Swan Creek Urban BMP Inventory and Assessment: Final Report in partial fulfillment of Lake Erie Protection Fund granting requirements

Project Completed by:
Toledo Metropolitan Area Council of Governments
Lucas County Soil and Water Conservation District

With Assistance from Partners:
Lucas County Engineer's Office
U.S. Department of Agriculture Natural Resources Conservation Service
City of Toledo
Village of Whitehouse
Springfield Township
Ohio Environmental Protection Agency

Special Acknowledgement:
Penta Career Center
Cuyahoga Soil and Water Conservation District

ABSTRACT
Toledo Metropolitan Area Council of Governments (TMACOG) and Lucas Soil and Water Conservation District (LSWCD) partnered to identify locations within the Swan Creek watershed that would be best suited for stormwater retrofits. The suggested retrofits included rain gardens, pervious pavement, green roofs and water quality devices. Using a combination of suitability analysis, desktop GIS analysis, and on the ground site ranking the project team identified 87 sites across the 67,000 acre study area for potential retrofit. Of these sites, 14 were found to be especially well-suited for retrofits based on potential landowner cooperation, education potential and the cost of the land needed for retrofit. This study resulted in a web accessible GIS database for use by stormwater planners within the Swan Creek watershed.

This project was funded through the Lake Erie Protection Fund with matching funds provided by members of the TMACOG Stormwater Coalition and the Lucas Soil and Water Conservation District. The LEPF is supported by the voluntary contributions of Ohioans who purchase the *Erie…Our Great Lake* license plate featuring the Marblehead lighthouse. www.lakeerie.ohio.gov

EXECUTIVE SUMMARY

Retrofitting existing stormwater management practices with sustainable best management practices (BMPs) such as rain gardens, pervious pavement, rain barrels and water quality devices offers many benefits. These benefits include pollutant reduction, reduced stream channel erosion and reduced water treatment costs, to name just a few. Upon receiving the Lake Erie Protection Fund Small Grant, the Toledo Metropolitan Area Council of Governments (TMACOG) in partnership with Lucas Soil and Water Conservation District (LSWCD) identified locations within the Swan Creek watershed that would be best suited for stormwater retrofits. The need for alternative stormwater practices in the Swan Creek study area was made clear by analysis of the Ohio EPA 2010 TMDL report, which identified sedimentation/siltation and accompanying nutrients as major causes of water quality impairments. The sources of these impairments are directly related to urban and rural land uses and include stormwater and agricultural runoff and habitat degradation.

The project team used geographic information systems (GIS) analysis and extensive field surveys to identify 87 sites in the study area that could best impact water quality by retrofitting existing stormwater practices with more sustainable BMPs. This was accomplished by ranking sites based on several criteria including the volume of water and paved surface area treated by the BMP retrofit, cost of the retrofit, the ability of construction equipment to access the site, and expected maintenance requirements. The current state of water quality impairments, landowner cooperation, potential for educational opportunities and the cost of the land required for implementation were also considered in the analysis. The project team reviewed the 87 sites and identified specific BMPs (e.g., rain gardens and pervious pavement) that could be applied to each of these sites. In all, 14 locations were identified as having the highest potential for retrofitting existing practices with BMPs.

The outcome of the project was a GIS-based tool for stormwater planners in the Swan Creek watershed. This product can be used in combination with existing stormwater plans to help managers pinpoint and prioritize areas for stormwater improvements. The tool provides users with information regarding site accessibility and the ability to maintain a suggested BMP in the context of the larger landscape. Additionally, landowners can use the database to view potential BMPs on their properties that can be used to receive non-residential stormwater credits. These datasets can be found on the project website:

http://www.tmacog.org/Environment/Stormwater/swancreek_BMP_retrofit.htm.

TECHNICAL REPORT

Project Background

The *Swan Creek Urban BMP Inventory and Assessment* project determined where stormwater retrofits and would be applicable across the Swan Creek watershed. The four project sub-watersheds in the Swan Creek Watershed were Wolf Creek (HUC 041000090803), Heilman Ditch-Swan Creek (HUC 041000090804), Lower Blue Creek (HUC 041000090802), and Gale Run-Swan Creek (HUC 041000090703) (see Attachment 1 for map). These watersheds were chosen because they are both urban and rural in land use and all are impaired by non-point source pollutants that could potentially be controlled with stormwater retrofits. Sources of non-point pollution in the study area range from impervious surface runoff, quarry/mining runoff, agricultural runoff, channelization, storm sewers and combined sewer overflows (CSOs).

Each of these watersheds was assessed with geographic information systems (GIS) analysis. To perform this analysis, we researched and considered guidance from the Center for Watershed Protection's (CWP) *Urban Stormwater Retrofit Practices Manual* (2007) as well as a similar project that was completed by the Cuyahoga Soil and Water Conservation District (2010). Both of these sources gave us ideas of how to approach our project, although we followed slightly a different method as described in the Methods section of this report.

Deliverables

1. A GIS-compatible database of feasible retrofits for existing BMPs and additional BMPs recommended for applicable sites/locations.
2. A GIS-based inventory of existing BMPs in the four Swan Creek sub-watersheds.
3. A presentation that can be given to entities responsible for implementing BMPs in Swan Creek (e.g. stakeholders in the four sub-watersheds, the Swan Creek Balanced Growth Committee, the TMACOG Stormwater Coalition), which would include how to use the database and a series of maps.

Timeline

Quarter 1: During the first quarter, TMACOG and Lucas SWCD staff followed the original schedule by beginning to gather data and determining who would be a part of technical team. We included representatives from communities in Swan Creek: Lucas County Engineer's Office, the City of Toledo, Springfield Township, and the Village of Whitehouse. These local jurisdictions combined with regional representation from Ohio Environmental Protection Agency (OEPA) and U.S. Department of Agriculture: Natural Resource Conservation Service (USDA: NRCS) provided a variety expertise for the project. Our first meeting was held on September 20th, 2011 with additional meetings each quarter.

After the initial meeting, we varied slightly from our original timeline as proposed in the request

for funding. Originally, we had planned to inventory all of the current Best Management Practices (BMPs) prior to assessment, but found that this was really only useful for stormwater ponds and dry ponds. Other BMPs were less likely to need retrofitting as those are the practices that we would actually suggest for retrofits. Because Lucas County and TMACOG had existing GIS data, the data collection of stormwater and dry ponds went quicker than expected.

Instead of inventorying in the first and second quarters and looking only at current BMPs to retrofit, we chose to apply a criteria system to the entire study area to identify areas where stormwater BMPs could be implemented. This criteria system was also applied to stormwater retention areas, culverts and outlets to identify practices that could be improved upon. This way, we were looking more at spaces that could be retrofitted rather than just improving on current practices, which prevented us from excluding areas that would be ideal for retrofits simply because they did not have a current stormwater feature. We did not inventory current best management practices until the fourth quarter.

Quarter 2: One task during the second quarter involved gathering additional data for the suitability analysis. To assist in data acquisition, we asked local high school students from Penta Career Center to digitize parking lots. This saved a significant amount of time that was better spent on technical applications and provided the students with a real-world project. During this quarter, we also prepared a poster about the project for the Maumee River Basin Partnership of Local Governments (MRBPLG) conference in Findlay, OH on October 20, 2011 (see Attachment 2)

Overall, the second quarter was primarily focused on performing the desktop analysis using the criteria system researched and fine-tuned in the first quarter. The analysis was almost entirely GIS-based using a technique known as suitability mapping. This process is explained in more detail in the methods section.

Quarter 3: The third quarter included developing a separate set of ranking criteria that we would use for field assessment of each potential retrofit location (see Attachment 3). During end of the third and beginning of the fourth quarter, the site visits were completed. The initial desktop analysis and "weeding step" provided us with a list of areas that we would actually visit to review. Once we had a manageable list of sites, we created an itinerary list to follow to make our sites visits more efficient. We developed a site visit "Ranking Criteria Sheet" that we filled in and attached a photo for each site. Sites were visited and ranked during this quarter

Quarter 4: Major milestones in the fourth quarter involved creating a user-friendly database of the 87 sites suitable for retrofit, inventorying current BMPs, creating printable maps, developing the project website, and project finalization all of which are discussed in more detail in the methods and details section. This quarter was challenging as the project changed hands to a new

project manager. Because of anticipated challenges, TMACOG requested and was granted an extension for final reporting of the project.

In addition, during the fourth quarter, project staff developed a project presentation that was given to several audiences, including the Stormwater Coalition at its August bi-monthly meeting and the Ohio Stormwater Conference in June.

Methods and Project Details

Suitability Analysis: Suitability analysis is a geographic-based process used to determine appropriateness of a particular use for a site. Suitability analysis was used to determine areas in the four sub-watersheds that are ideal for the following types of stormwater retrofits: bioretention areas, roof retrofits (e.g., downspout disconnects and green roofs), parking lot retrofits (e.g., pervious pavement), culvert retrofits, outfall retrofits, and hotspots. For the purpose of this study, hotspots are developed areas where nonpoint source pollution may be an issue, but other retrofits are not appropriate. Each of these potential BMPs had its own criteria because each retrofit requires different factors to make a location "ideal" (see Attachment 4). Criteria for each type of BMP were based on the CWP *Urban Stormwater Retrofit Practices Manual* (2007) and the *Swan Creek Balanced Growth Plan: Final Report* (2009).

The criteria data were all in a GIS format allowing us to perform suitability analysis. Suitability maps are developed by taking each vector data layer (data format used in GIS to symbolize points of interest, roads and land parcels) and converting it to a raster. Raster is a data type represented by a matrix of pixels, for example, a photo or satellite images. This converts the vector data into a continuous data format allowing us to give each area a score and perform calculations. Each data layer is then added together to find the areas that overlap, much like a Venn diagram. These overlapping places are the areas that should have a high potential to retrofit. Through the process of suitability mapping, total of 624 sites were identified as areas with retrofit potential. TMACOG staff developed a guidance document that explains the suitability analysis process in more detail. This can be used by GIS professionals or engineers in other watersheds to develop their own suitability mapping projects and can be accessed on the project website.

Desktop Review and pre-screening: Visiting all areas identified by the suitability analysis was not practical due to the large number of sites and the size of some of the areas. To get a more refined list of sites to visit, we conducted a qualitative review of each of the 624 retrofit potential sites using visual analysis of aerial imagery. Each site was given a ranking of "low", "medium", or "high" retrofit potential based on the best professional judgment and local knowledge of the project team. Additionally, parking lots less than 0.25 acres and sites with existing water quality provisions were eliminated due to the limited potential for BMP retrofits to have an impact on water quality improvements. The 133 sites ranked high were chosen for site visits.

Determining Potential Retrofit Sites

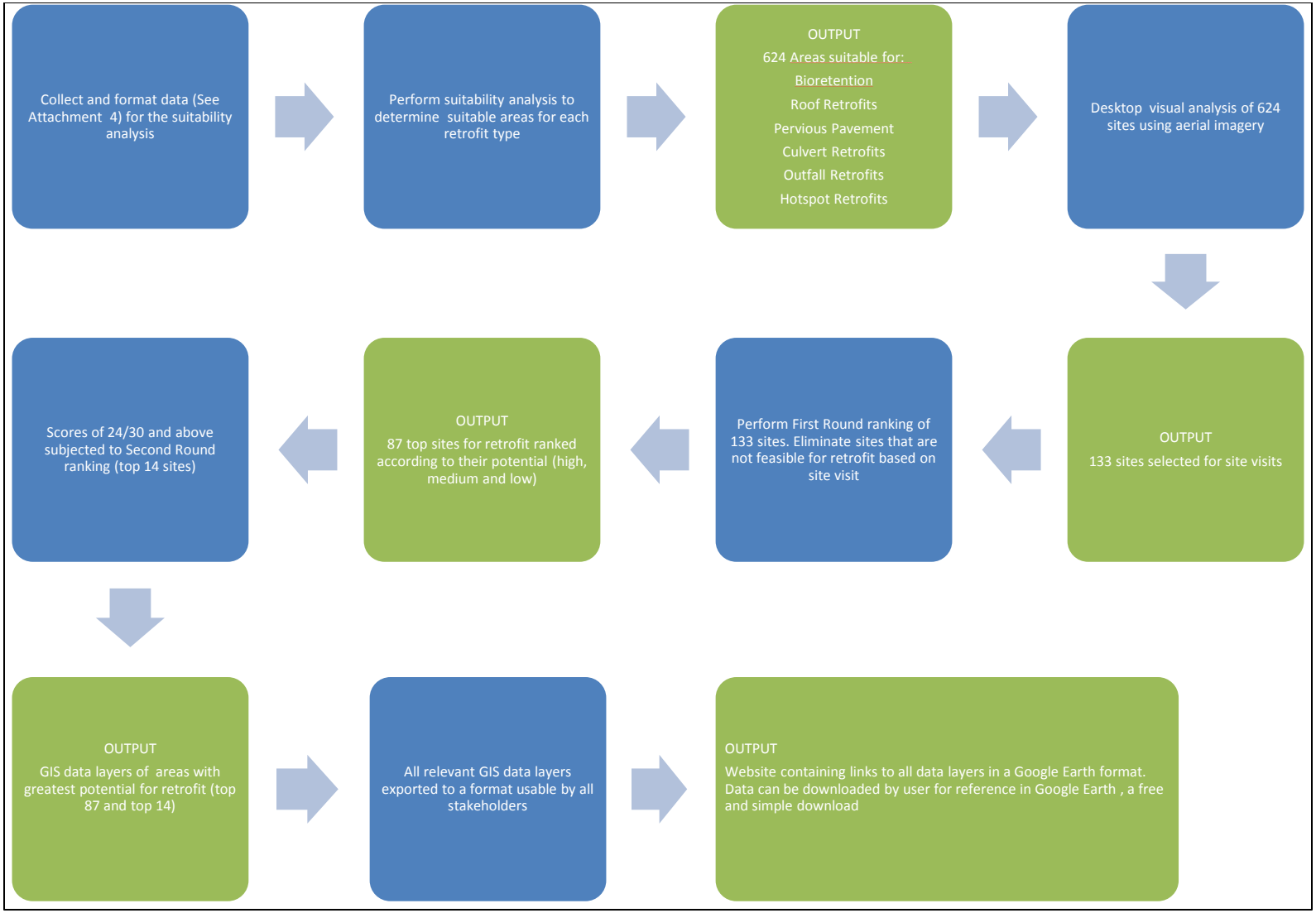


Figure 1: Suitability mapping and assessment process

First Round Ranking and Site Visits: First round ranking criteria included volume of water treated by retrofitted BMP, cost of treatment, accessibility, impervious area treated, habitat and biotic integrity, maintenance requirements, and available land area (Attachment 3.) Each site was assessed both in the office and during a site visit where the above criteria were applied and a score given on a scale of 1-5. Prior to actually visiting each site, project staff compiled a list of address intersections near the sites so we could visit multiple sites in one day. Due to the large number of sites and difficulty finding many sites, it was necessary to use a GPS rather than printed maps. Many of the areas were located over multiple addresses and we learned it was easier to have an aerial image of each site with street locations for reference. We used a ranking sheet to record accessibility and maintenance scores at each site and to write a short narrative of any potential problems we saw. Several of the sites were changed to low ranking and not assessed for all of the ranking criteria after we visited them. The demoted ranking was for numerous reasons, but often we lowered a sites ranking potential because of drainage patterns and accessibility. A few sites first ranked high were changed to low because of wetland species present. For these reasons, the ground-truthing portion of this project is imperative even though it takes significant time and resources to visit each site. Ultimately, we ended up with 87 sites that would be given a first round ranking score. A GIS data layer of potential BMP retrofits for each site was created based on site reviewer feedback and aerial imagery analysis.

