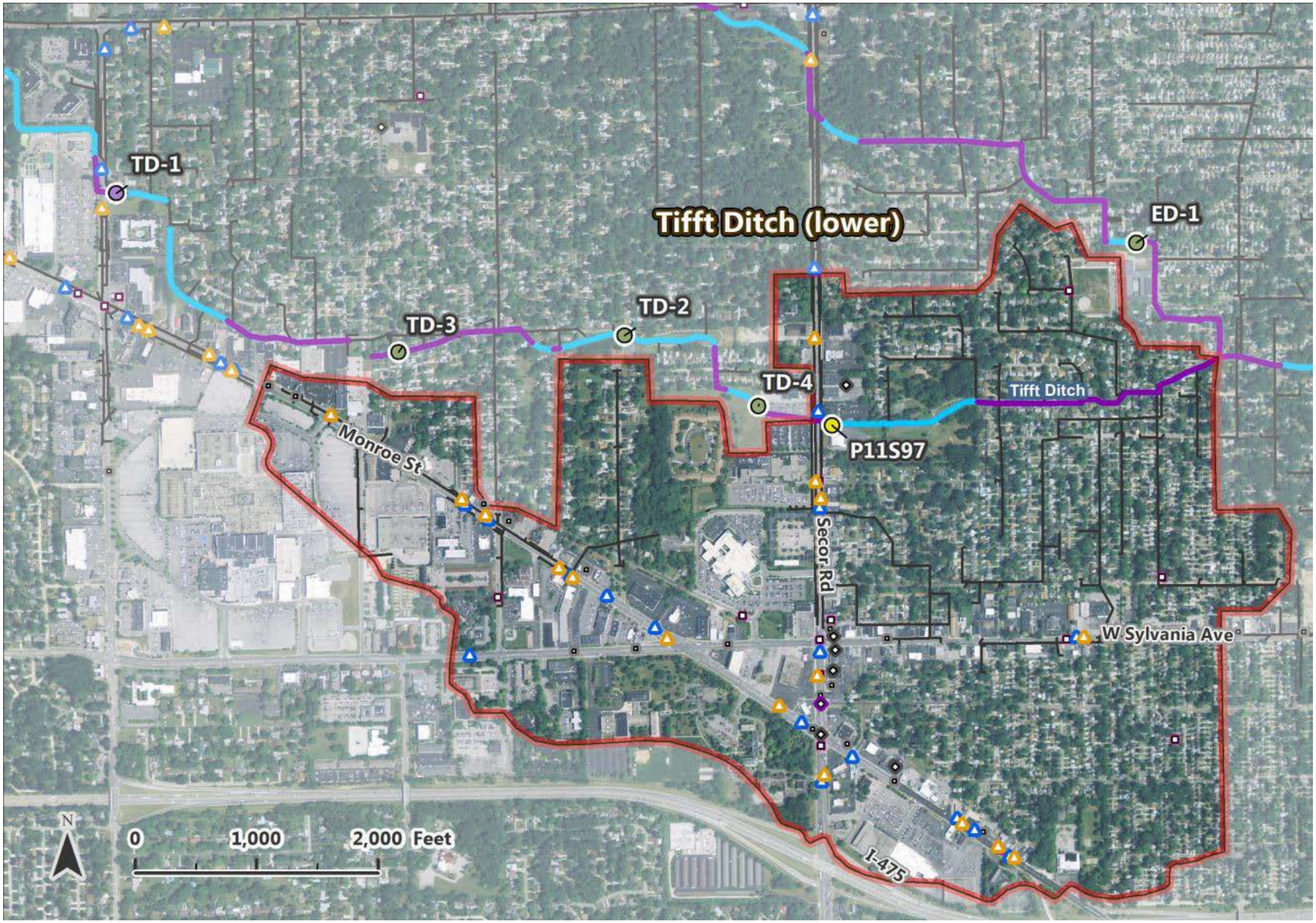

Figure E-2. Recommended sample locations along Tifft Ditch and on Eisenbraum Ditch.

