Tinkers Creek Wetland Assessment and Green Infrastructure Plan for 2009/2010

September 10, 2010

Prepared for:

Cuyahoga County Board of Health
5550 Venture Drive
Parma, Ohio 44130

Prepared by:

Tetra Tech
1468 W. 9th Street
Suite 620
Cleveland, OH 44113

Biohabitats
2026 Murray Hill Road
Room 107
Cleveland, OH 44106

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Executive Summary

Tinkers Creek is the largest tributary of the Cuyahoga River and drains an area of approximately 100 square miles. The watershed is highly urbanized, especially in its northern section, but also includes many areas of high-quality habitat, including wetland swamps, bogs, and fens. Despite the high-quality habitat in portions of the watershed, several streams do not currently meet Ohio Environmental Protection Agency water quality standards and appear on the state's list of impaired waters. The identified causes of impairment include habitat alterations, flow alterations, and nutrients. Nutrients are considered a problem not only within Tinkers Creek, but also for their potential role in contributing to excessive algal growth in the Cuyahoga River and in Lake Erie.

A number of agencies and groups are working to protect and restore the Tinkers Creek watershed, including the Cuyahoga County Board of Health (CCBH) and the Tinkers Creek Watershed Partners. CCBH commissioned a 2008 study of the watershed to inventory and assess the ecological, hydrologic and economic value of wetlands. The study concluded that despite the rapid growth within the watershed, the watershed contains important wetland resources whose ecosystem functions provide a high societal value. The major value of wetlands from an economic standpoint came from their recreational value, stormwater retention capabilities, and avoided permitting and mitigation costs. High value wetlands were often found to be protected by parks, but several unprotected high quality wetlands remain in the watershed.

CCBH sponsored this supplemental study to further quantify the water quality benefits provided by the wetlands within the watershed. One conclusion of the study is that the largest existing source of nutrients to Tinkers Creek is stormwater runoff from highly developed areas. Conversion of the existing wetlands to highly developed areas would increase the load of nitrogen and phosphors to the creek by 13,000 and 500 kg/yr, respectively, simply due to the lower loading rate of wetlands compared to high intensity development. Furthermore, assuming that existing wetlands drain an area equal to twice their size, they keep an additional 8,600 kg/yr of nitrogen and 1,100 kg/yr phosphorus from the creek due to their ability to store and assimilate runoff from adjacent areas.

In addition, new constructed wetlands can help to further reduce nutrient loading in the watershed. For example, the creation or restoration of 100 hectares (approximately 250 acres) of wetlands is expected to reduce nitrogen loading to the creek by 4 percent and phosphorus loading by 5 percent. The estimated cost for the 100 hectares of wetlands is high ($32 million), but the total benefits they would provide is estimated at nearly $100 million. Several studies (e.g., Kerr+Boron Associates 2005; White and Fennessy 2005; CRCPO 2008; Liptak et al. 2008) document the benefit of the existing wetlands in the watershed or identify those areas that would be most suitable for the restoration of lost wetlands.

To further address nutrient loading within the Tinkers Creek watershed, this study also sets forth a green infrastructure approach for managing stormwater runoff. A range of green infrastructure best management practices that are appropriate for application across the Tinkers Creek watershed are identified and described. These include downspouts disconnection, sustainable turf management, biofiltration, permeable pavement, green roofs installation, and stream/riparian rehabilitation. Information is provided on each of these and other practices, and a holistic green infrastructure strategy is presented for a representative subwatershed. The potential load reduction benefits of each practice are also presented, along with planning-level design and construction cost estimates.

The following recommendations are made as a result of this study:

1) A high priority should be placed on protecting the existing wetlands, especially those high-quality wetlands that are not currently located in parks. These existing wetlands in the watershed have been shown to provide an important water quality benefit in addition to the recreational, hydrologic, and economic benefit documented by the previous study.

2) Project partners should work to secure a grant to create or restore additional wetlands within the watershed. The effort should be pursued as a pilot project to learn about the process to benefit future, larger restoration activities.
3) Project partners should work with landowners and government agencies to implement several of the green infrastructure practices identified for the Bear Creek subwatershed. Similar to the pilot wetland restoration project, the initial efforts can serve to educate and inform future, larger stormwater management activities within the watershed.

1. Introduction

The Tinkers Creek watershed is a sub-basin of the Cuyahoga River, a major tributary to Lake Erie in northeastern Ohio. The watershed encompasses an area of approximately 100 square miles, and includes portions of four counties (Summit, Portage, Geauga and Cuyahoga; see Figure 1). Tinkers Creek is the largest tributary of the Cuyahoga River and lies on a glaciated plateau. Soils are mostly silt loam and clayey silt loam and wetland swamps, bogs and fens are common in the upper watershed. Flows in the lower section of the creek are highly influenced by the discharge of treated wastewater from upstream wastewater treatment plants (WWTPs). Portions of the stream are on bedrock and create waterfalls, which are a natural barrier to fish passage. The lower portions of the stream have formed the Tinkers Creek Gorge, which is a National Natural Landmark.

Land cover in the watershed varies along the length of Tinkers Creek. About 35 percent of the land is classified as high intensity development, about 19 percent cropland, and about 16 percent as turf grass (Table 1). Land use in the northern half of the watershed tends to be more urban and developed than in the southern half. The population ranges from approximately 10,441 people in Bedford Heights to approximately 21,883 people in Solon (U.S. Census Bureau 2009).

Table 1. Land cover percentages in the Tinkers Creek watershed

Land Cover	Percentage of Watershed
Row Crops	19.3
Forest	18.6
Pasture/Hay	1.1
High Intensity Developed	34.5
Low Intensity Developed	3.8
Turf/Golf	15.8
Wooded Wetland	7.0
Total	100.0

Land development within the Tinkers Creek watershed has resulted in an increased stress on its water resources. Several assessment units do not currently meet Ohio Environmental Protection Agency water quality standards and appear on the state's list of impaired waters. The identified causes of impairment include habitat alterations, flow alterations, and nutrients.