Second Round Ranking and Review: First round ranking scores ranged from 10 to 30 (with 30 being the highest possible score). To further refine the list of potential retrofits, sites that scored 24 or higher were ranked again using the second round criteria. These criteria include: landowner cooperation, educational potential and cost of the land needed. The 14 sites, in ranking order by combined score of first and second round, can be found in Table 1. The technical team reviewed all of the final 14 sites and identified specific projects that could be tied into some existing projects for stormwater treatment trains. Map documents (.pdf) were created for each of the top 14 recommended sites (Attachment 5) and are available on the project website. These maps highlight potential retrofit sites and provide an aerial view of the landscape surrounding each site. The maps can easily be printed by users and provide a quick reference for stormwater managers and decision-makers. Each site in the maps can be referenced in Table 1 via the field "Retrofit ID"

Making Data Usable and Accessible: The following GIS datasets were converted to a format that could easily be shared with users via the internet: potential retrofit (based on the top 87 sites), estimated impervious area, estimated drainage area, ditches and streams, hydrologic units and jurisdictions. These data layers were converted to a KML file format that can be used in the Google Earth desktop application. These data will allow users to click on a potential BMP retrofit site and view information specific to that site including site acreage, reasons for ranking and comments from reviewers. The ancillary data will allow users to view estimated impervious

area and drainage area associated with that BMP and to view all of this information in the context of existing hydrology and land cover (provided by Google's imagery.) A "user's manual" was developed that walks users through downloading the data and Google Earth application, explains the relevance of each data layer and details how to use the various data layers for making decisions about stormwater retrofits.

Aside from the analysis of potential retrofits, an inventory of current "green" BMPs was completed. This was accomplished through cooperation between TMACOG and local stormwater and green infrastructure professionals. Local stakeholders were asked to provide details and locational data of known green BMPs in the study area. Implementation of green infrastructure is expected to grow into the future as developers and organizations become more aware of the benefits of stormwater BMPs and green infrastructure. As a result this database will be continually updated and data continually shared between organizations. All of this information was added to the project website.

Retrofit ID	Cumulative Score	Current Stormwater Practice	Community	Suggested Retrofit	Area (acres)
67	43	stormwater pond	Toledo	water quality device	1.50
69	41	outlet	Toledo	extra drainage before outfall	1.33
4	37	parking lot	Maumee	grass swales or bioretention along sides of lot	0.27
65	37	parking lot	Toledo	pervious	1.80
112	37	outlet	Waterville Twp.	extra drainage for outlet	3.64
129	35	stormwater pond	Springfield Twp.	water quality device	0.31
5	33	parking lot	Toledo	parking lot island bioretention and pervious around catch basins	0.10
11	33	stormwater pond	Springfield Twp.	water quality device	12.58
18	33	stormwater pond	Springfield Twp.	water quality device	4.07
64	33	parking lot	Toledo	pervious around catch basins	0.02
75	33	bioret/RG/swale	Toledo	extra drainage before outfall	1.04
61	31	stormwater pond	Monclova Twp.	water quality device	0.59
62	31	stormwater pond	Monclova Twp.	water quality device	0.27
132	29	stormwater pond	Springfield Twp.	water quality device	0.43

Table 1: Top 14 sites suitable for retrofit

Outcomes

A project webpage was created to make all GIS data and documents publicly available. Documents include printable maps (Attachment 5), instructions for using the Google Earth files, the final report, a suitability mapping tutorial, and other relevant information. All project information and the deliverables detailed below are available at: http://www.tmacog.org/Environment/Stormwater/swancreek_BMP_retrofit.htm.

Deliverable 1: A GIS-compatible database of feasible retrofits for existing BMPs and additional BMPs recommended for applicable sites/locations. The GIS data of the potential retrofits were converted to the KML format recognized by Google Earth. These data are included in the *Swan Creek BMP Retrofit Database,* which is available for download from the TMACOG project website along with a link to download Google Earth. In addition to the potential retrofit data, the dataset also includes ancillary data layers: watershed boundaries, ditches and streams, drainage areas, impervious areas and jurisdictions. Using Google Earth to view the datasets offers an advantage over static maps as the program allows users to view multiple datasets at once and view important information about each site, such as accessibility and predicted long term maintenance requirements. The ancillary data combined with aerial imagery will give users a bird's eye view of potential BMP retrofits for their street, watershed or jurisdiction in the context of surface water features and local land use. Users can also "fly" instantly to specific BMP retrofits by clicking on the appropriate BMP number.

Deliverable 2: A GIS-based inventory of existing BMPs in the four Swan Creek sub-watersheds. A dataset of existing green infrastructure in the Toledo Area is available in Google Earth's file format KML and can be downloaded along with the potential retrofit dataset mentioned above. This download is titled *Reference Data* and also includes the user's manual and a map legend image.

Deliverable 3: A presentation that can be given to entities responsible for implementing BMPs in Swan Creek, which would include how to use the database and a series of maps. The results of this project were presented to a group of stormwater professionals at the 2012 Ohio Stormwater Conference in June. Additionally, a project poster (Attachment 2) was presented at the TMACOG table at the conference. The presentation was also given to area stormwater stakeholders at the bimonthly Stormwater Coalition meeting in August. The group was briefed on the project results and was shown how to access the project data and documents on the TMACOG website for use in future stormwater planning and decision-making. The presentation, poster, database user's manual, and maps are all available on the project website.

New Partnerships

One unexpected outcome from this project was outreach with a local high school's GIS students. By working with students at Penta Career Center, we were able to educate them about stormwater issues including impervious surfaces and their impacts on stormwater. The project provided them with the opportunity to learn new GIS techniques that they can use on future projects.

Another unexpected partnership resulting from this project is one between TMACOG and the University of Toledo. During fall semester of the 2012-2013 academic year UT students in a senior-level civil engineering course will be planning and designing green infrastructure retrofits for three of the final 14 sites. The resulting partnership for this work may lead to future collaboration on implementation of retrofit projects.

Application to Future Projects

The intent of this project was to use a systematic approach to identify sites for future retrofits, which we anticipate will provide strong justification for future funding of green infrastructure implementation projects. Soliciting stakeholder input from a variety of agencies ensured that the results of this project were endorsed on a broad scale. Stormwater managers on the county and municipal levels have expressed interest in using the resulting database as a starting point for future stormwater management projects. Lucas County has recently started a stormwater credit program, through which non-residential property owners can receive credits on their stormwater utility for implementing stormwater BMPs. Interest has been expressed in using the sites identified through this project for priority stormwater credits.

Lessons Learned

The project greatly benefited from coordination among project staff and partners. Potential project design problems were discovered early on in the project timeline and immediately addressed. The group learned that flexibility is necessary in the development and implementation stages of a project. As a result, the project timeline diverted somewhat from the original proposal, but the outcome was a more comprehensive analysis of the Swan Creek watershed and a more useful tool for stormwater managers.

References

Center for Watershed Protection. *Urban Subwatershed Restoration Series, Manual No. 3:Urban Stormwater Retrofit Practices, Version 1.0.* August, 2007.

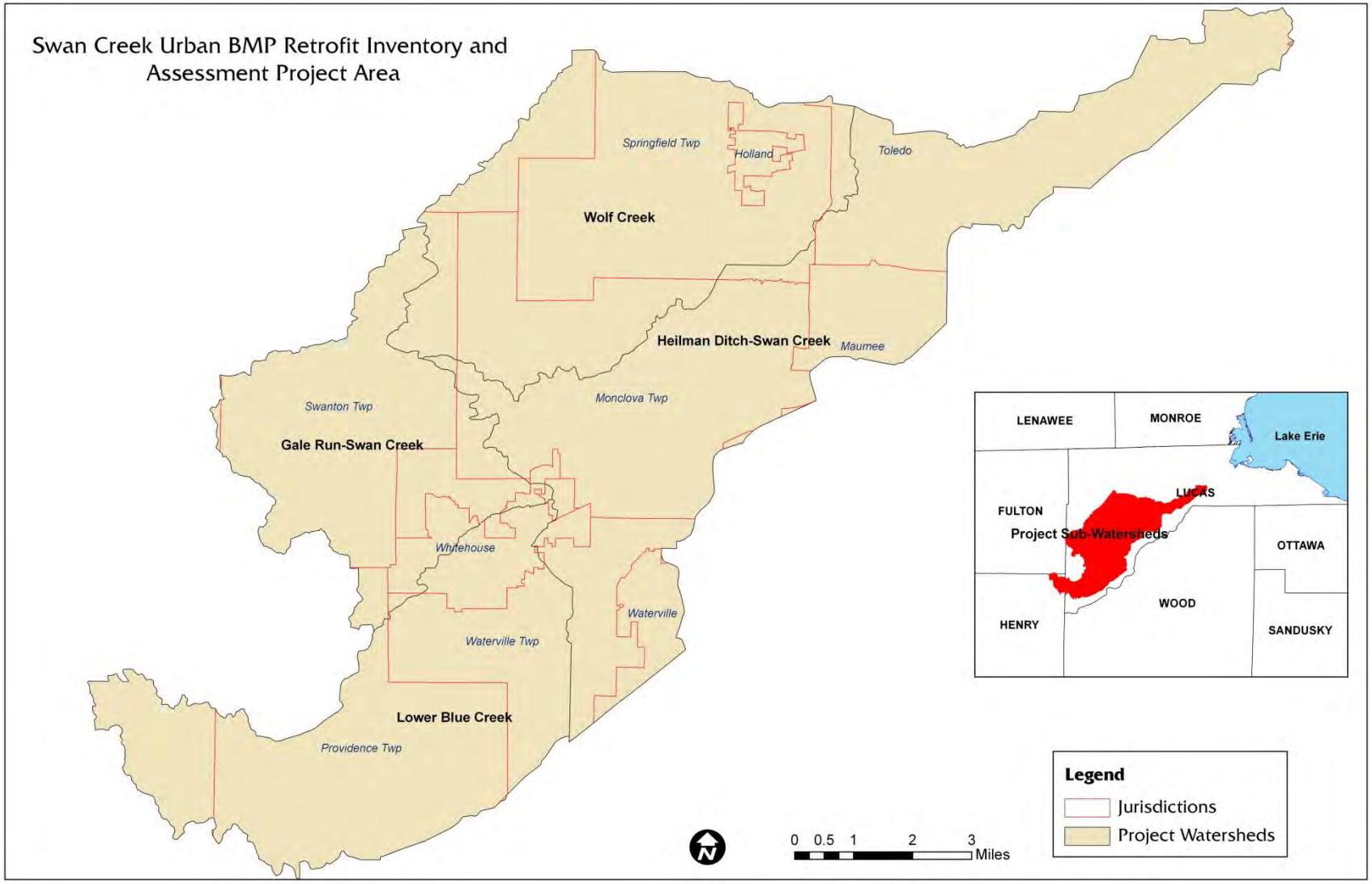
Cuyahoga Soil and Water Conservation District. *Targeting Storm Water Retrofits to Improve Urban Streams.* April 27, 2010.

Ohio Environmental Protection Agency, Division of Surface Water. *Total Maximum Daily Loads for the Swan Creek Watershed: Final Report.* October 9, 2009.

Toledo Metropolitan Area Council of Governments and Lucas Soil and Water Conservation District. *Swan Creek Watershed Balanced Growth Plan, Final Report of the Swan Creek Watershed Pilot Project.* June 2009.