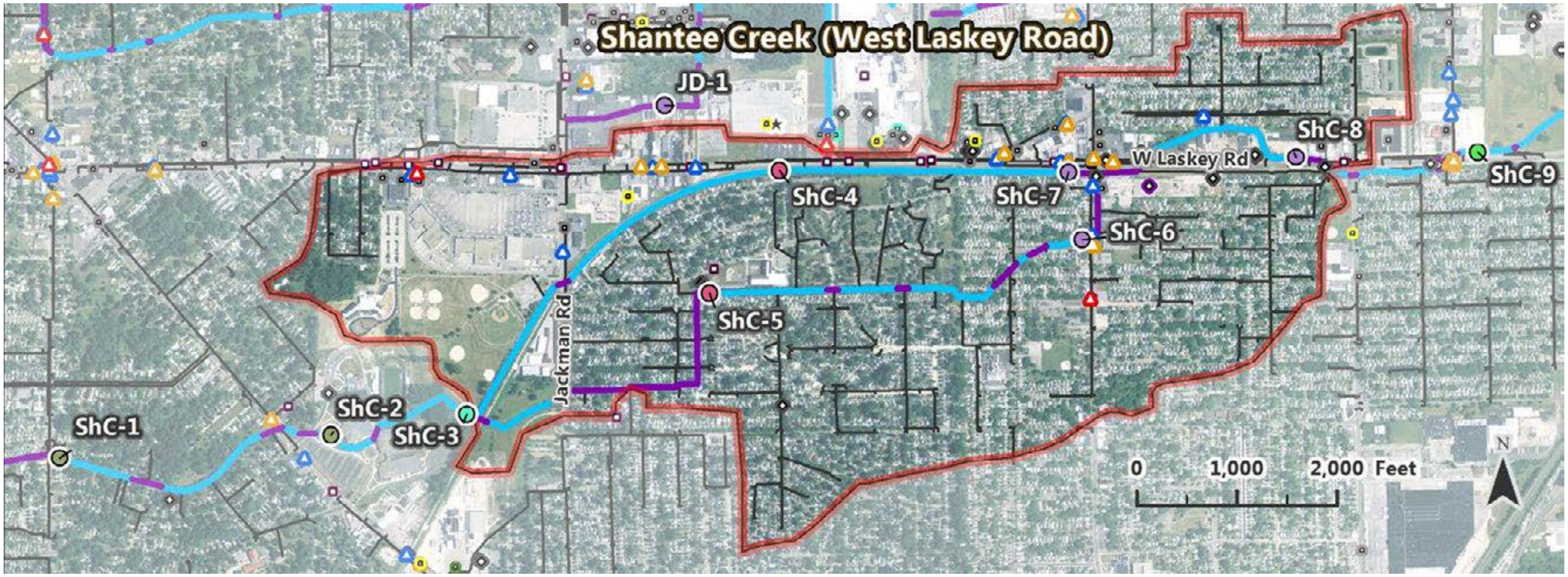

Figure E-3. Recommended sample locations along Shantee Creek in and upstream of the West Laskey Road critical area.