A number of agencies and groups are working to protect and restore the Tinkers Creek watershed, including the Cuyahoga County Board of Health (CCBH) and the Tinkers Creek Watershed Partners. CCBH commissioned a 2008 study of the watershed to inventory and assess the ecological, hydrologic and economic value of wetlands (Liptak et al. 2008). Geographic information system (GIS), aerial/satellite imagery, secondary data, and limited field data were used to score and rank 951 wetlands located within the watershed. The ecological value was evaluated using Ohio Rapid Assessment Method for Wetlands (ORAM) and the presence of threatened and endangered species. Hydrological values were obtained using watershed modeling with two scenarios (existing and with full build-out of wetlands) and calculated wetland volumes. The economic values were determined by assessing the following factors: recreational value, property value, flood reduction potential, permitting, mitigation, and stormwater retention. The study concluded that despite the rapid growth within the watershed, the watershed contains significant wetland resources whose ecosystem functions provide a high societal value. The major value of wetlands from an economic standpoint came from their recreational value, stormwater retention capabilities, and avoided permitting and mitigation costs. High value wetlands were often found to be protected by parks, but several unprotected high-quality wetlands remain in the watershed.

CCBH sponsored this supplemental study to further quantify the water quality benefits provided by the existing and potentially new wetlands within the watershed. This study also sets forth a green infrastructure approach for managing stormwater runoff in the Tinkers Creek watershed.

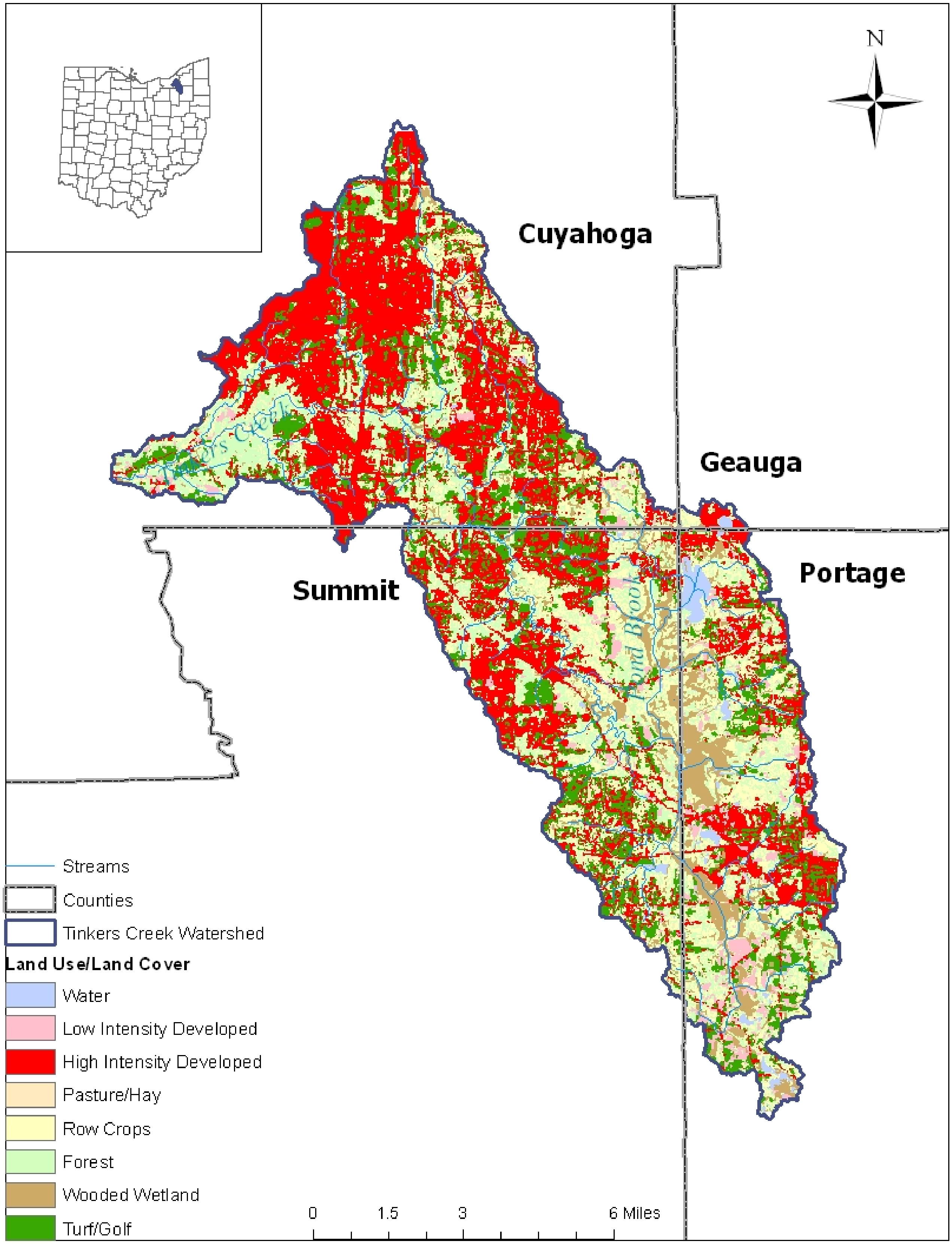


Figure 1. The Tinkers Creek watershed.

2. Modeling the Water Quality Benefits of Wetlands

One component of this project was to determine the water quality benefits provided by wetlands in the Tinkers Creek watershed. A review of the pertinent literature was first conducted to compile existing information on this topic. Concurrent to the literature review, the existing ArcView Generalized Watershed Loading Functions (AVGWLF) model of the watershed was updated to include the simulation of nutrients. The updated AVGWLF model and the companion Pollution Reduction Impact Comparison Tool (PRedICT) were then used to simulate the potential water quality benefits of new wetlands in the watershed.

Literature Review

The literature review involved compiling and assessing previous studies of the Tinkers Creek watershed to identify any information they might provide regarding the water quality benefits of the existing wetlands. The literature review also involved compiling and assessing previous peer-reviewed journal articles and similar studies on the effectiveness of wetlands for improving water quality. The most relevant studies are summarized in the following section.