ATTACHMENTS

Attachment 1 – Map of the Project Area



Attachment 2 – Project Poster

Swan Creek Urban BMP Retrofit Inventory and Assessment Project

By: Ann-Drea Hensley, Jeff Grabarkiewicz, Cheryl Rice, and the project's Technical Team

Project Introduction

Stormwater retrofits are becoming increasingly necessary to deal with flooding and water quality issues. Retrofits are typically implemented at developed sites that lack Best Management Practices (BMPs) or have under-performing BMPs. The Swan Creek Urban BMP Retrofit Inventory and Assessment Project looks at retrofit planning holistically on a watershed scale. The project will help determine the most cost-effective and efficient stormwater practices for locations across four Swan Creek sub-watersheds. Options being considered are:

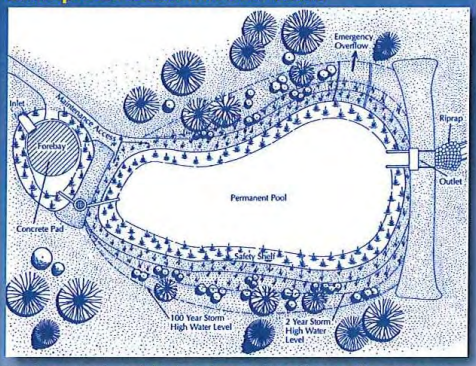
- Pond retrofits (water quality outlet improvements and wetland benches)
- Bioretention cells
- Rooftop retrofits
- Pervious surfaces for parking lots
- Outfall retrofits
- Culvert retrofits
- Overwide and two-stage ditches

Intended Outcomes

The project will result in three deliverables:

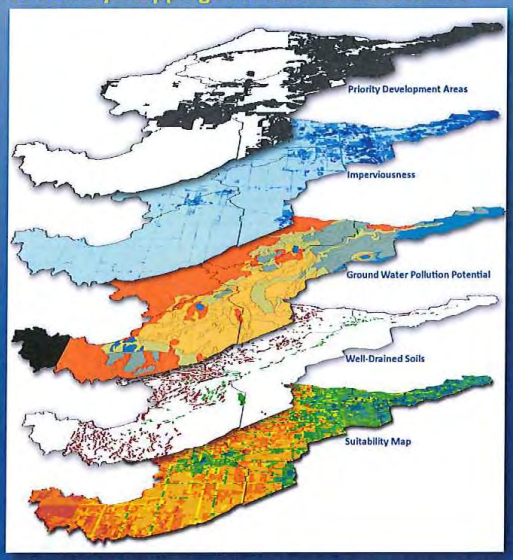
1. A GIS-based inventory of existing and potential retrofit BMPs in the four sub-watersheds.
2. A GIS-compatible database of feasible retrofits for existing BMPs and additional BMPs for ideal locations.
3. A presentation that can be given to entities responsible for stormwater management.

Example of a Stormwater Pond



Retrofits can provide needed water quality controls on older or non-functioning stormwater ponds. Pond retrofits are cost-effective compared to other strategies. Options are outlet improvements and wetland benches.

Suitability Mapping Process: Bioretention Cell

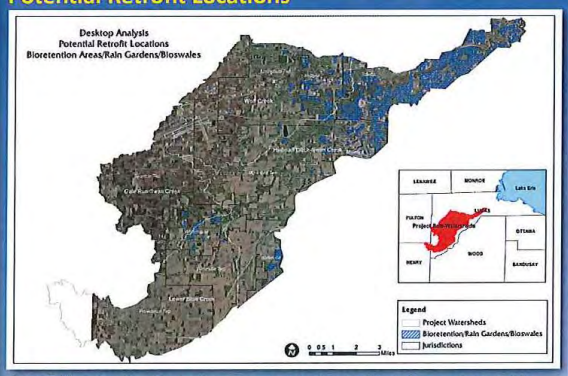


Analysis using Geographic Information Systems (GIS) datasets made research of a large area more manageable. Locations were narrowed by each retrofit's criteria. With GIS layers representing those criteria, we scaled and combined these layers to produce suitability maps. This illustration shows a bioretention cell. The process was repeated for all of the BMPs considered.

Bioretention cells are ideal in areas with:

- High imperviousness
- Well-draining soils
- Priority Development Areas (as defined by the Swan Creek Balanced Growth Program)
- Little or no potential for groundwater pollution

Potential Retrofit Locations



Potential locations for bioretention areas, rain gardens, or bioswales are shown in blue.

Acknowledgements

The Swan Creek Urban BMP Retrofit and Assessment Project and all products produced under this project are funded through the Ohio Lake Erie Commission (OLEC) and the Lake Erie Protection Fund (LEPF). The LEPF is supported by the citizens of Ohio through their purchase of the Lake Erie License Plate.

Attachment 3 – Ranking Criteria

Criteria	Sub-criteria	Method for determining	"1" Ranking	"3" Ranking	"5" Ranking
Volume of water treated by BMP		Drainage area rainfall coefficient	Comparative Metric*	Comparative Metric*	Comparative Metric*
Cost per treated cubic ft. of runoff		$ for BMP/(Drainage area rainfall coefficient)	Comparative Metric*	Comparative Metric*	Comparative Metric*
Access	Stable/flat slopes	Contour or DEM map of site	> 5%	2-5%	< 2%
	Construction access will not disrupt neighboring property owners (commercial versus residential, buffer parcels, etc.)	Parcel data and ownership information; zoning	close quarters residential (except for small BMPs)	close quarters industrial/commercial/etc. (except for small BMPs) and large residential parcels	Industrial/commercial/etc. with adequate green space and very large agricultural/residential parcels
	Tree clearing or plant removal not needed	Aerial photography/site visits/land use maps	Dense forest/shrubs/etc. @ >50% coverage	Forest/shrubs/etc. @ > 20% coverage	Forest/shrubs/etc. @ < 20% coverage
	Easements in place	Auditor's office	No easement	No easement, but potential	Easement in place
	Positioning of structures is ideal for BMP placement	Aerial photography/site visits/site plans	No space between structures; BMP would damage structures, etc.	Limited space where BMP could fit, but design costs would increase to make site work	Adequate space for BMP and safety conditions met
	Access for needed equipment/vehicles is available	Roadway widths, aerial photography	No construction equipment can access site	Either construction access limited or equipment needed to access site is non-standard	Adequate access to site for all standard equipment used to construct BMP
Impervious area treated		GIS layers and assessment of impervious cover on-site	0-5 acres	5-15 acres	> 15 acres
Position relative to impairments	QHEI	WQ reports	High score	Medium score	Low score
	IBI	WQ reports	High score	Medium score	Low score
	ICI	WQ reports	High score	Medium score	Low score
	Personal knowledge of quality/other criteria	Lucas SWCD, OEPA	High quality habitat	Good, but not excellent	Poor quality
Lasting impact	Ability to maintain BMP (resources)	Evaluate property owners access to equipment and resources to maintain (mowers, suction devices/pumps, ability to replace damaged items, etc.) via type of property owner	Low ability	Medium ability	High ability
	Ability to maintain BMP (staffing/grounds keeping)	Commercial/public versus residential ownership, contacting to find out if they have grounds keeping staff	No staff	Some staff but not trained	Fully trained staff
	Level of education required for maintenance	Based on the type of BMP	BMP requires significant training to maintain properly	BMP requires some maintenance, but the method is easy to learn	BMP requires some maintenance and it is already generally known how to maintain
	On-going maintenance requirements	Based on the type of BMP	BMP requires daily or weekly maintenance/inspection	BMP requires monthly or quarterly maintenance/inspection	BMP requires yearly or multi-yearly maintenance/inspections

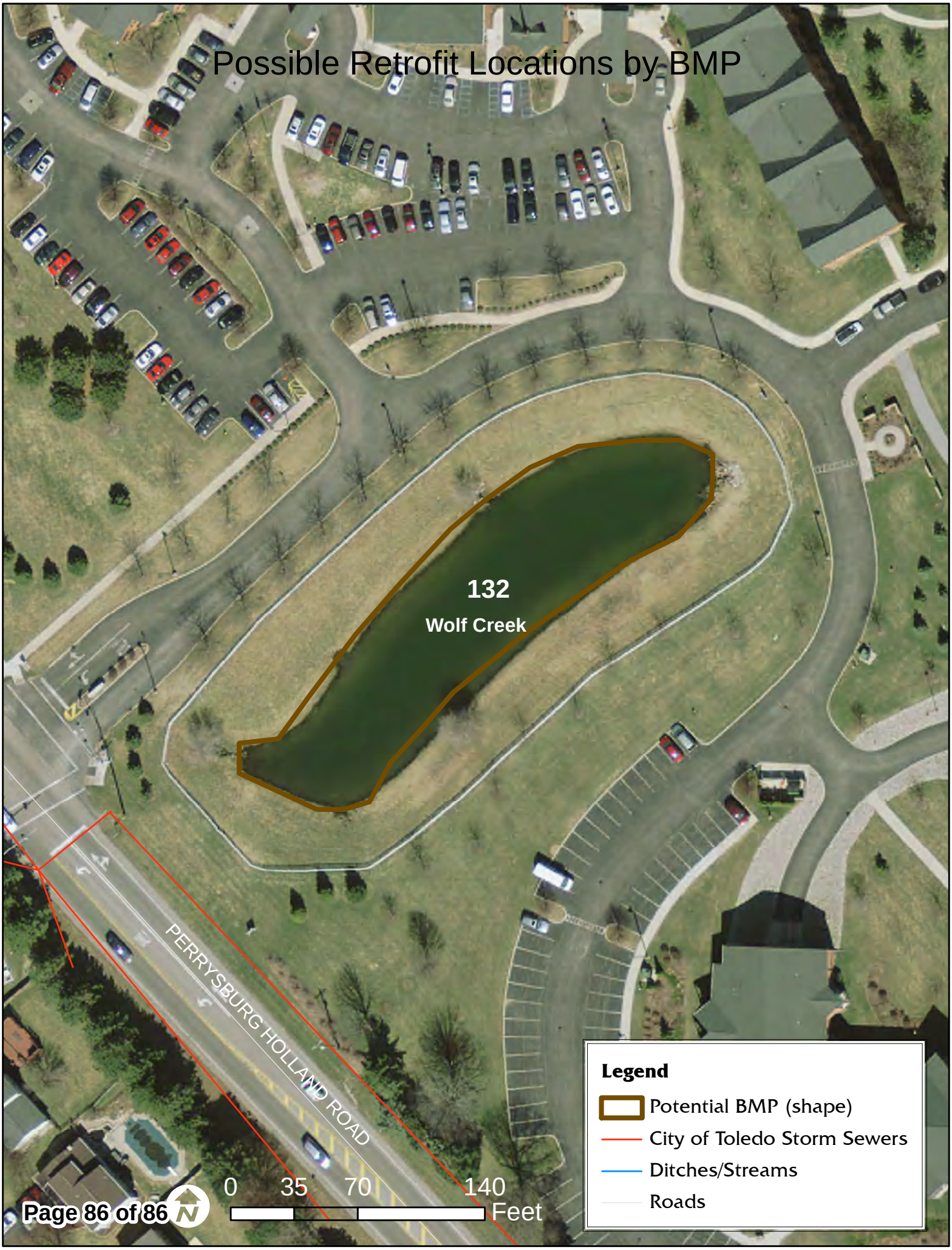
*A qualitative score of "1", "3", or "5" was given based on the range of values for these criteria.

Attachment 4 – Table of Criteria by BMP Retrofit Type

Retrofit	Suitability Analysis Criteria
Bioretention	• Access to streets • Imperviousness • Residential/commercial/industrial areas • Well-draining soils • PDA's • Public lands • Groundwater Pollution Potential areas (avoid) • Sewered areas
Roof retrofits	• Zoning hotspots (commercial/industrial districts) • Floodplain areas • Imperviousness • PDA's • Public lands
Pervious pavement	• Slope <2% • PDA's • Groundwater pollution potential • Imperviousness • Zoning hotspots (commercial/industrial districts) • Well-draining soils
Culvert retrofits	• Barren/open space (using LULC) • Parks • Road right of ways • Well-draining soils • PCA's • Public lands • Groundwater Pollution Potential areas (avoid) • Existing culverts (Euclidean distance)
Outfall retrofits	• Parks • Imperviousness • Groundwater pollution potential • PDA's • Public lands
Hotspots	• Priority Development Areas • Groundwater pollution potential • Imperviousness • Zoning hotspots (commercial/industrial districts)

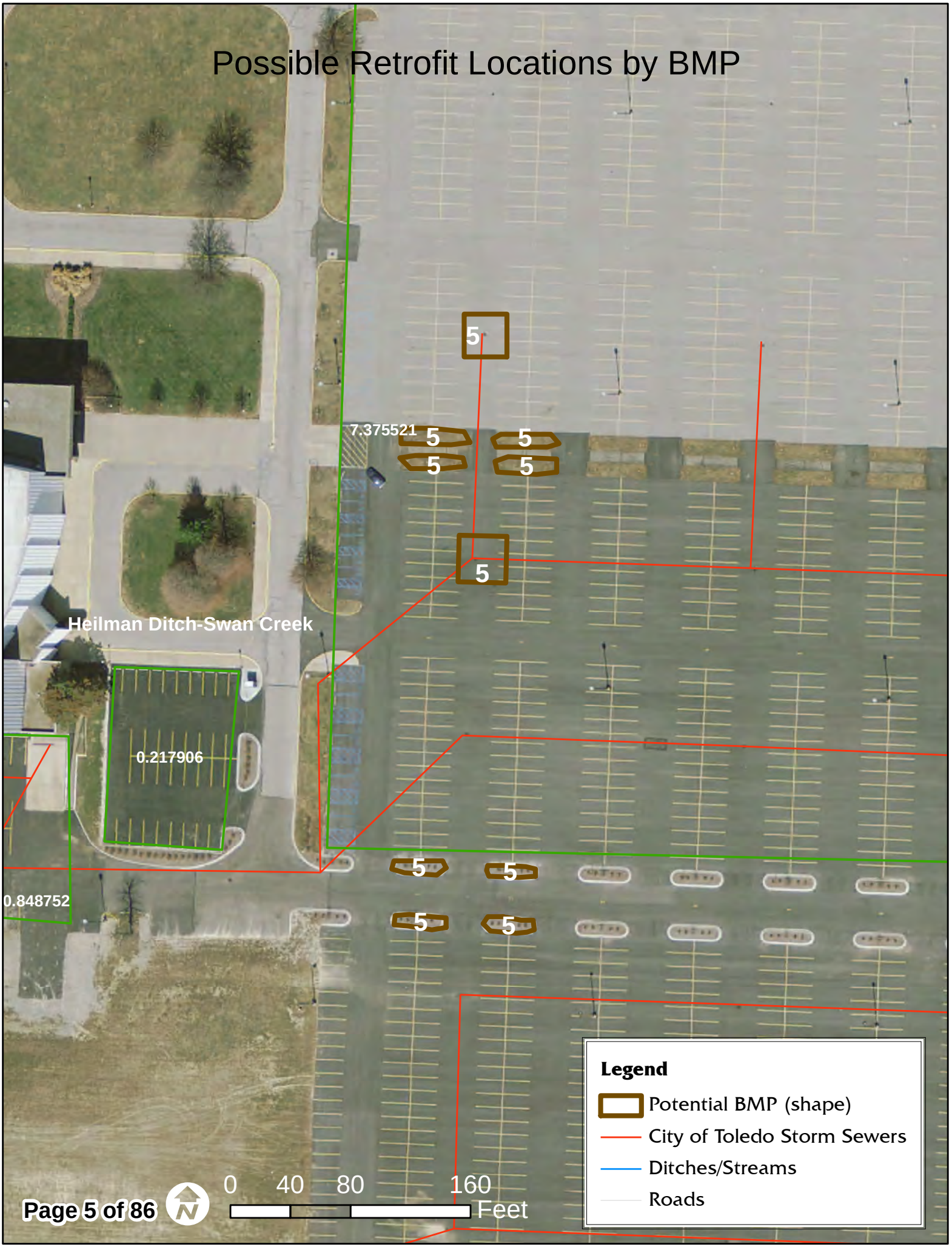
Attachment 5

Maps of the 14 sites that underwent second round ranking


Possible Retrofit Locations by BMP
132
Wolf Creek
PERRYSBURG HOLLAND ROAD
0
35
70
140
Feet
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads