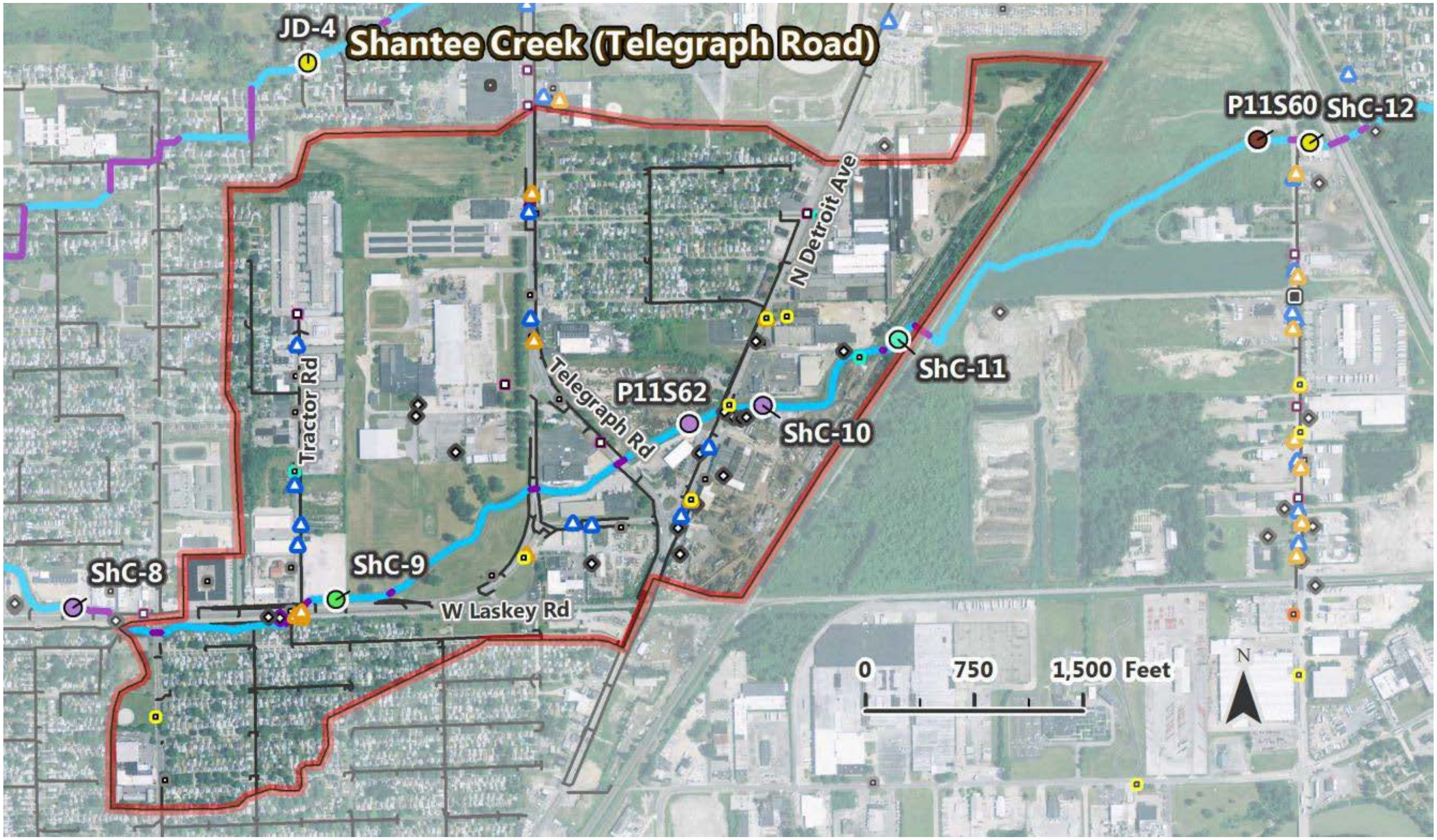

Figure E-4. Recommended sampling locations along Shantee Creek in the Telegraph Road critical area.