Landscape design and the role of created, restored, and natural riparian wetlands in controlling nonpoint source pollution (Mitsch, W.J. 2003)

An analysis of case studies for a natural riparian wetland in southern Illinois, an in-stream wetland in northern Ohio, and several constructed riparian wetlands in northeastern Illinois showed sediment and phosphorus retention vary by wetland. Constructed wetlands tended to have better phosphorus retention rates (63 to 96 percent) than natural wetlands (4 to 10 percent); however, the actual masses of retention are more similar because natural wetlands tended to receive much larger nutrient loads.

Seasonal and storm event nutrient removal by a created wetland in an agricultural watershed (Fink, D.F., and W.J. Mitsch. 2004)

The effectiveness of a created emergent marsh at reducing nutrient loads was evaluated during baseflow and stormwflow conditions. The wetland, which drains an agricultural and forested area in the Ohio River Basin, derives its source water from surface inflows and groundwater discharges. Over the course of the two-year study, the authors found that loads reduced from wetland inflow to outflow for the following nutrients: nitrate plus nitrite (40 percent reduction), soluble reactive phosphorus (56 percent reduction), and total phosphorus (59 percent reduction). They also found that the designed wetland retained a significant portion of the additional influent nutrient load during heavy precipitation events, including no significant increase in nitrate plus nitrite loads.

Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects (Mitsch, W.J., L. Zhang, C.J. Anderson, A.E. Altor, and M.E. Hernandez. 2005)

Two wetlands (one with planted macrophytes and one without) were created to study successional patterns, water quality changes and the effects of hydrologic pulsing. Each wetland received continuous inflow from a river for over 10 years. Though the two wetlands developed in similar manners, at the end of 10 years, the planted wetland had greater diversity. The unplanted wetland was more productive but also more susceptible to stresses. At the end of the study period, both wetlands were still retaining nitrate and soluble reactive phosphorus but showed signs of diminishing retention of sediment and total phosphorus.

Tinkers Creek Watershed Plan (Kerr+Boron Associates 2005)

Wetlands in the Tinkers Creek watershed were evaluated and scored in the *Tinkers Creek Watershed Land Conservation Priority Plan*, based upon their ecological value. Weighted values for a number of elements (e.g., wetlands, geology/soils, land cover, hydrology) were combined in GIS to assess the ecological system value for each land parcel. Productive areas (e.g., wetlands, woodlands, riparian corridors) were assumed to generate benefits, such as flood mitigation and pollutant removal, whereas consumptive areas (e.g., urban/industrial land use, impervious land cover) were assumed to contribute to air pollution, flooding, and water quality degradation.

The most valuable wetlands were found to be located in headwaters areas, contain hydric soils, and are well-connected to other riparian areas, to create large, interconnected habitats. The value of a wetland in the *Plan* was determined using measures of the following factors: hydric soils, slope, permeability, connectivity to riparian zones, wetland size, and riparian zone. The Tinkers Creek confluence, the Pond Brook and the Tinkers Creek State Park subwatersheds tended to have the most ecological valuable lands with the more urban and more dense suburbs tending to have less ecologically valuable land.

Modeling the suitability of wetland restoration potential at the watershed scale (White and Fennessy 2005)

White and Fennessy (2005) developed a GIS-model to predict the suitability for wetland restoration in the Cuyahoga River watershed using a two-phase approach focused upon the watershed scale. The objective of their model was to use GIS to assess the potential for wetland restoration in the Cuyahoga River watershed by identifying the total population of sites suitable for restoration, then prioritizing those sites according to the likelihood of restoration success and the relative ability of a restoration project to contribute to improved downstream water quality.

The first phase of the analysis relied on resource factors (e.g., soil properties, proximity to other wetlands, topographic properties, existing land use/land cover) to determine where wetland restoration could occur. The second phase focused upon filtering the available locations by application or goal of the wetland restoration; this phase included such factors as land ownership, connectivity of landscapes, size, and desired wetland quality. Metrics within these factors accounted for stream water quality, level of attainment within the streams, and distances to such streams, since the water quality benefits of wetlands were assumed to diminish as distance of a stream from the restored wetland increases. All three model scenarios showed that many locations within the Tinkers Creek watershed have mid- to high-level potential for valuable wetland restoration.

Prioritizing wetland restoration potential in the tributaries of the Cuyahoga River Area of Concern (AOC) (CRCPO 2008)

The Cuyahoga River Community Planning Organization designed a GIS model to rank potential wetland restoration sites by their watershed performance and restoration potential. The study noted that much of the regional wetland mitigation involves conserving or restoring wetlands outside of the Cuyahoga River AOC, which tend to be in high-quality, rural watersheds and not in the heavily impacted, urban watersheds that most need more and better wetlands. Wetlands that affect water quality and quantity were highlighted during the watershed performance scoring. Field data and aerial imagery were used to evaluate restoration potential by identifying and analyzing the land cover stressors in the wetland and surrounding areas.

During evaluations of existing wetlands the authors found that the number of high-quality wetlands decreased and the area of lower quality wetlands increased from the Upper Cuyahoga to the Middle Cuyahoga to the Lower Cuyahoga. They also found that “the most important hydrologic stressors related to [wetland] condition were ditching, dikes, stormwater input, filling, and roads” (p. 11). The ditching tended to be historic from former agricultural fields. Of the subwatersheds in the Cuyahoga River AOC, most of the identified wetlands were found to be located in the upper portions of the Tinkers Creek watershed.

The State of Wetlands in Cleveland Metroparks: Implications for Urban Wetland Conservation and Restoration (Durkalec et al 2009)

The Landscape Development Index and ORAM were used to assess wetlands in northeast Ohio, including within the Tinkers Creek watershed. Within the Cleveland Metroparks, approximately two-thirds of wetlands were in good or very good condition. The authors found that the shape and size of a park were determining factors in the quality of a wetland. Larger and squarer wetlands were of higher quality than smaller and elongated wetlands. The Bedford Reservation, in the Tinkers Creek watershed, was large and square with a good perimeter to area ration, giving it a good potential for high-quality wetlands. They also found that high intensity development within 100 meters of a wetland tended to preclude better quality wetlands. The authors evaluated the results of the Cuyahoga

River wetland assessment and found their conclusions to be similar to those in the Cuyahoga River wetland assessment.