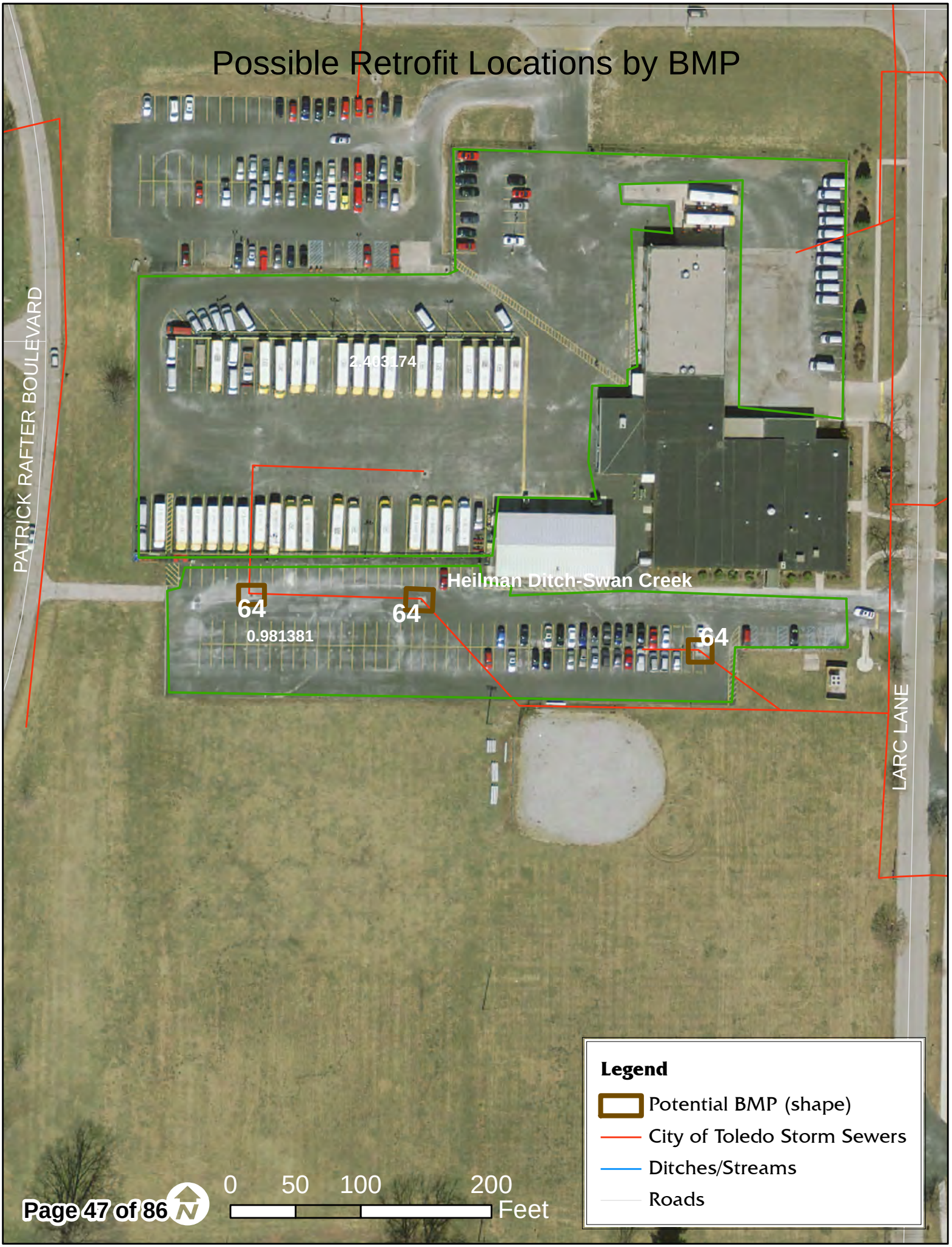

Possible Retrofit Locations by BMP
61
Heilman Ditch-Swan Creek
BRIARFIELD BOULEVARD
124
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
25
50
100
Feet

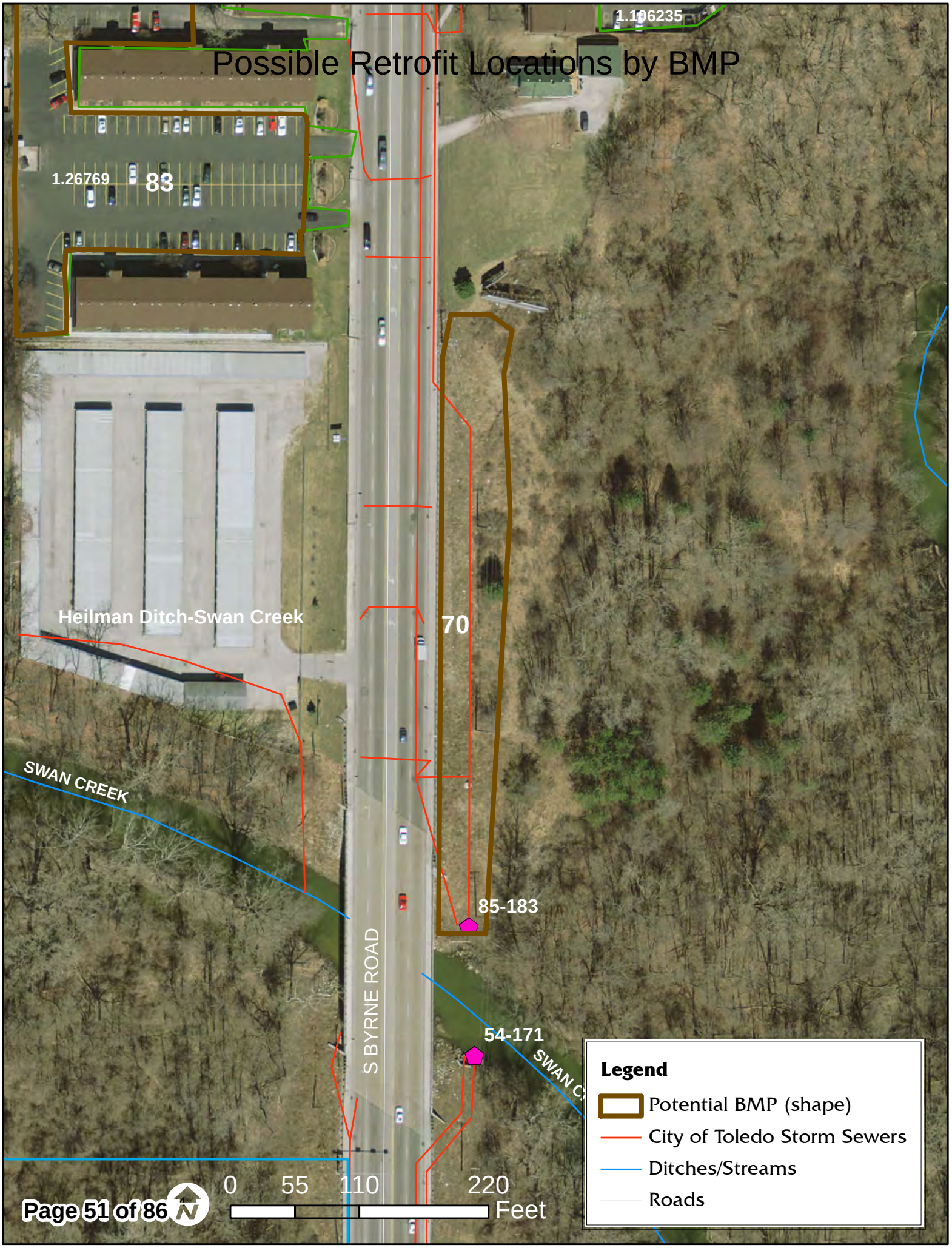
Possible Retrofit Locations by BMP

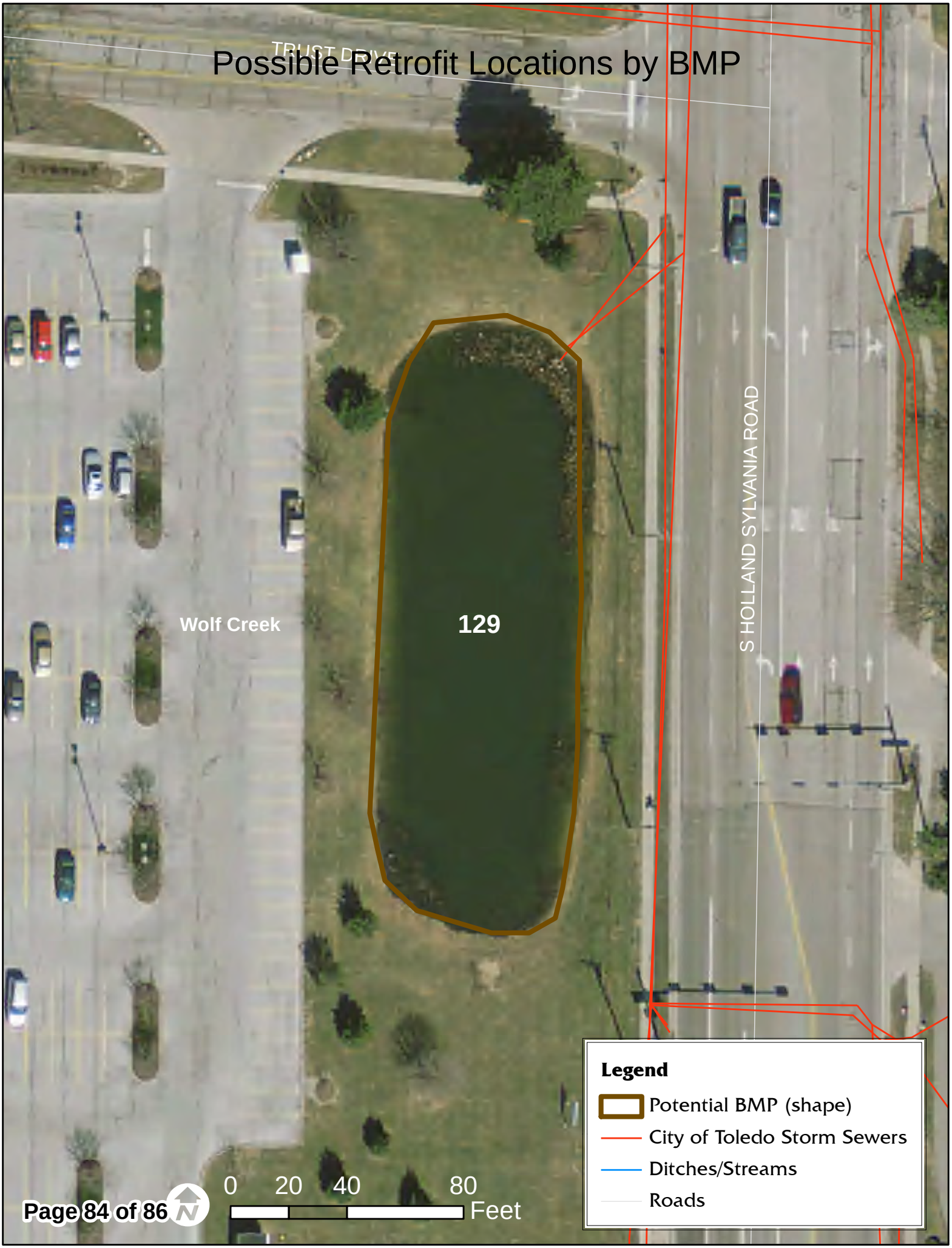

Possible Retrofit Locations by BMP
7.375521
Heilman Ditch-Swan Creek
0.217906
0.848752
5
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
40
80
160
Feet