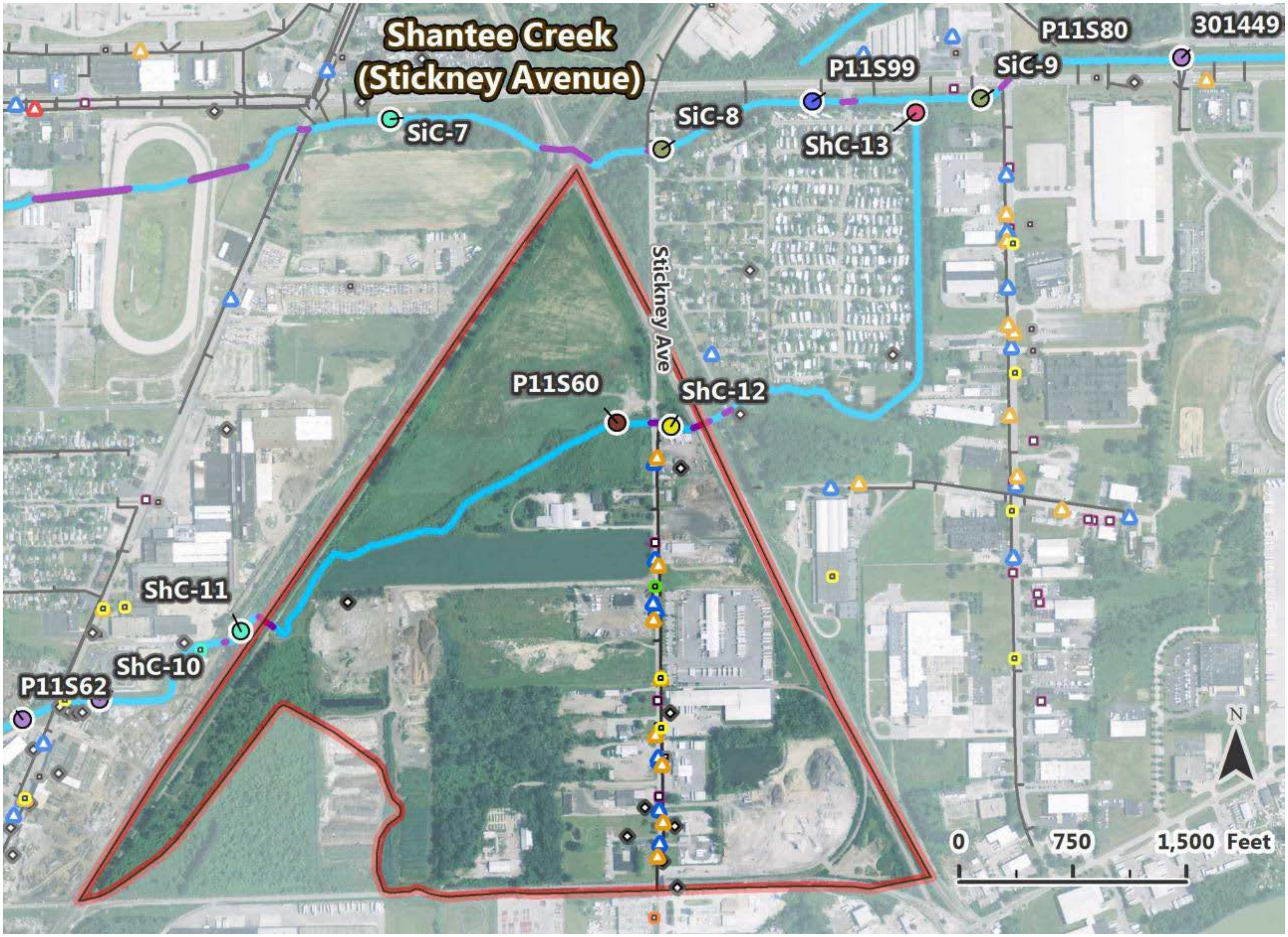

Figure E-5. Recommended sampling locations along Shantee Creek in and downstream of the Stickney Avenue critical area.

Figure E-6. Recommended sampling locations along Silver Creek upstream of and in the General Motors critical area.

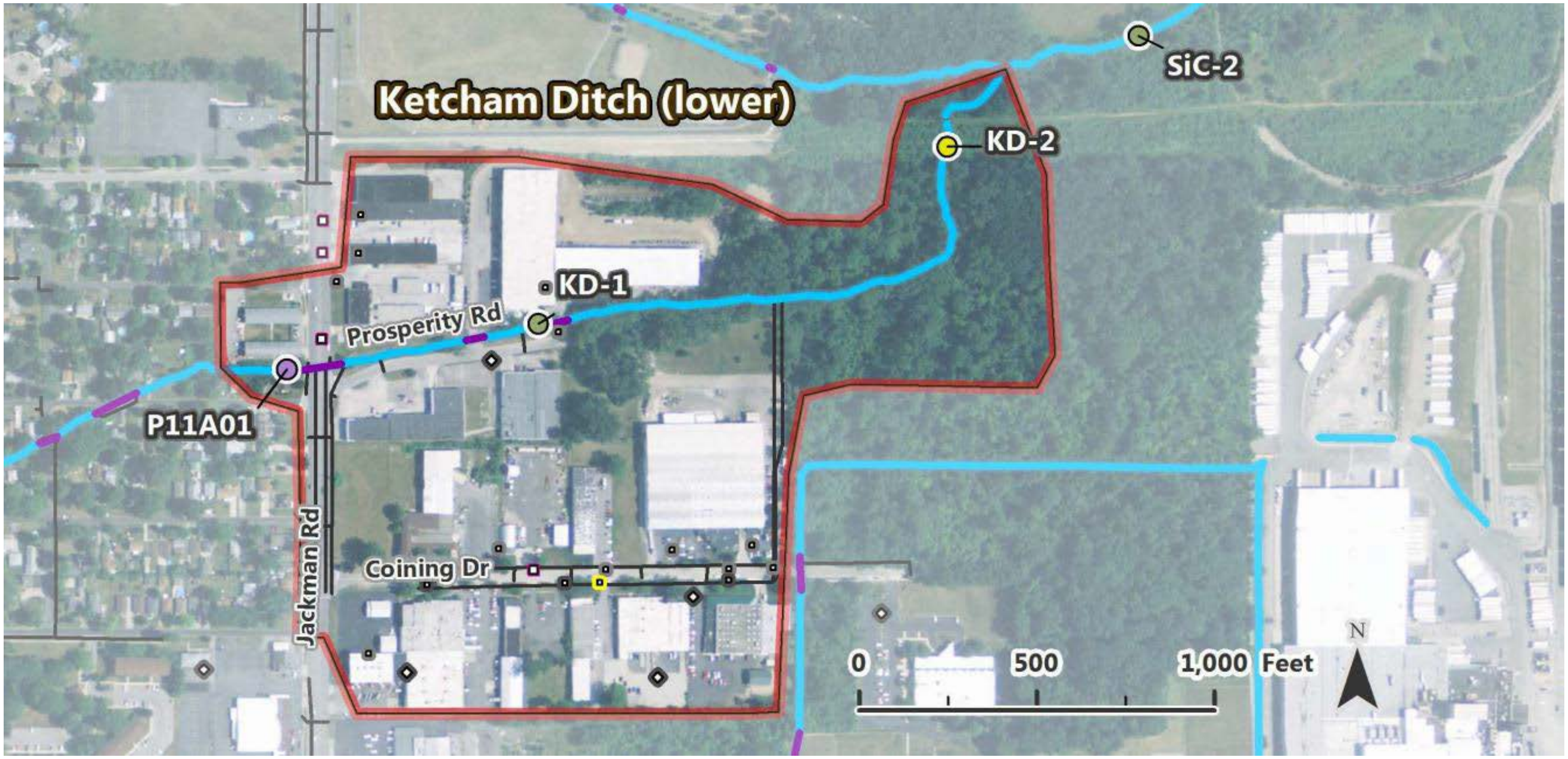

Figure E-7. Recommended sampling locations in the Ketcham Ditch (lower) critical area.