AVGWLF Model Update

An un-calibrated AVGWLF model was previously set up for the Tinkers Creek watershed to support the *Tinkers Creek Watershed Comprehensive Wetland Assessment and Prioritization Plan for 2007/2008*. Tetra Tech obtained the modeling files from that effort and updated them to support an assessment of the water quality benefits of wetlands in the watershed.

The AVGWLF model provides a mechanistic, but simplified, simulation of precipitation-driven runoff and sediment delivery. Sediment erosion, runoff, and groundwater seepage are used to estimate particulate and dissolved-phase pollutant delivery to a stream, based on pollutant concentrations in soil, runoff, and ground water. AVGWLF simulates runoff and stream flow by a water-balance method, based on measurements of daily precipitation and average temperature. Precipitation is partitioned into direct runoff and infiltration using a form of the curve number method (SCS 1986). The curve number determines the amount of precipitation that runs off directly, adjusted for antecedent soil moisture based on total precipitation in the preceding 5 days.

The user of the AVGWLF model must divide land uses into "rural" and "urban" categories, which determines how the model calculates loading of sediment and nutrients. For the purposes of modeling, "rural" land uses are those with predominantly pervious surfaces, while "urban" land uses are those with predominantly impervious surfaces. Monthly sediment delivery from each "rural" land use is computed from erosion and the transport capacity of runoff, whereas total erosion is based on the universal soil loss equation (USLE) (Wischmeier and Smith 1978), with a modified rainfall erosivity coefficient that accounts for the precipitation energy available to detach soil particles (Haith and Merrill 1987). Thus, erosion can occur when there is precipitation, but no surface runoff to the stream; delivery of sediment, however, depends on surface runoff volume. Nutrient loads from rural land uses may be dissolved (in runoff) or solid-phase (attached to sediment loading as calculated by the USLE).

For "urban" land uses, soil erosion is not calculated, and delivery of nutrients to the waterbodies is based upon an exponential accumulation and washoff formulation. All nutrients loaded from urban land uses are assumed to move in association with solids.

AVGWLF requires three input files to simulate runoff and pollutant loads from each subwatershed. The weather file contains daily values of precipitation and average temperature. The transport file contains land use areas and parameters for estimating runoff, erosion, and evapotranspiration. The nutrient file contains nitrogen and phosphorus concentrations for groundwater, runoff, and build-up wash off rates from urban areas. This section of the report describes the modeling assumptions used to develop these three files for the Tinkers Creek watershed.

Weather data for the previous AVGWLF application were for an "average" year; these were updated to provide an assessment of wetland function for a variety of conditions (e.g., below average, average, and above average precipitation). Daily climatologic data from the National Climatic Data Center (NCDC) weather station in Hiram (ID 33780) for the period January 1, 2000 to December 31, 2006 were used to run the AVGWLF model. This station was selected because it was the one closest to the watershed with the required data.

Subwatershed delineations, land use areas, runoff curve numbers, and evapotranspiration rates were obtained from the previous AVGWLF model and left unchanged. Seasonal rainfall erosivity factors were developed based on regional values available from the GWLF User's Manual. The Natural Resources Conservation Service (NRCS) soils database was used to estimate the average land slope in each subwatershed as well as area-weighted soil erodibility and length-slope factors. Cover factors for each land use were based on values suggested in Agriculture Handbook 537 (Wischmeier and Smith 1978).

Water stored in soil may evaporate, be transpired by plants, or percolate to groundwater below the rooting zone. The amount of water that can be stored in soil (the soil water capacity) varies by soil type and rooting depth.

Based on soil water capacities reported in the soils database, soil types present in the watershed, and AVGWLF user's manual recommendations, a soil water capacity of 10 centimeters was used.

The AVGWLF model has three subsurface zones: a shallow unsaturated zone, a shallow saturated zone, and a deep aquifer zone. Behavior of the second two zones is controlled by a groundwater recession and a deep seepage coefficient. The recession coefficient was set at 0.1 per day and the deep seepage coefficient was modified to 0.02, based on several calibration runs of the model.

The AVGWLF model simulates nutrient runoff from rural land uses and washoff from urban land uses. In addition, soil is assumed to carry attached nutrients which can be a source of uncertainty in the modeling. To address this, soil phosphorus concentrations were based on soil sampling conducted in the watershed during the Spring of 2010. Soil samples were taken across a range of land uses and subwatersheds so that soil phosphorus values could be area-weighted (i.e., more samples were taken from prevalent land uses and fewer samples were taken from less prevalent land uses). A GIS analysis was conducted to identify potential site locations, and property owners were sent a consent letter requesting their participation. A Global Positioning System (GPS) unit was used to navigate to the preselected sample location and soil was sampled to a depth of 6 inches using a stainless steel soil auger. Plant residue, roots and large gravels were removed from the sample prior to placing in sample bag. Soil samples were then mailed to an agricultural and environmental analytical laboratory (A&L Eastern Laboratories, Inc.) and analyzed for phosphorus (P) using the Bray testing method.

The testing sites were located across a range of land uses and subwatersheds and the results were area-weighted to provide an input to the model (Table 2). Turf/grass was found to have the highest average soil phosphorus content and low-intensity development was found to have the lowest. Dissolved nutrient concentrations in runoff from each land use were set to AVGWLF default values.

Table 2. Summarized results of soil phosphorus sampling in the Tinkers Creek watershed

Land Use	Number of Samples	Soil Phosphorus Content (ppm)		
		Minimum	Average	Maximum
Row Crop & Pasture/Hay	8	5	15.3	37
Forest	21	1	8.6	24
High Intensity Development	17	4	9.6	21
Low Intensity Development	2	5	6.0	7
Turf/Golf	16	4	22.0	77
Wooded Wetland	9	4	16.9	66

Figure 2. Photos of soil sampling sites in the Tinkers Creek watershed. Left: high intensity development (13 ppm); Middle: forest land use (1 ppm); Right: turf land use (77 ppm).