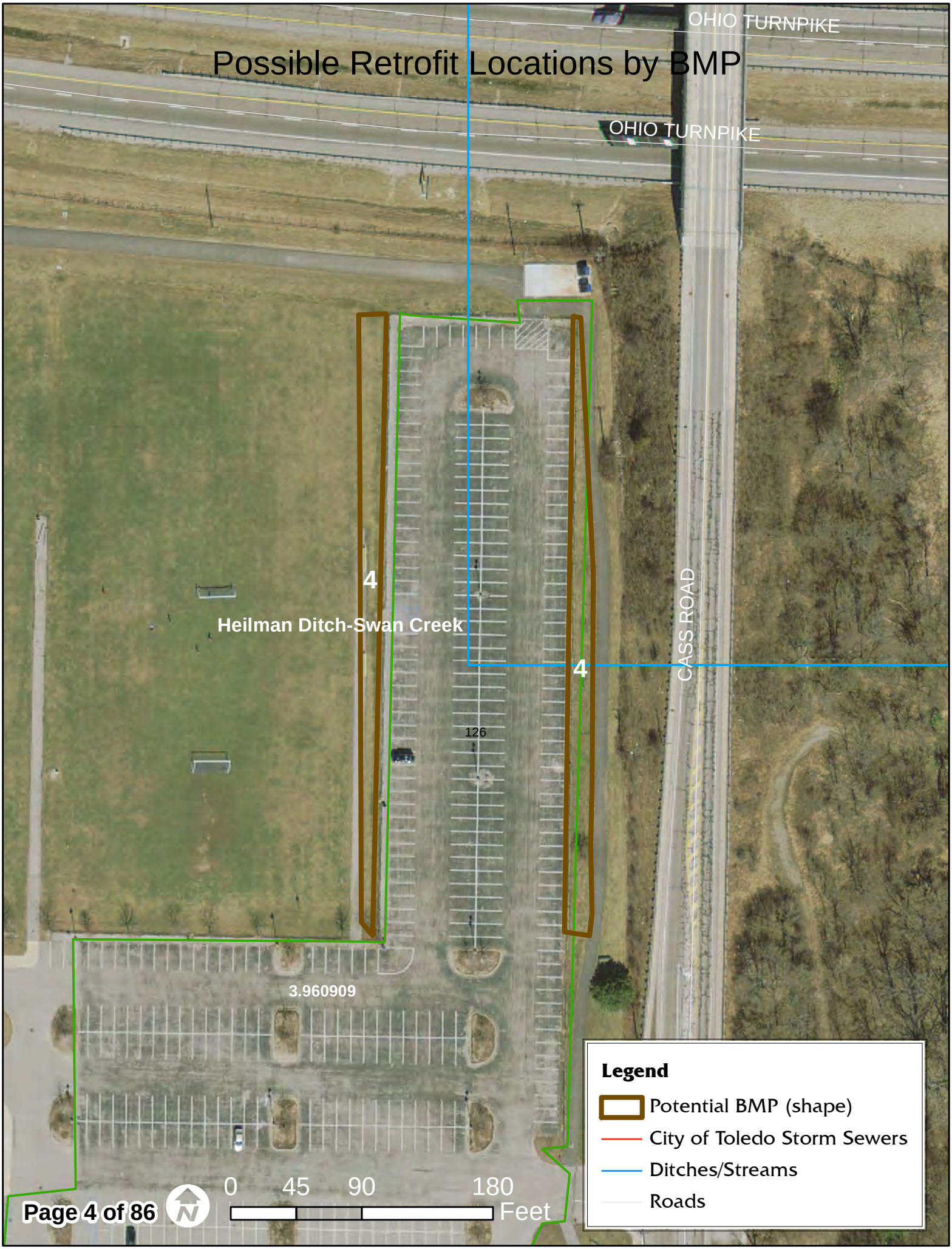
Possible Retrofit Locations by BMP


Possible Retrofit Locations by BMP
AQUADUCT PK
PIMLICO PK
Wolf Creek
STONRIDGE FARMS
18
BLAIR DITCH
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
65
130
260
Feet


Possible Retrofit Locations by BMP
PATRICK RAFTER BOULEVARD
LARC LANE
2.403174
Heilman Ditch-Swan Creek
64
0.981381
64
64
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
50
100
200
Feet

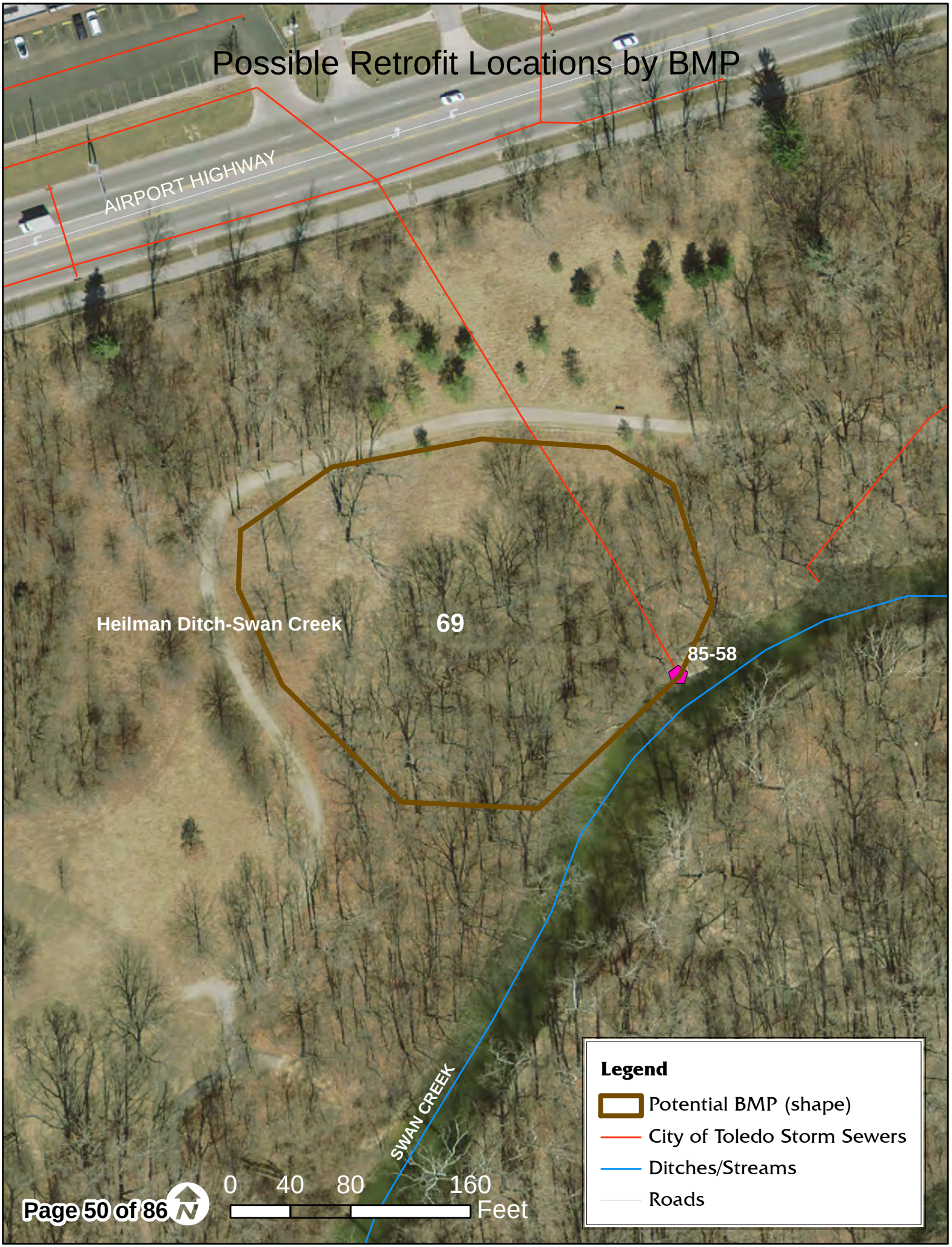

Possible Retrofit Locations by BMP
1.106235
1.26769
83
Heilman Ditch-Swan Creek
70
SWAN CREEK
85-183
S BYRNE ROAD
54-171
SWAN C
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
55
110
220
Feet


Possible Retrofit Locations by BMP
TRUST DRIVE
S HOLLAND SYLVANIA ROAD
Wolf Creek
129
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0 20 40 80
Feet
N


Possible Retrofit Locations by BMP
OHIO TURNPIKE
OHIO TURNPIKE
CASS ROAD
4
4
Heilman Ditch-Swan Creek
126
3.960909
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
45
90
180
Feet


Possible Retrofit Locations by BMP
67
LONG WINTER LANE (PVT)
2.403174
1.80564
65
Heilman Ditch-Swan Creek
64
0.981381
LARC LANE
OPAL STREET
0
70
140
280
Feet
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads

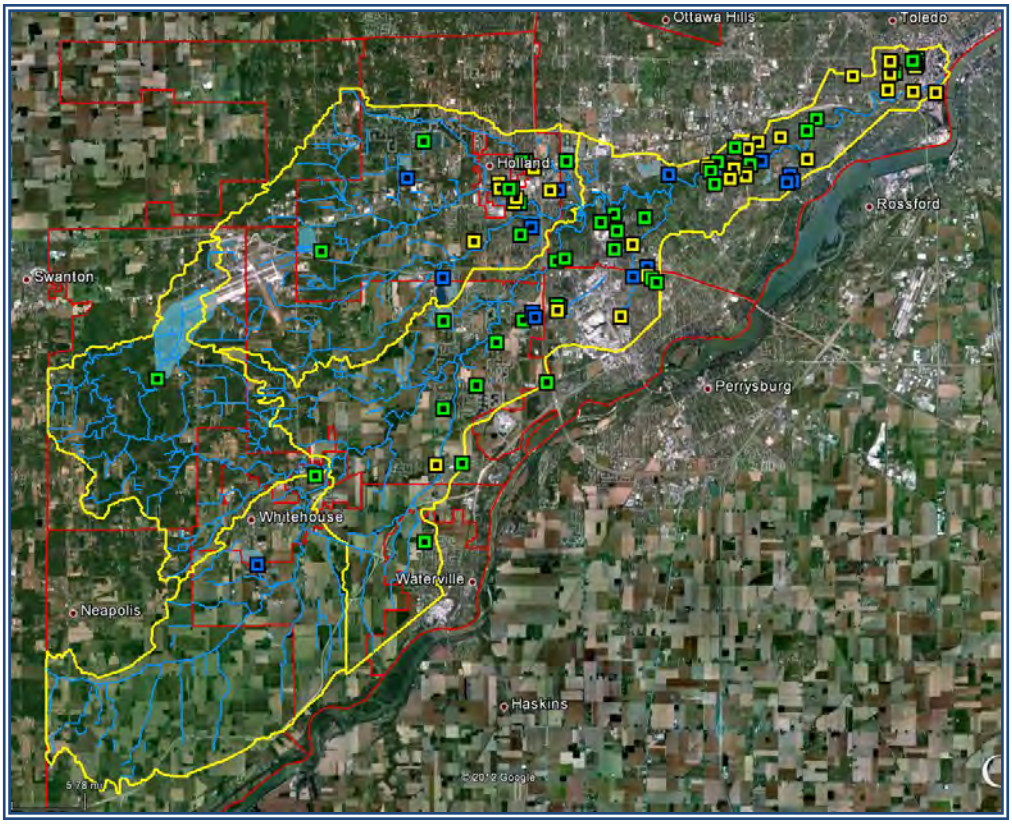

Possible Retrofit Locations by BMP
PROVIDENCE STREET
STILES ROAD
Lower Blue Creek
112
ROACH DITCH
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
95
190
380
Feet
N


Possible Retrofit Locations by BMP
AIRPORT HIGHWAY
Heilman Ditch-Swan Creek
69
85-58
SWAN CREEK
0 40 80 160
Feet
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads


Possible Retrofit Locations by BMP
Heilman Ditch-Swan Creek
67
LAKE POINTE DRIVE (PVT)
GARDEN LAKE DRIVE
ARC LANE
Legend
Potential BMP (shape)
City of Toledo Storm Sewers
Ditches/Streams
Roads
0
60
120
240
Feet

Swan Creek BMP Retrofit Database User's Manual

Toledo Metropolitan Area Council of Governments
Lucas County Soil and Water Conservation District
September, 2012



This project was funded through the Lake Erie Protection Fund with matching funds provided by members of the TMACOG Stormwater Coalition and the Lucas Soil and Water Conservation District. The LEPF is supported by the voluntary contributions of Ohioans who purchase the Erie…Our Great Lake license plate featuring the Marblehead lighthouse. www.lakeerie.ohio.gov

Background Information

In 2011, Toledo Metropolitan Area Council of Governments (TMACOG) and Lucas Soil and Water Conservation District (LSWCD) partnered to identify locations within the Swan Creek watershed that would be best suited for stormwater retrofits. The project team used geographic information systems (GIS) analysis and extensive field surveys to identify 87 sites in the study area that could best impact water quality by retrofitting existing stormwater practices with more sustainable BMPs. This was accomplished by ranking sites based on several criteria. The project team reviewed the 87 sites and identified specific BMPs (e.g. rain gardens) that could be applied to each of these sites. In all, 14 locations were identified as having the highest potential for retrofitting existing practices with BMPs. See the **project report** for full documentation of project methods.

The outcome of the project was a spatial database that operates entirely within the Google Earth framework. The goal of the database is to provide a tool for stormwater planners, decision-makers, and property owners to use in combination with existing stormwater plans that helps pinpoint and prioritize areas for stormwater improvements. The database includes the 87 potential retrofit sites ***(Potential Retrofits)*** and other supporting layers that together provide users with general information regarding site accessibility and the ability to maintain a suggested BMP in the context of the larger landscape. Additionally, landowners can use the database to view potential BMPs on their properties that can be used to receive non-residential stormwater credits.