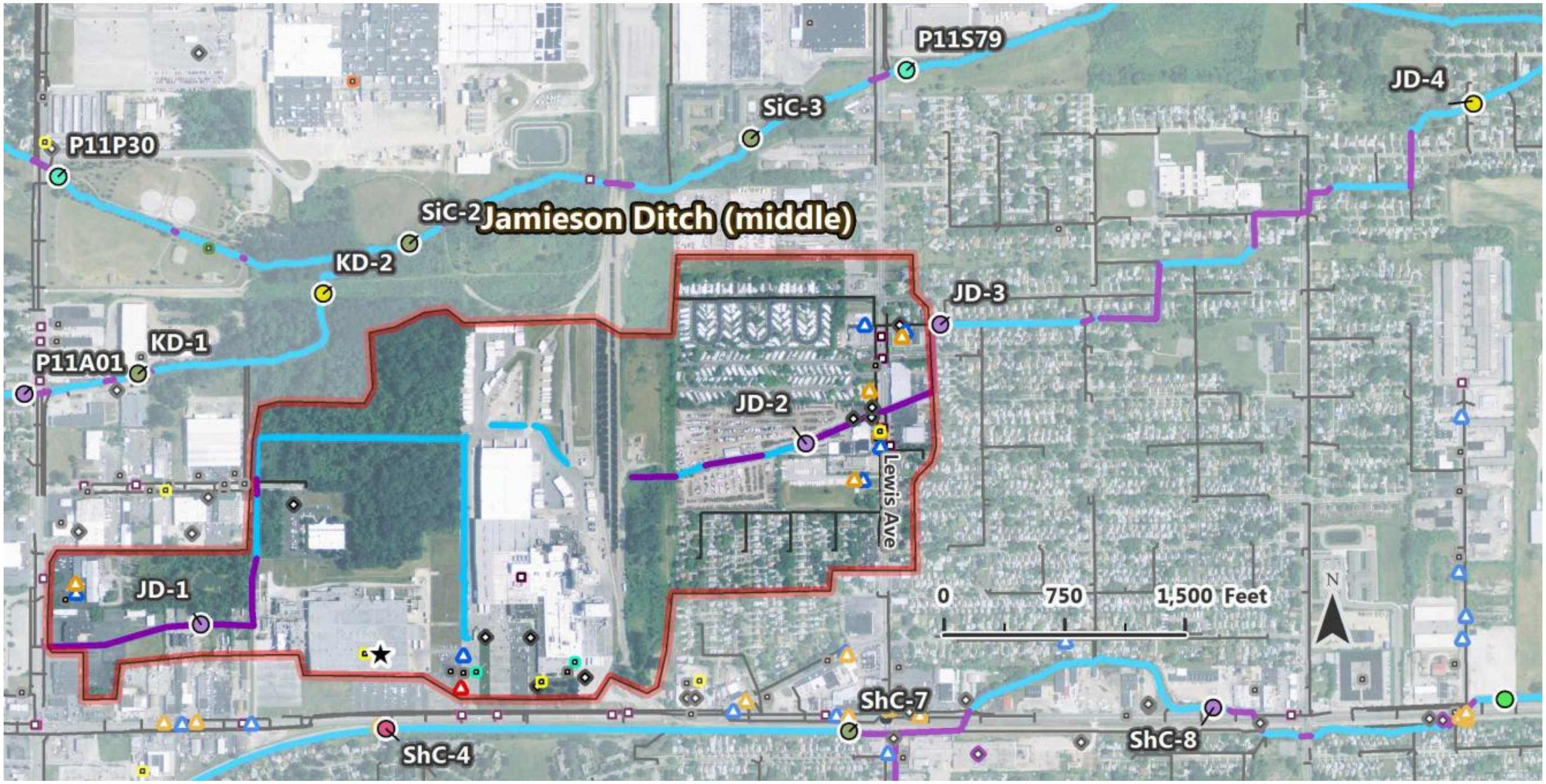

Figure E-8. Recommended sampling locations along Jamieson Ditch.