Flow and nutrient loads from the WWTPs in the Tinkers Creek subwatershed were obtained from the Ohio Environmental Protection Agency and also added to the AVGWL model (Table 3). Average values were calculated based on the monthly data for the period January 1, 2000 to December 31, 2006.

Table 3. Average flow and nutrient loads input to AVGWLF for the wastewater treatment plants in the Tinkers Creek watershed

Facility	Flow (MGD)	TN Load (kg/month)	TP Load (kg/month)
Aurora Shores WWTP No 29	0.4	27	5
Aurora Westerly WWTP	1.5	89	4
Bedford Hts WWTP	2.4	201	5
Bedford WWTP	2.6	152	6
City of Solon Water Reclamation	4.0	144	12
City of Twinsburg WWTP	2.9	197	8
Streetsboro Hudson Regional WWTP	2.8	218	5
Total	16.6	1028	45

Model Calibration

Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. Hydrologic calibration precedes water quality calibration because runoff is the transport mechanism by which nonpoint source pollution occurs.

The AVGWLF model predicts flow volumes from runoff at monthly intervals. Simulated flows were compared to observed flows at the U.S. Geological Survey gage at Bedford (gage ID 04207200). Daily flows reported from January 2000 through December 2006 were summed by month for comparison with the AVGWLF simulation. The period from 2000 to 2006 includes years with low, average, and high monthly flows.

Figure 3 compares the monthly flow volumes observed at the gage to AVGWLF estimates and indicates that the model matches the observed trends well. The simulated flow mimics the trends and magnitude of the observed flows during both low and high flow months, with the flow in only a few months having been over-estimated, possibly due to storms that were recorded at the weather station but that did not affect the watershed.

Table 4 presents the error statistics for the modeling and also indicates a good agreement between observed and simulated values. The volume of flow simulated for the entire modeling period was within one percent of the observed value, and errors in the simulated seasonal flows were each less than 15 percent.

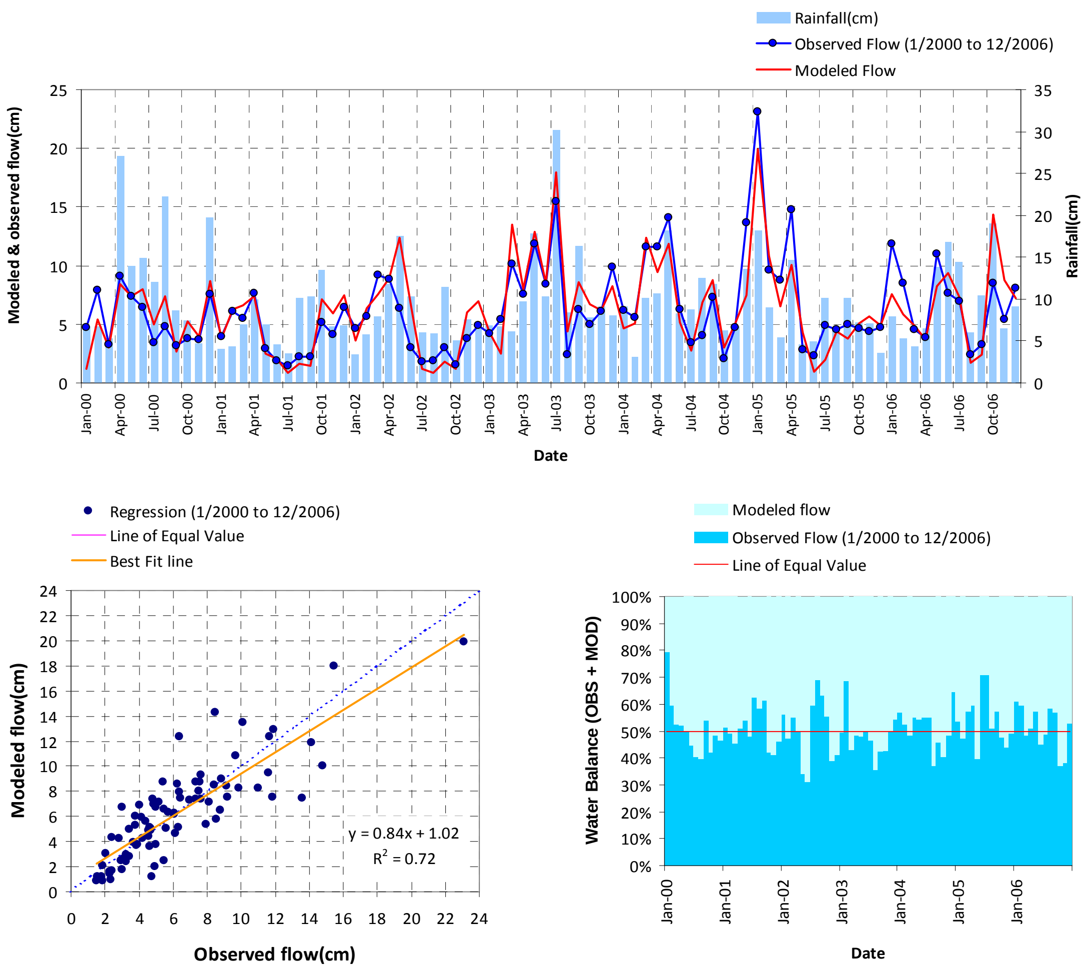
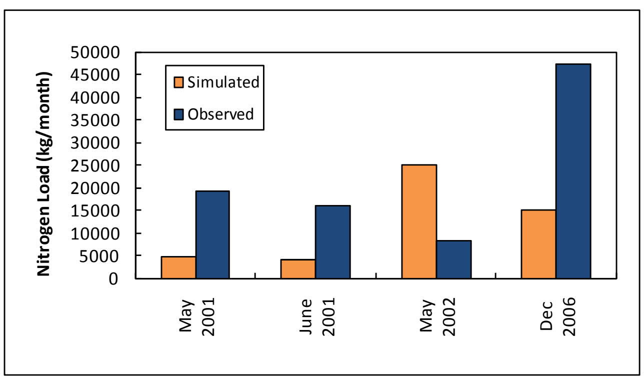


Figure 3. Graphical comparison of observed and simulated flow for the Tinkers Creek watershed.