Downloads

First, you will need to download Google Earth if you do not already have it installed on your computer. You will also need to download the Swan Creek BMP Retrofit Database and Reference Material

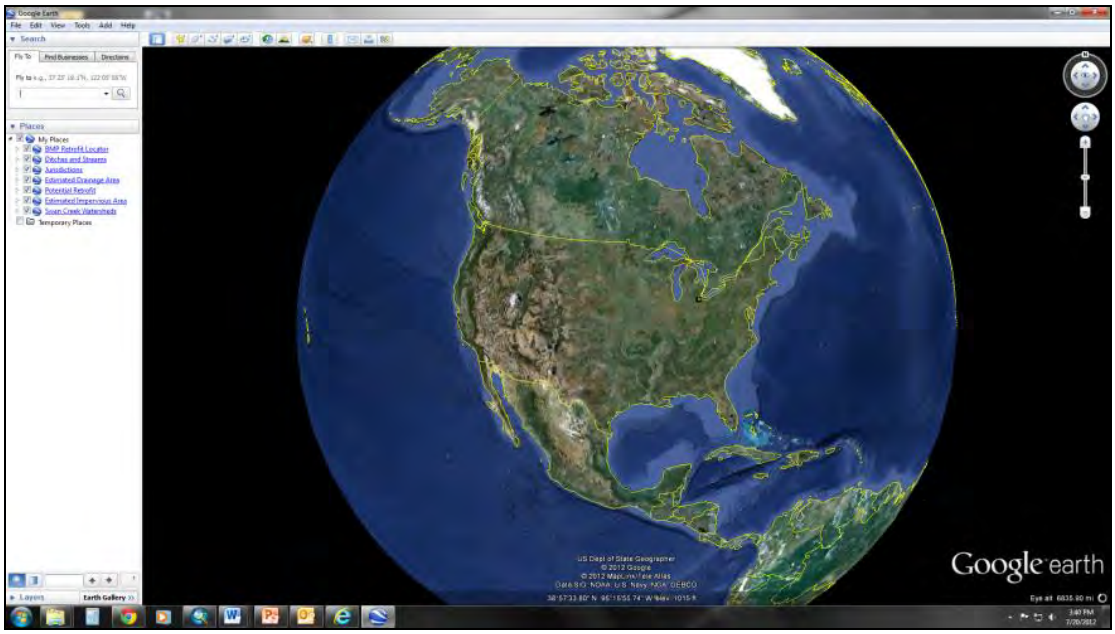
Google Earth and all datasets are available for download on the **project website.**

Download Google Earth:

1. Go to the **Google Earth Homepage** and click on the "download Google Earth" button. Read agreement and system requirements. Click "agree and download."

2. The file GoogleEarthSetup.exe should automatically download to your "Downloads" directory. However, you may be given the option to save the file to your computer. Either way, you will have to open and "run" the file to install Google Earth.

3. When the installation is complete, Google Earth should open automatically. If it does not, find where the program is located and open it. It will look like this when it opens:



Downloads, continued

Download datasets:

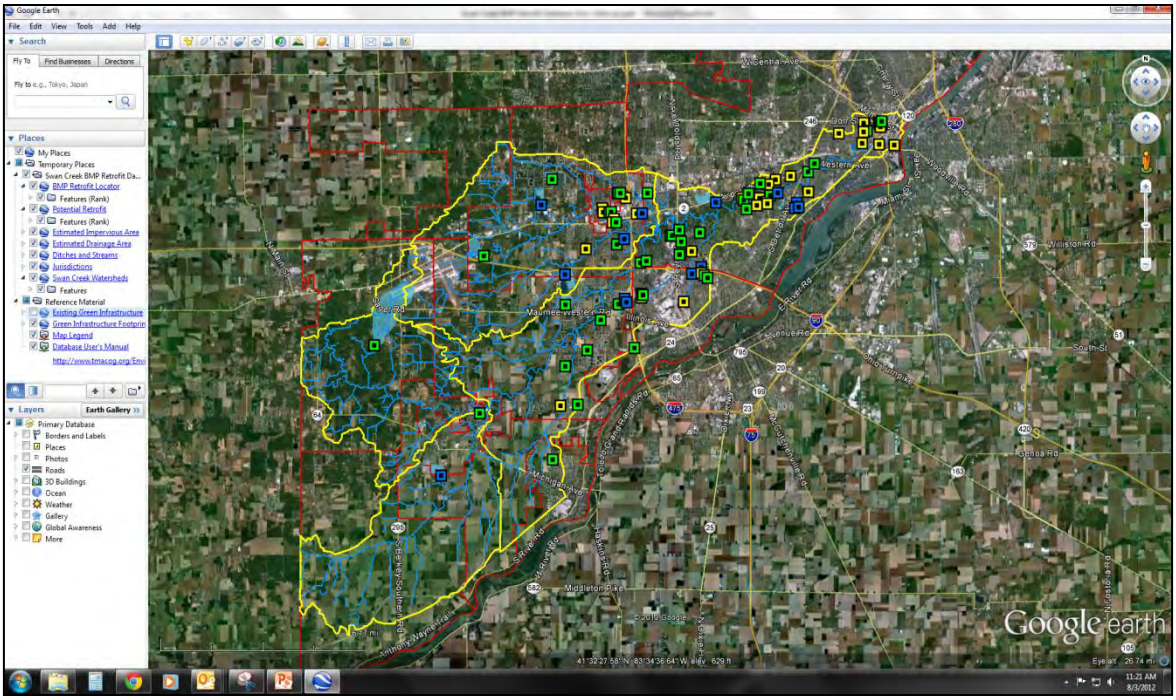
1. Go to the **project webpage** and find the downloads at the bottom of the page

2. Click on the first dataset ***Swan Creek BMP Retrofit Database***. How you download will vary depending on your web browser. However, most browsers will prompt you to either "save" the download to your computer or "open." Choosing "open" will open each file directly in the Google Earth application you just downloaded. The files will not be saved to your computer. Choosing "save" will allow you to choose a location to save the files and then open from the file location.

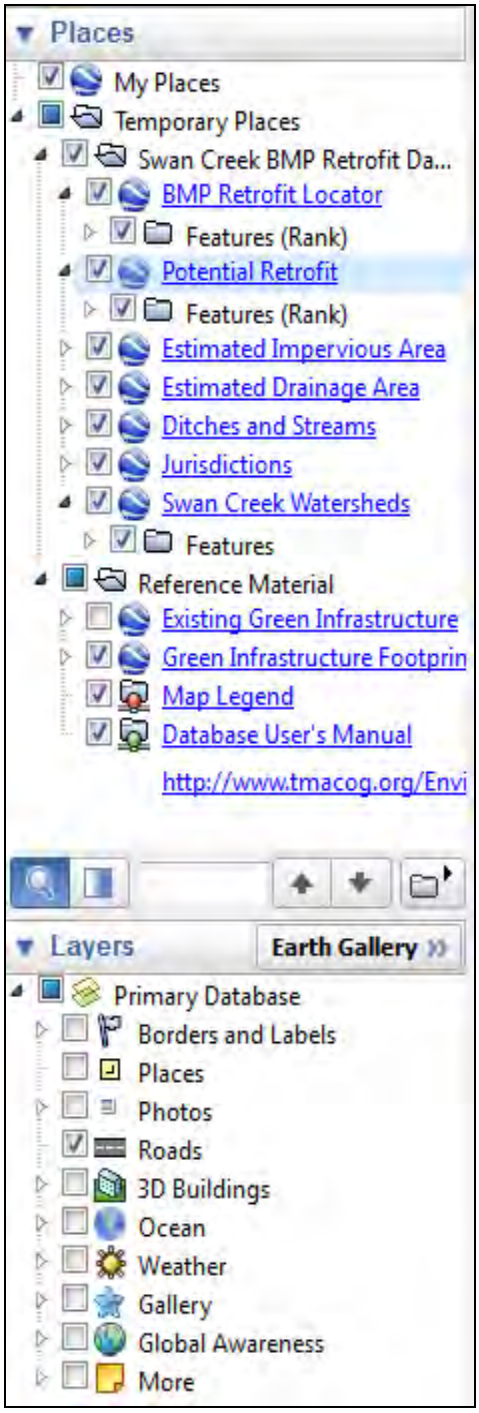
3. After the database is opened in Google Earth, your map extent will "zoom" quickly to the Swan Creek study area.

4. Next, download the dataset named ***Reference Material.***

5. After both datasets are downloaded and installed in Google Earth, your view should look something like the image below. Note that all layers will load under "Temporary Places".



Swan Creek BMP Retrofit Database



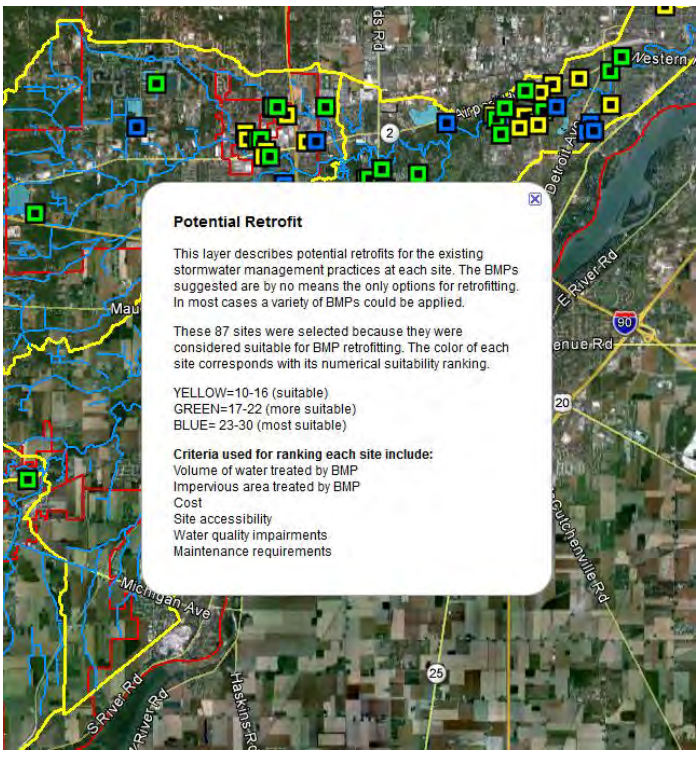
All Data loaded with Potential Retrofit layer selected

Finding information about each layer:

- Clicking on each data layer in the sidebar will show an information pop-up bubble in the middle of your map. This is an important first step in understanding what each dataset represents and its utility in analyzing the main data set ***Potential Retrofits***

- Double Clicking the dataset will zoom you in to the spatial extent of that dataset.

- To become familiar with the database, o this for each layer in the ***Swan Creek Retrofit Database*** before going further



This information bubble will pop up when you click Potential Retrofit layer

Below are the descriptions that pop up for each dataset

BMP Retrofit Locator

Marks the general location of each potential retrofit

Potential Retrofit

This layer describes potential retrofits for the existing stormwater management practices at each site. The BMPs suggested are by no means the only options for retrofitting. In most cases a variety of BMPs could be applied. These 87 sites were selected because they were considered suitable for BMP retrofitting. The color of each site corresponds with its numerical suitability ranking.

YELLOW=10-16 (suitable)
GREEN=17-22 (more suitable)
BLUE= 23-30 (most suitable)

Criteria used for ranking each site include:
Volume of water treated by BMP
Impervious area treated by BMP
Cost
Site accessibility
Water quality impairments
Maintenance requirements

Swan Creek Watersheds

Sub-watersheds in the Swan Creek study area

Jurisdictions

Municipal and Township Boundaries in Swan Creek watershed

Ditches and Streams

Ditches and Streams in the Swan Creek watershed

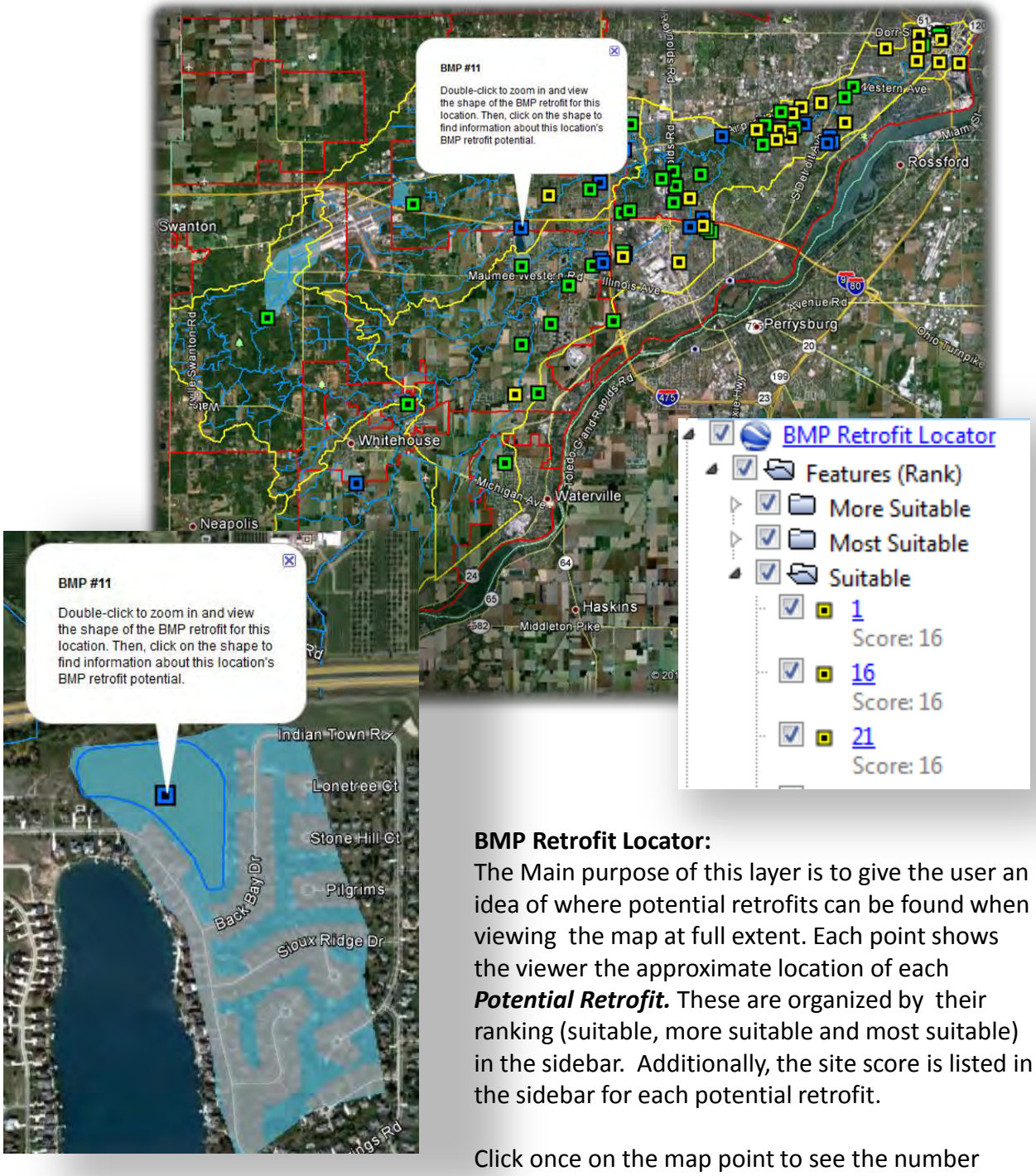
Estimated Drainage Area

This layer shows the approximate drainage area of the corresponding BMP. The number shown in the information pop-up when clicking each drainage area corresponds to the BMP number.