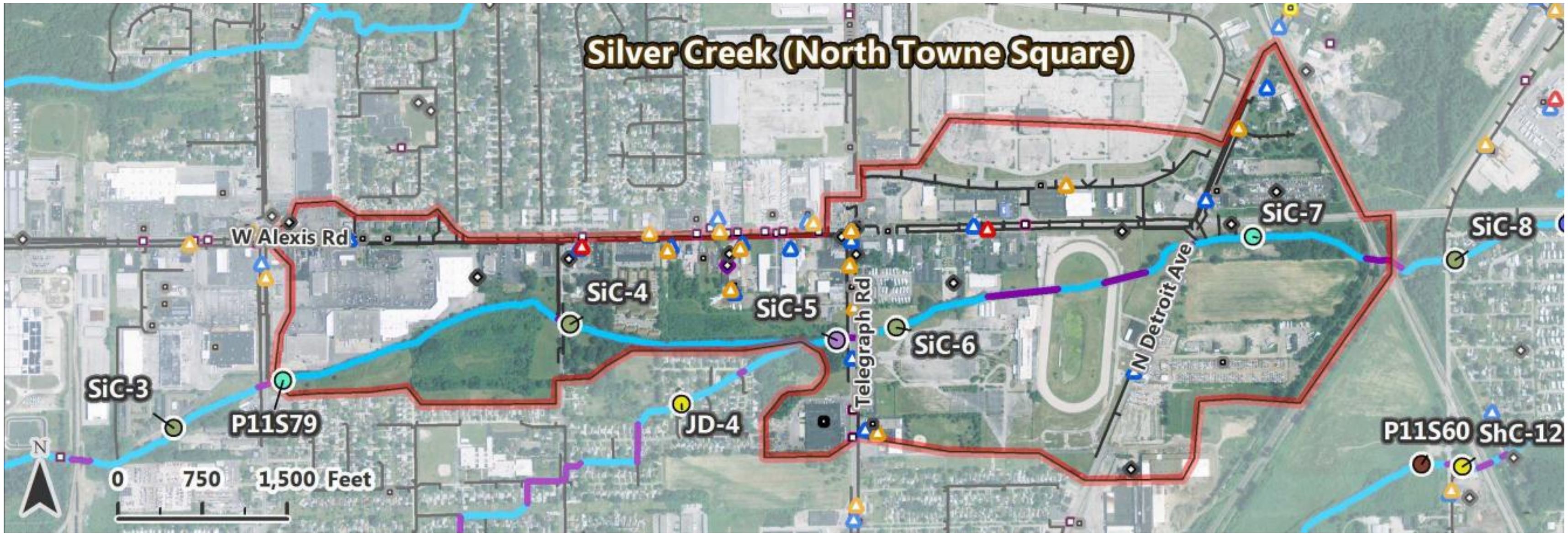

Figure E-9. Recommended sampling locations in and downstream of the North Towne Square critical area.