Table 4. Statistical comparison of observed and simulated flow for the Tinkers Creek watershed.

Average Observed Flow (cm/yr)		Average Simulated Flow (cm/yr)	
Total Observed In-stream Flow:	87.43	Total Simulated In-stream Flow:	87.79
Total of Observed Highest 10% Monthly Volume:	19.42	Total of Simulated Highest 10% Monthly Volume:	19.18
Total of Observed Lowest 50% Monthly Volume:	62.64	Total of Simulated lowest 50% Monthly Volume:	63.49
Observed Summer Flow Volume (7-9):	15.02	Simulated Summer Flow Volume:	15.62
Observed Fall Flow Volume (10-12):	19.66	Simulated Fall Flow Volume:	22.53
Observed Winter Flow Volume (1-3):	26.76	Simulated Winter Flow Volume:	23.61
Observed Spring Flow Volume (4-6):	25.98	Simulated Spring Flow Volume:	26.03
Overall Error		**Seasonal Volume Error**	
Error in total volume:	0.41%	Seasonal volume error - Summer:	3.98%
Error in 10% highest flows:	1.22%	Seasonal volume error - Fall:	14.61%
Error in 50% lowest flows:	1.35%	Seasonal volume error - Winter:	-11.79%
Mean Absolute Error (cm)	1.53	Seasonal volume error - Spring:	0.18%
RMS Error (cm)	2.06		
Relative RMS Error (%)	9.51		

Limited water quality data were available with which to calibrate the water quality portion of the AVGWLF model. Grab samples collected during the modeling period were converted to average monthly load estimates by assuming they represented average concentrations for the entire month. Large errors are likely associated with these estimates because of the probable variability in actual concentrations that occur throughout a month. The observed loads were compared with the simulated loads for the same months, and the results suggest that the simulated loads are within the same range as the observed loads, although there are errors in the month-to-month comparisons.



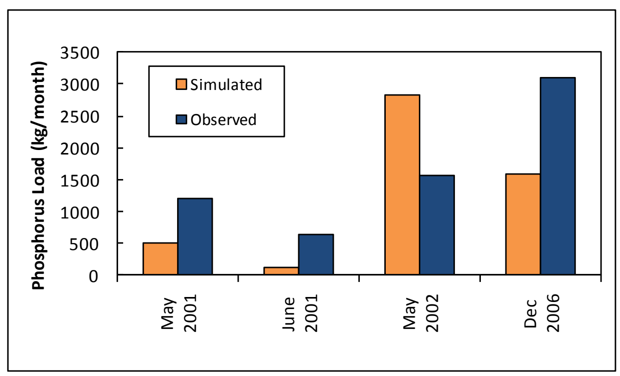


Figure 4. Comparison of simulated and observed loads of nitrogen and phosphorus in the Tinkers Creek watershed.

Model Results and Scenarios

Following calibration, the AVGWLF model was run to estimate the sources of phosphorus and nitrogen in the Tinkers Creek watershed. As shown in Table 5, the largest source of both nutrients is high intensity development[1].

[1] Groundwater loads are not included in the ranking because (a) they are somewhat a function of the overlying land uses and (b) they are difficult to control.

This is due to a combination of the relatively high unit area loading rate from high intensity development and its prevalence throughout the watershed. Other large sources of nitrogen and phosphorus in the watershed include the row crops, turf grass, and the WWTPs.

Table 5. Sources of nitrogen and phosphorus within the Tinkers Creek watershed

Source	Area (Ha)	Total Nitrogen (kg/yr)	Total Nitrogen (%)	Total Phosphorus (kg/yr)	Total Phosphorus (%)
Pasture/Hay	273	969	0.4%	87	0.5%
Row Crops	4,828	33,122	14.0%	4,459	26.2%
Forest	4,666	602	0.3%	319	1.9%
Wooded Wetland	1,745	918	0.4%	999	5.9%
Turf/Golf	3,973	9,907	4.2%	1,218	7.2%
Low Intensity Development	945	576	0.2%	96	0.6%
High Intensity Development	8,650	68,914	29.1%	7,506	44.1%
Groundwater	--	108,057	45.6%	1,081	6.4%
Streambank Erosion	--	1,614	0.7%	710	4.2%
Wastewater Treatment Plants	--	12,324	5.2%	531	3.1%
Total	25,080	237,003	100.0%	17,006	100.0%

Using the information presented in Table 5, conversion of the existing wetlands to highly developed areas would increase the load of nitrogen and phosphors to the creek by 13,000 and 500 kg/yr, respectively, simply due to the lower loading rate of wetlands compared to high intensity development. Furthermore, assuming that existing wetlands drain an area equal to twice their size, they keep an additional 8,600 kg/yr of nitrogen and 1,100 kg/yr phosphorus from the creek due to their ability to store and assimilate runoff from adjacent areas. The results for individual wetlands are included in Attachment E[2].

The PRedICT tool was used to assess the ability of constructed wetlands to mitigate the nitrogen and phosphorus loading within the watershed. This tool allows the user to create various “scenarios” in which current landscape conditions and pollutant loads can be compared against “future” conditions that reflect the use of different pollution reduction strategies such as urban best management practices (BMPs). The tool includes pollutant reduction coefficients for nitrogen, phosphorus, and sediment, and also has built-in cost information. The reduction coefficients are 53 percent for nitrogen, 51 percent for phosphorus, and 88 percent for sediment. The user initially specifies desired conditions such as percentage of urban areas to be treated by wetlands. Based on this information, built-in reduction coefficients and unit costs are used to calculate resultant pollutant load reductions and scenario costs.