Estimated Impervious Area

This layer shows an approximate footprint and area (acres) of the impervious surface treated by the corresponding BMP. The number shown in the information pop-up when clicking each impervious feature corresponds to the BMP number.

Using Each Dataset

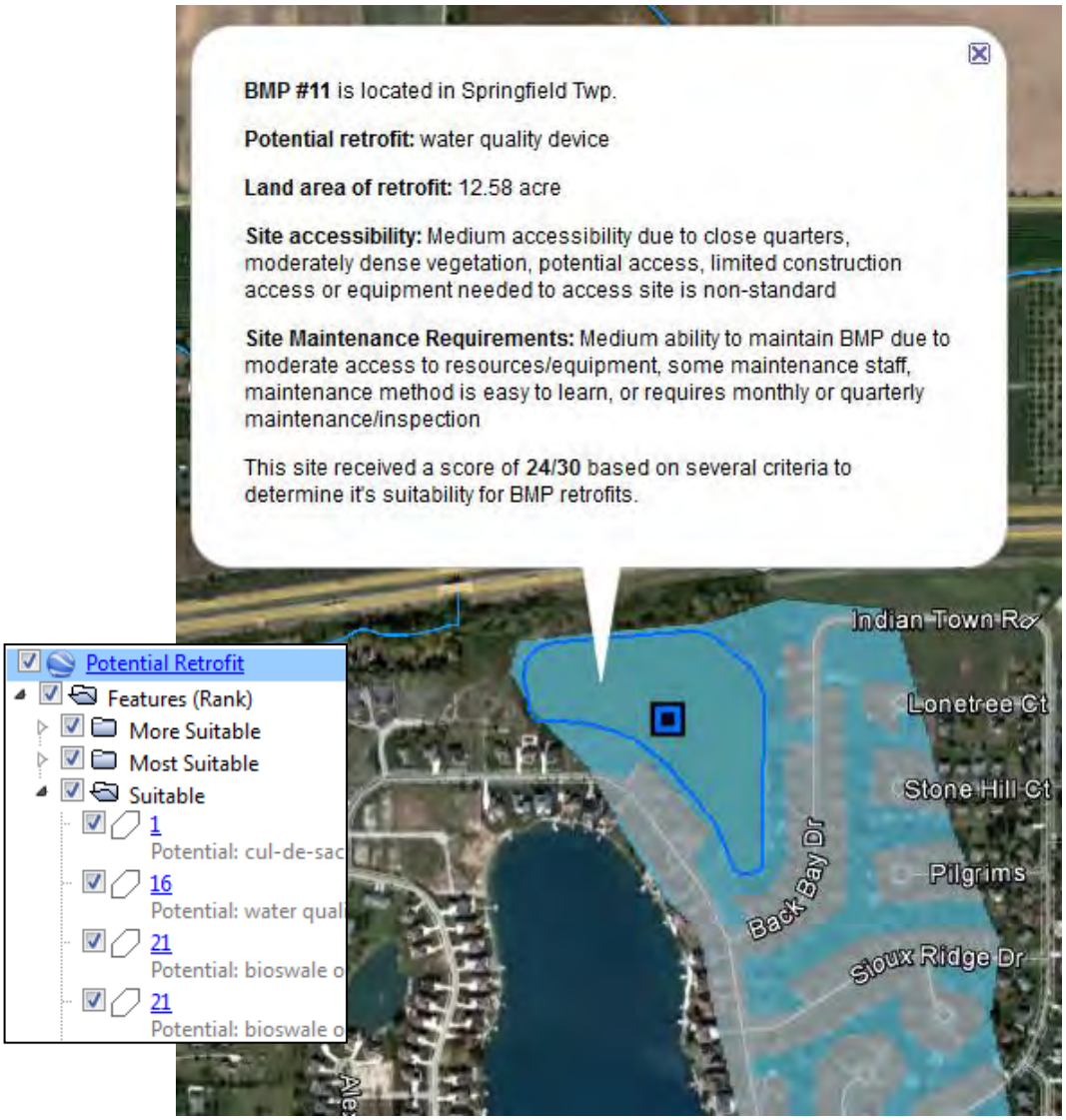


BMP Retrofit Locator:
The Main purpose of this layer is to give the user an idea of where potential retrofits can be found when viewing the map at full extent. Each point shows the viewer the approximate location of each ***Potential Retrofit.*** These are organized by their ranking (suitable, more suitable and most suitable) in the sidebar. Additionally, the site score is listed in the sidebar for each potential retrofit.

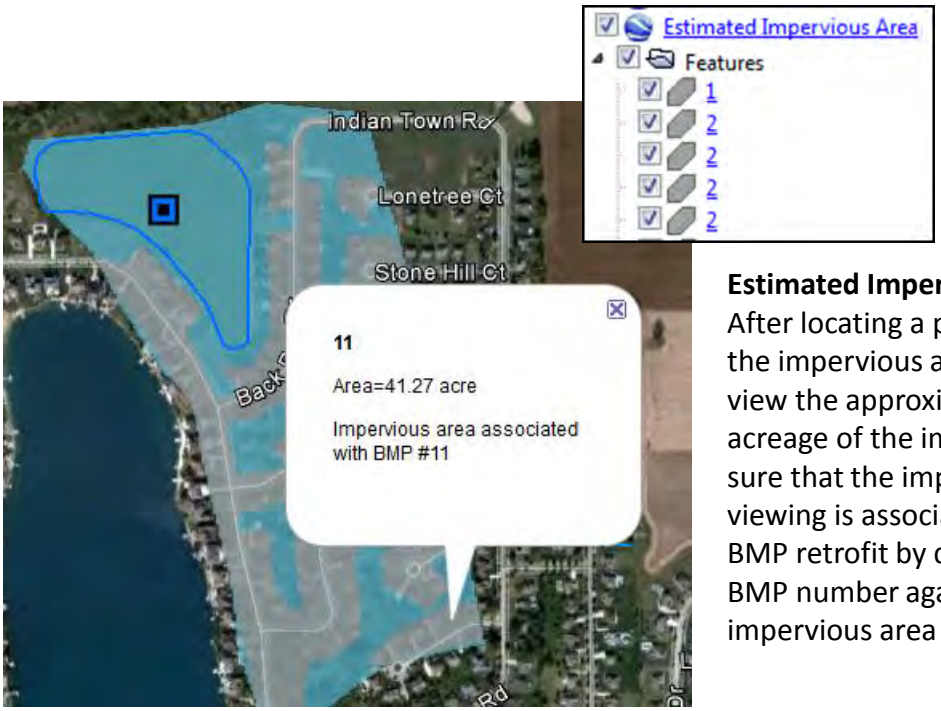
Click once on the map point to see the number assigned to the potential retrofit. Double-click to zoom to the location of the potential retrofit. Once at the location, you will see the outlined shape of the retrofit corresponding to the color and number of the locator point.

Using Each Dataset, Cont.

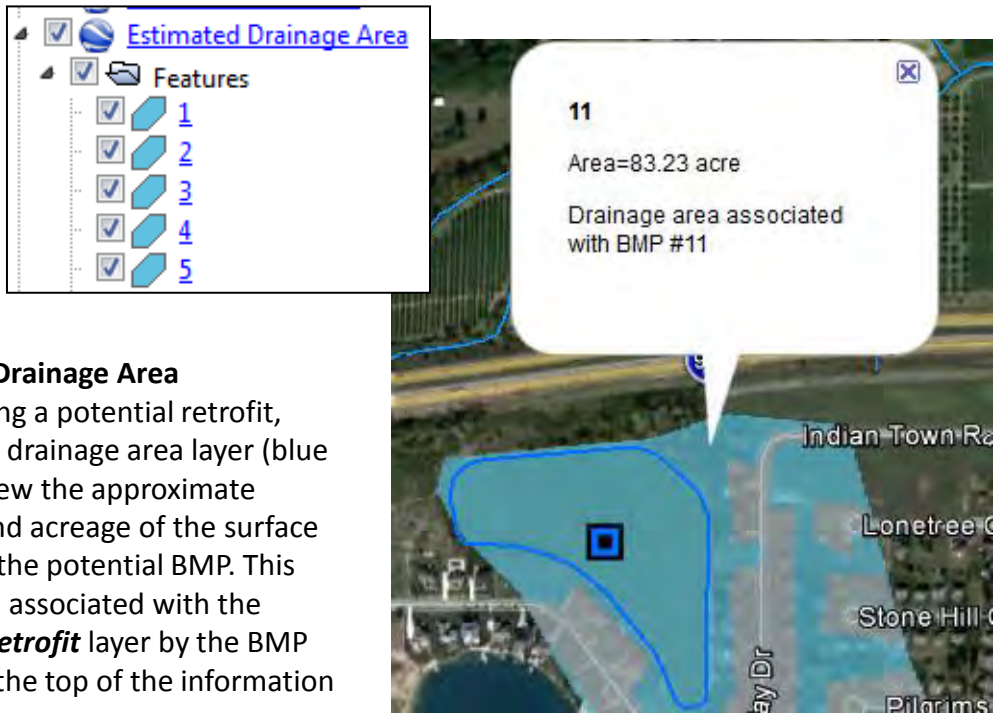
Potential Retrofit:
Each potential BMP is numbered and each number matches the corresponding feature in the ***Estimated Impervious Area*** and ***Estimated Drainage Area*** layers. Find specific BMPs by either using the ***BMP Retrofit Locator*** or click on the number of the desired BMP retrofit in the side bar. To do this you will have to expand all folders under ***Potential Retrofit.*** Once zoomed in to the potential retrofit site you can click on the BMP retrofit shape to view a pop-up information bubble. This gives a narrative that should help in the site selection process. Information includes the suggested BMP retrofit, jurisdiction of the potential BMP, land area of the retrofit, accessibility information, site maintenance requirements and site score out of 30 possible points. Note: ***Site Accessibility*** and ***Site Maintenance Requirements*** describe possible issues for each site. Not all of the issues listed necessarily relate to that specific site.



Using Each Dataset, Cont.



Estimated Impervious Area
After locating a potential retrofit, click on the impervious area layer (gray areas) to view the approximate footprint and acreage of the impervious surface. Make sure that the impervious area you are viewing is associated with the correct BMP retrofit by double checking the BMP number against the number in the impervious area pop-up.

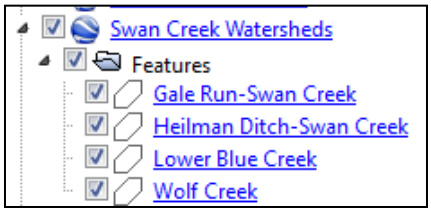


Estimated Drainage Area
After locating a potential retrofit, click on the drainage area layer (blue areas) to view the approximate footprint and acreage of the surface drained by the potential BMP. This layer is also associated with the ***Potential Retrofit*** layer by the BMP number at the top of the information bubble.

Using Each Dataset, Cont.

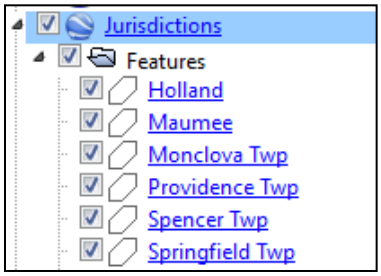
Swan Creek Watersheds

This layer allows the user to view potential retrofits in the context of each subwatershed. To zoom directly to a specific watershed, double-click on the watershed name in the side bar. This will also bring up an information bubble with the 12-digit hydrologic unit (HUC) of that watershed.



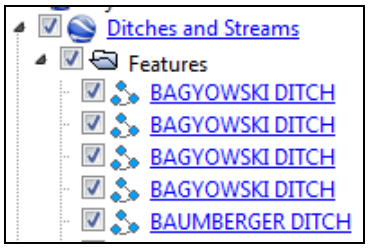
Jurisdictions

This layer allows the user to view potential retrofits in the context of each municipality or township. To zoom directly to a specific jurisdiction, double-click on the jurisdiction name in the side bar.



Ditches and Streams

This layer allows the user to view potential retrofits in the context of local waterways. The sidebar can be used as a navigation tool to zoom to a specific stream segment. However, with nearly 700 stream segments each listed separately, finding the area you are looking for by clicking on a stream name may not be as effective as zooming to a specific address or location. This layer is most useful when stream information is needed for a specific site . To do this, zoom into a site and click on nearby streams to see the information pop-up.