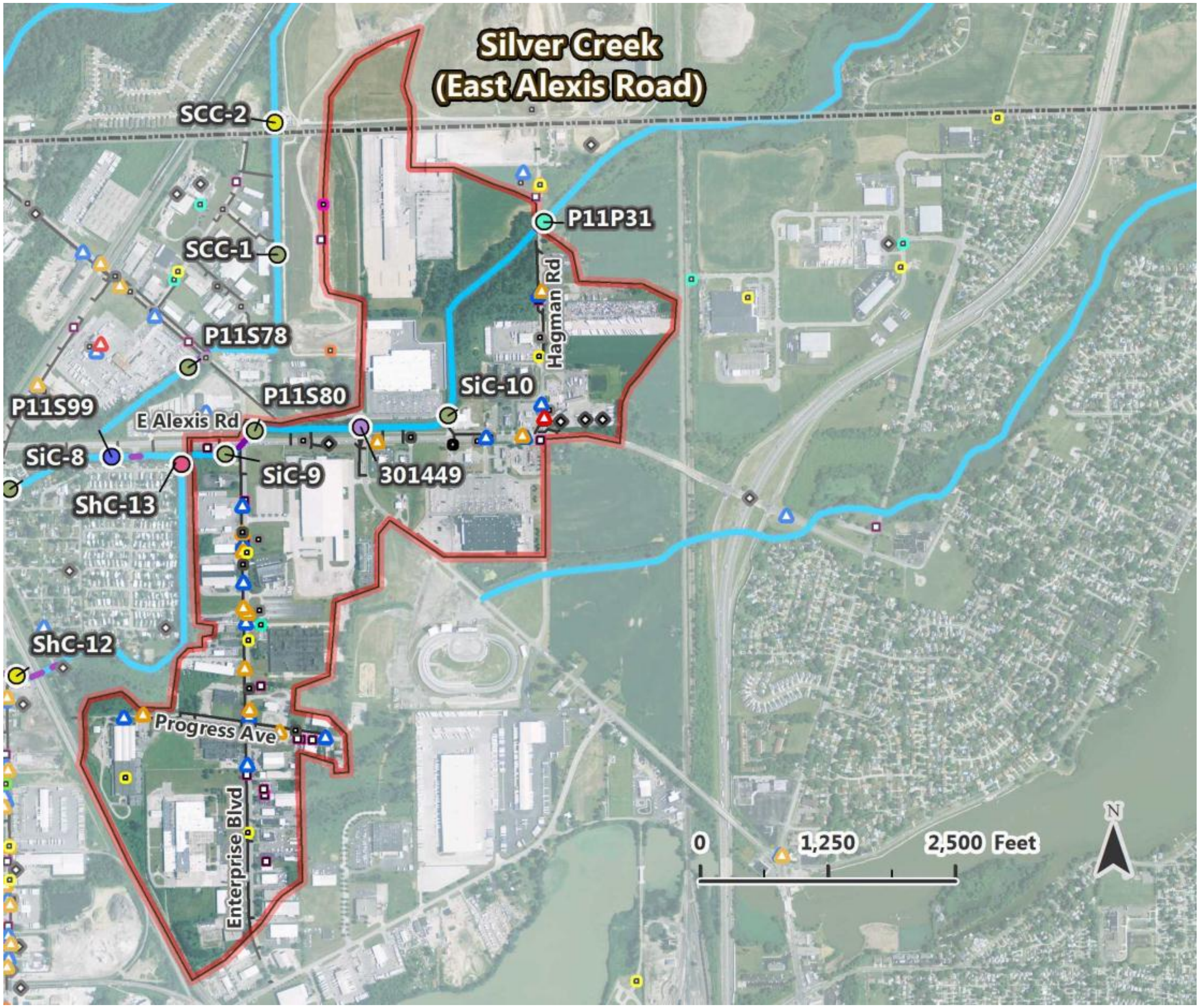

Figure E-10. Recommended sampling locations along Silver Creek in the East Alexis Road critical area.