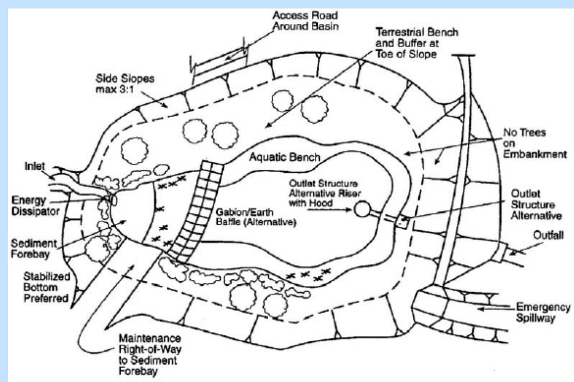
Table 6 presents the projected load reduction of nitrogen and phosphorus that would occur from constructing new wetlands to treat the runoff from high intensity development within the watershed. A fairly large area of constructed wetlands would need to be created to obtain a significant reduction in nitrogen or phosphorus loads in the watershed. The associated costs are also large, with $33 million needed to achieve a 5 percent reduction in phosphorus loads. However, the constructed wetlands will also provide recreational, ecological, hydrological, and economic benefits as suggested in *Tinkers Creek Watershed Comprehensive Wetland Assessment and Prioritization Plan for 2007/2008.* For example, the economic benefit associated with a $33 million investment in constructed wetlands is estimated to be approximately $97 million.

[2] The total load reduction shown in Attachment E does not equal the total calculated from the modeling land use data because of a discrepancy in the total acreage of wetlands. The GIS coverage provided by CCBH has a total of 1,745 hectares of wetlands, whereas the table of individual wetlands included in the initial study report (Liptak et al, 2008) totals 1,585 hectares.

Table 6. Results of PRedICT modeling for treating runoff from high intensity development with constructed wetlands

Area of Newly Constructed Wetlands (Ha)	Total Nitrogen Load Reduced		Total Phosphorus Reduced		Cost ($)
	kg/yr	%	Kg/yr	%	
5	364	0.2	40	0.2	1,433,754
25	2,190	0.9	232	1.4	8,592,595
50	4,382	1.8	461	2.7	17,185,190
75	6,208	2.6	653	3.8	24,347,341
100	8,399	3.5	882	5.2	32,939,936

A constructed stormwater wetland treats runoff through a series of shallow pools that support wetland plants. This device stores some stormwater runoff and reduces stormwater outflow. The detention of stormwater allows excess sediment to settle out of the water. The wetland conditions encourage bacteria and plants to use excess nutrients. Portions of other pollutants may also be removed. The permanent pool varies in depth, but is generally no deeper than 3 feet. An outlet structure controls the flow of water out of the wetland. Large stormwater wetlands may have a forebay, which is a small depression lined with rocks that slows the incoming stormwater flow and settles out larger soil particles.



3. Green Infrastructure Approach to Stormwater Runoff

A second component of this project was to set forth a green infrastructure approach for managing stormwater runoff in the Tinkers Creek watershed, with a specific focus on the Bear Creek subwatershed. Topics covered include:

- *Green Infrastructure as a Sustainable Design Approach*. Sets forth a definition of green infrastructure for consideration by the CCBH.
- *Green Infrastructure BMPs for Stormwater Management*. Describes the range of green infrastructure BMPs that are appropriate for application across the Tinkers Creek watershed.
- *Opportunities within the Bear Creek Subwatershed*. Details the green infrastructure strategy developed for the Bear Creek subwatershed.
- *Potential Effectiveness of BMPs in the Bear Creek Subwatershed*. Presents planning-level estimates of potential annual Total Phosphorus (TP) reduction that may result from application of the green infrastructure strategy.

Green Infrastructure as a Sustainable Design Approach

Green infrastructure can be defined widely as "strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations" (The Conservation Fund at http://greeninfrastructure.net, 2010). This definition includes stormwater management as well as other sustainable systems such as ecological corridors, recreational trails and open space, wastewater treatment, renewable energy systems, and public transportation. Green infrastructure also can be more narrowly focused on stormwater management, as in the EPA's definition as "wet weather management using designs and technologies that infiltrate, evapotranspire, capture and reuse stormwater in order to maintain or restore natural hydrologies." (EPA 2010). In either definition, green infrastructure acknowledges the value of ecological services provided by preserved, restored, or technologically emulated natural systems. More detail on Biohabitats' approach to green infrastructure is provided in Attachment A.

Green Infrastructure BMPs for Stormwater Management

This effort is focused on the application of green infrastructure BMPs to provide stormwater management benefits. BMPs are often defined as engineered, structural practices that provide stormwater runoff treatment and management through infiltration, filtration, or detention. However, BMPs can range in complexity from simply changing maintenance practices to more structural designs. For example, landscape conversion and sustainable turf management are relatively simple conversions of existing landscapes while functional landscapes, such as biofiltration swales or cells, include elements that require a greater level of design to provide benefits and functions such as stormwater treatment. Treatment features such as bioretention, rain gardens, and street tree pits are examples of functional landscapes that are designed to be integrated into landscape areas to receive and filter stormwater runoff. In all stormwater BMPs, restoring the natural hydrology of the site through infiltrating stormwater into the ground is ideal. However, the ability to infiltrate is dependent on soil characteristics and landscape position.

A range of green infrastructure BMPs was reviewed and those that are appropriate for application across the Tinkers Creek watershed were identified. These include:

- Disconnection
- Sheetflow to Conservation Area
- Forest Management, Restoration, and Preservation
- Landscape Conversion

- Sustainable Turf Management
- Biofiltration
- Permeable Pavement
- Underground Filters
- Rainwater Harvesting
- Green Roofs
- Outfall Treatment
- Stormwater Ponds/Wetlands
- Stream/Riparian Rehabilitation

These BMPs are applicable across the watershed regardless of soil conditions. Although infiltration is preferable, these BMPs can be designed to accommodate a range of soil types. More detail on each type of BMP is provided in Attachment B.

Opportunities within the Bear Creek Subwatershed

The Bear Creek subwatershed was selected as the study area for this evaluation. The limits of the study area are the drainage area to the point at which Bear Creek crosses Emery Road. The subwatershed boundary was defined as the drainage delineation used by the Northeast Ohio Regional Sewer District in the Regional Intercommunity Drainage Evaluation (RIDE) Study. The RIDE Study is a technical evaluation of intercommunity storm drainage problems across 348 square miles within the District's existing service area and drainage areas.