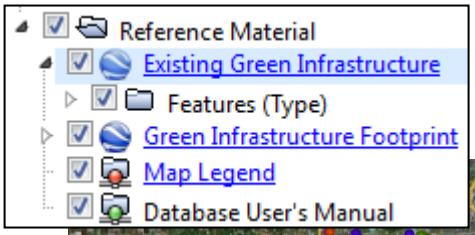


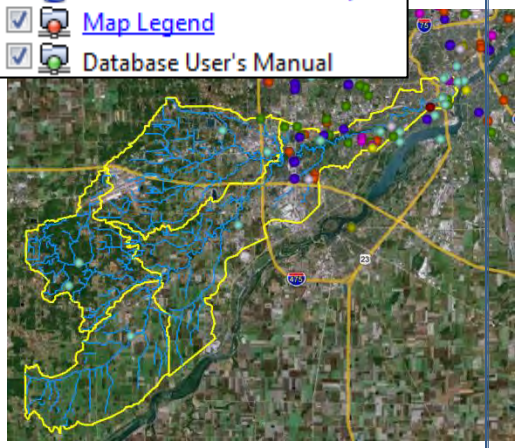
Reference Material

Included in the file named ***Reference Material*** are several pieces of information to help you better understand the database. These include a map legend, the database user's manual and a data layer of current Green Infrastructure practices in the Toledo area.

Viewing current Green Infrastructure (GI)

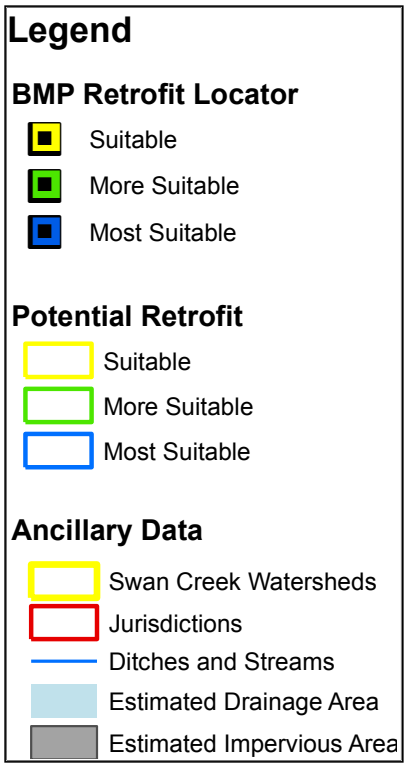
Location data for GI practices in the Toledo area are located in the data layer named ***Existing Green Infrastructure.*** This dataset includes locations of existing green stormwater practices that can be used as examples for stormwater retrofits. Some of the sites are marked only by a point while others have a point marker as well as a polygon "footprint" of the GI practice. The footprint s are all located in the layer named ***Green Infrastructure Footprint***. Clicking on the point for each GI practice will tell you information about the site.





Viewing map legend

You will notice that the data layers listed on the left panel do not show the symbology used to represent each layer. This can be a problem when trying to interpret the map. Clicking on ***Map Legend*** will pop up an image on your map view of the legend with symbology for each layer in the Retrofit database.



When you are finished viewing the legend click the blue "***X***" in the top right corner to clear the legend from your field of view. You can reference the legend this way at any time during your Google Earth session.

User's Manual

Clicking on ***Database User's Manual*** in the sidebar will open the document in the Google Earth window. When you are finished click on the ***Back to Google Earth*** button in the top left corner.

Tips for Using the Sidebar

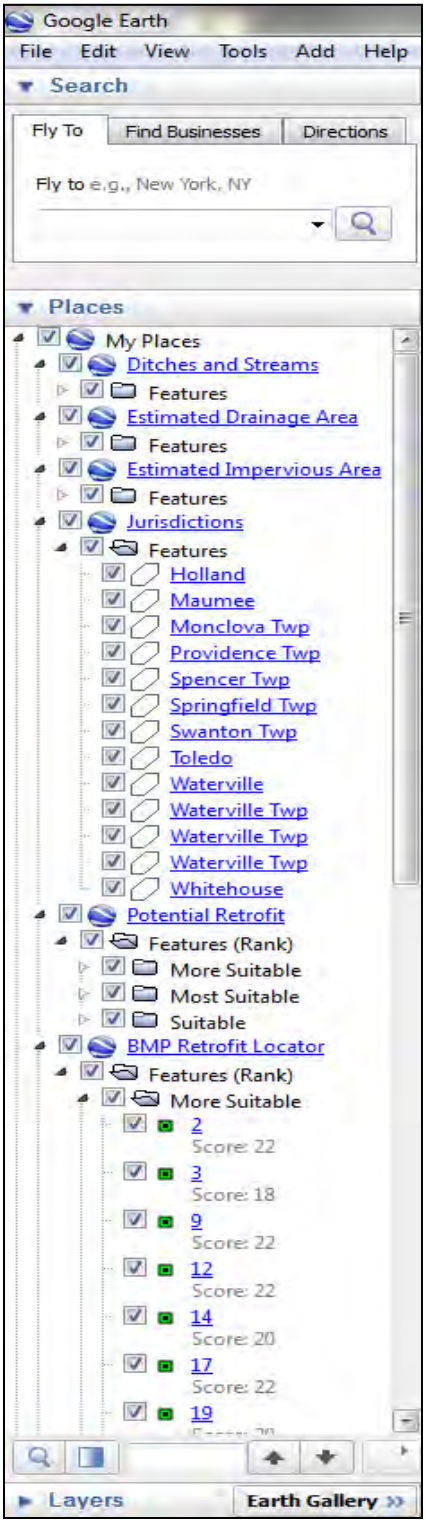
- All newly opened data will be placed in the ***Temporary Places*** folder. Moving data to ***My Places*** will save the data so next time you open Google Earth your data will be already loaded. Move data to ***My Places*** by right clicking ***Temporary Places*** and selecting ***Save to My Places***

- Uncheck the box for each layer to turn the data off in the map. Check boxes to turn map data back on.

- Click the small arrows next to each dataset to expand information about each layer. Each layer's ***Features*** folder contains individual features on the map. Some datasets are grouped into sub folders. Use the scroll bar to fully view each expanded folder. Click the arrow again to collapse the folder.

- Clicking features once will show a pop-up with information for that specific feature. The pop-up also has a pointer which directs you to the specific location of the feature.

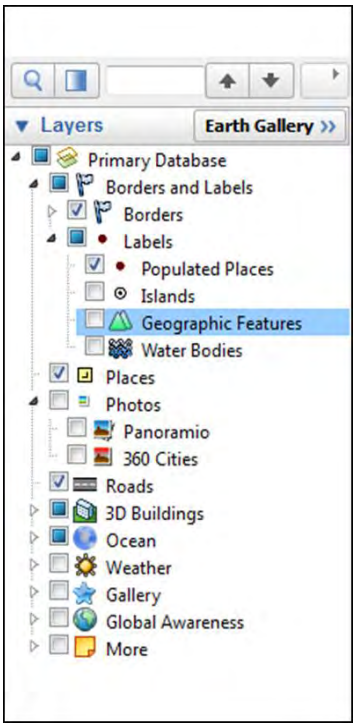
- Double-clicking features will bring up the same information bubble and will also fly and zoom you directly to the feature.



Tips for Controlling Google Earth

Larger polygon features take priority over the smaller features within them when clicking for information. For example, you may be clicking on a feature in the ***Potential BMP*** dataset, but rather than seeing information about the retrofit, you are seeing an information pop-up for the watershed that the site is in (See illustration below.) When this happens, simply turn off the dataset of larger feature in the sidebar.

Turning layers on and off also may help in understanding the shape of each feature. Sometimes features overlap and create a visual barrier for the features underneath.

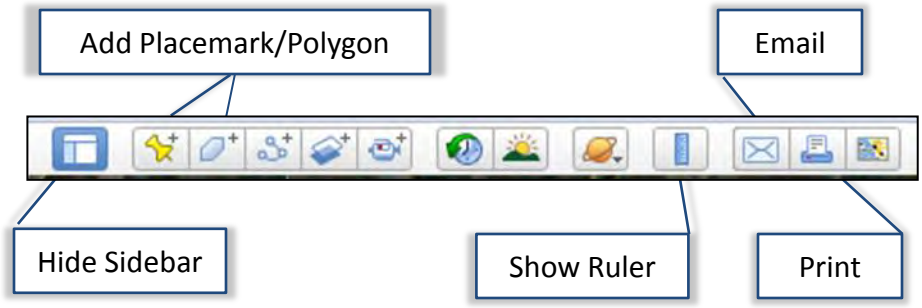


Google Earth has plenty of additional data to enhance your map viewing experience. However, many of these data layers are unnecessary and can clutter your map. To shut off unnecessary data uncheck, the box next to all of the datasets you don't care to view. Google Earth data files are at the bottom of the left panel under the heading ***Layers.***

You can also hide the ***Layers*** navigation window by clicking on the downward pointing arrow. To show this window again, click the right arrow next to "Layers" at the bottom of your screen

Note: these data layers may be useful later as a reference when users begin to make decisions about BMP retrofits. If you are interested in viewing these layers, make sure you click all arrows within each dataset to fully expand each layer.

Google Earth Toolbar



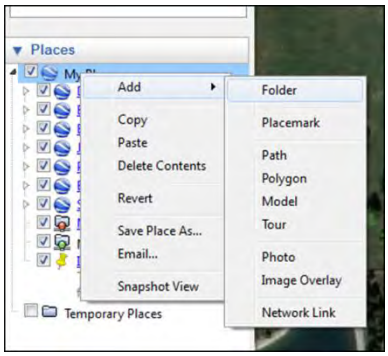
The toolbar offers many functions for map viewers. Those that are most relevant to the Swan Creek BMP Retrofit Database are detailed below.

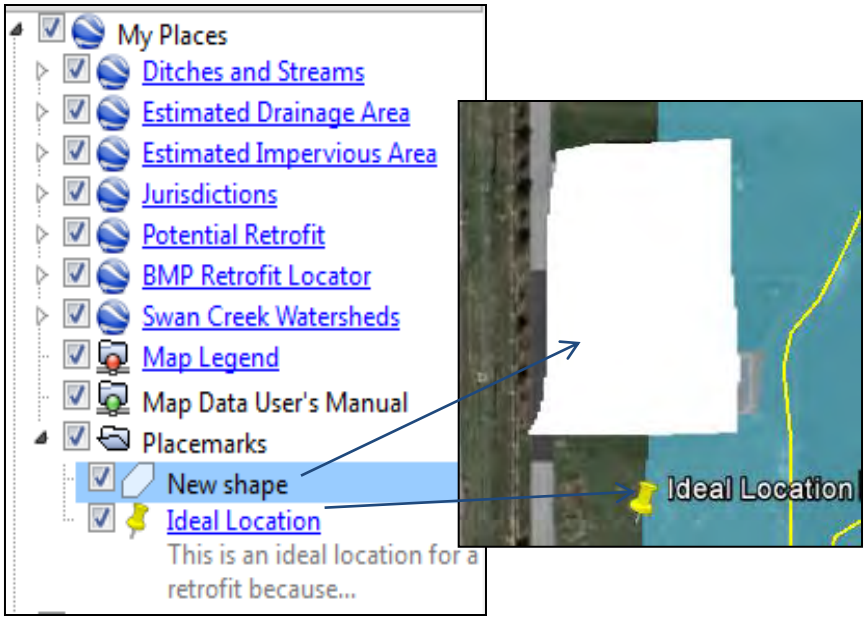
Hide Sidebar

Clicking hides the left sidebar from view. Clicking again shows the sidebar.

Add Placemark or Polygon

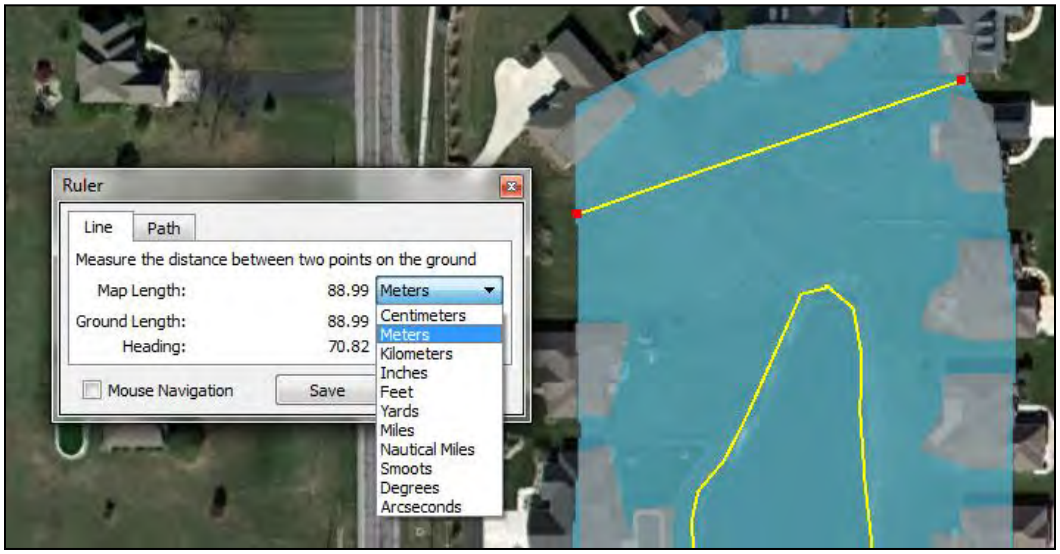
Adds a placemark or polygon to the map. This can be useful for making notes on a specific site or highlighting an area of interest. The placemark or polygon will be added to whatever layer is selected in the sidebar, so first add a new folder (name it appropriately in the dialog box that pops up) to ***My Places*** to contain all of your placemarks and polygons.





Show Ruler

The ruler allows you to measure distances on the ground. When opening the ruler, a box will pop up with several option for units of measure. Drag the cursor across the length you would like to measure. The results will show in the box.



Email

You can email a graphic file (JPG) or a Google Earth compatible file (KMZ) to share information and data using Outlook or your Gmail account. When selecting the first option, a JPG of your current map extent will be sent. The recipient can open this file in several photo viewers. When receiving a selected placemark/folder (the last option) the recipient will only be able to open the KMZ file in Google Earth. This option is useful when you want to send the actual geographic data to another Google Earth user. Make sure that the layer, feature or placemark that you want to send is hilighted in the sidebar.

Email an image of your current map view

Email a Google Earth file of your data