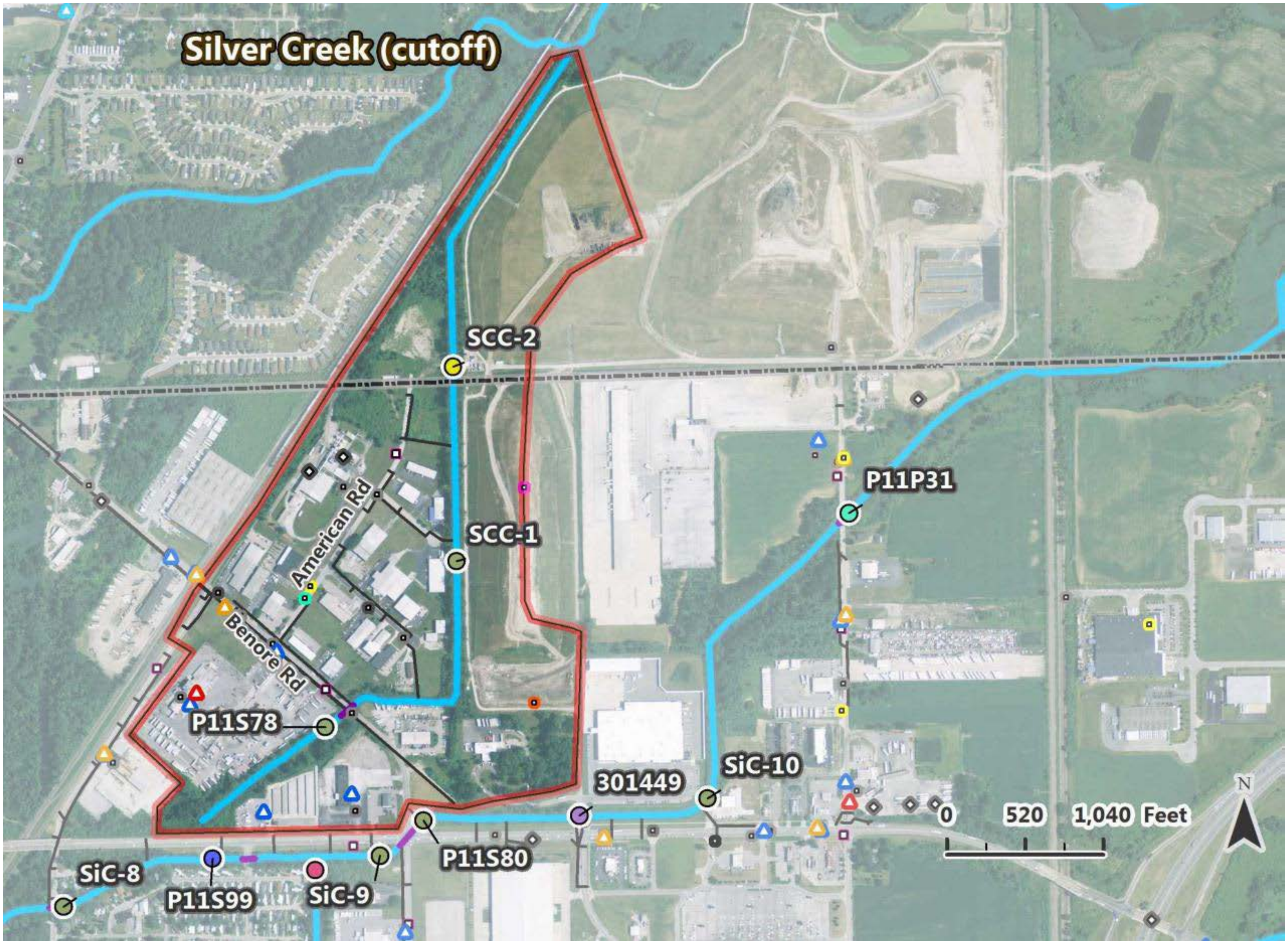

Figure E-11. Recommended sampling locations along Silver Creek Cutoff.

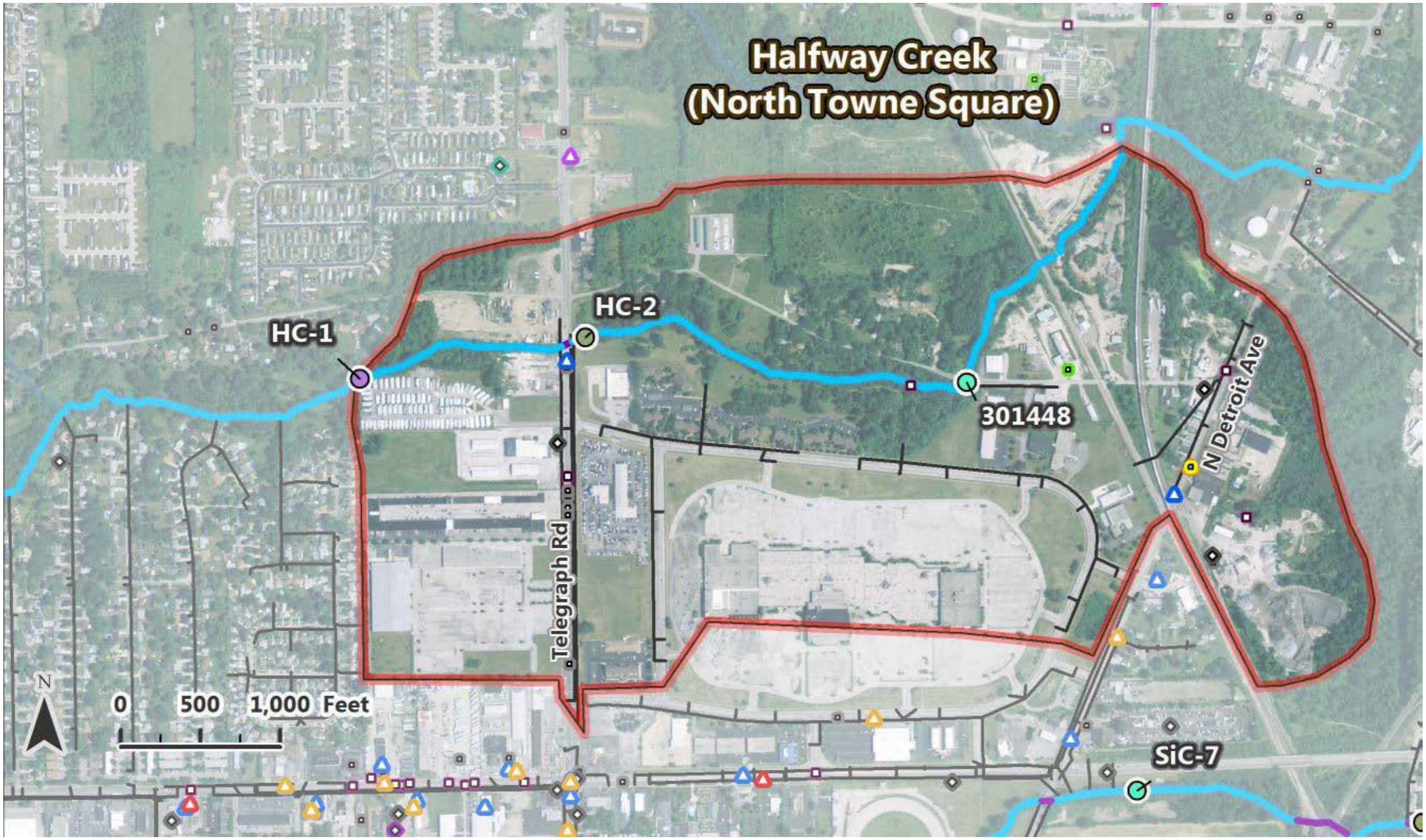

Figure E-12. Recommended sampling locations along Halfway Creek in the North Towne Square critical area.