This portion of the Bear Creek subwatershed, which is in the Cities of Warrensville Heights and Highland Hills, is suburban in nature. Land use is predominantly residential, commercial, and institutional. Some parcels of contiguous forested area remain. Bear Creek is piped in its northern reaches before flowing into its degraded channel south of Clarkwood Parkway.

The Request for Proposals for this project suggested that the University of New Hampshire Stormwater Center's field test site for stormwater practices serve as a model for this effort. The field test site is an outdoor, controlled laboratory focused on evaluating the effectiveness and life expectancy of stormwater practices. Several stormwater practices have been constructed and are currently being monitored. The intent of this effort is to develop a green infrastructure *strategy* for the Bear Creek subwatershed, not to design specific stormwater practices. As such, the approach to developing a green infrastructure strategy for the Bear Creek subwatershed – and to evaluate its potential effectiveness – was based on defined *precincts* within the subwatershed.

Retrofit, restoration, and general stormwater management opportunities are best integrated into the landscape in a way that responds to the type of land use, scale of the existing infrastructure, landscape elements, and ecological conditions. As such, the subwatershed was broken down into the following seven *precincts*:

- high density residential
- medium density residential
- commercial
- public open space
- major rights-of-way
- institutional
- riparian corridor

These precincts are displayed in Figure 5. For each precinct, a representative parcel was selected (Figure 6). These parcels, which were identified through both field investigations and desktop analyses, have common land cover, existing infrastructure, and landscape elements found at parcels throughout each precinct. Each of these example sites was evaluated and BMP opportunities were identified. These example sites are representative of how green infrastructure may be applied across each precinct.

Due to the developed nature of the subwatershed, the green infrastructure strategy for each example site focuses on opportunities to *retrofit* the existing land use with stormwater BMPs. Stormwater retrofitting is defined as integrating BMPs into the existing landscape where little or no prior stormwater controls exist.

A description of the green infrastructure strategy, along with an illustrative concept, is provided for each example site below. The concept identifies the potential extent of the surface area for each type of green infrastructure BMP that may be applied to the site.

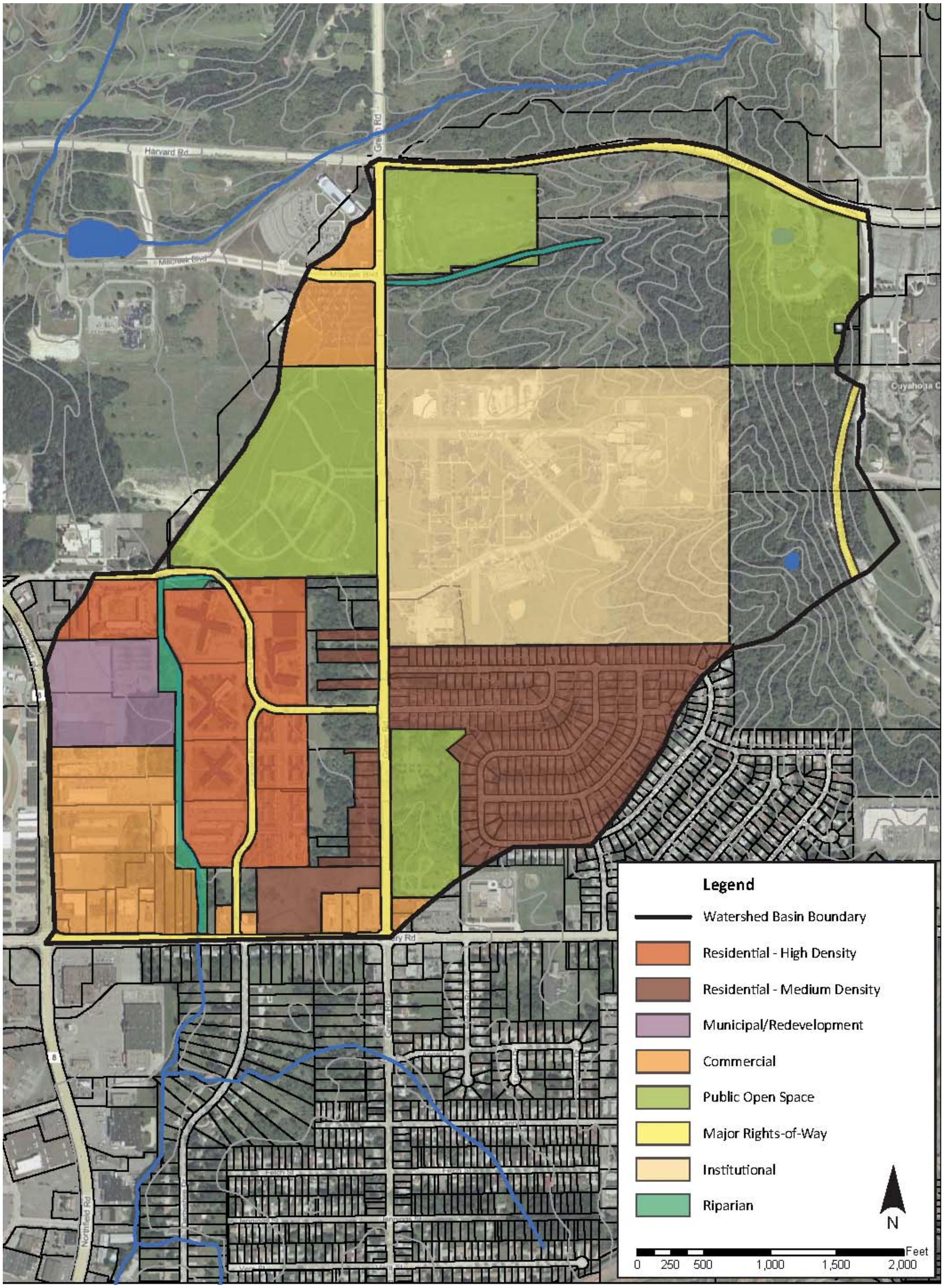


Figure 5. Precincts within the Bear Creek Subwatershed

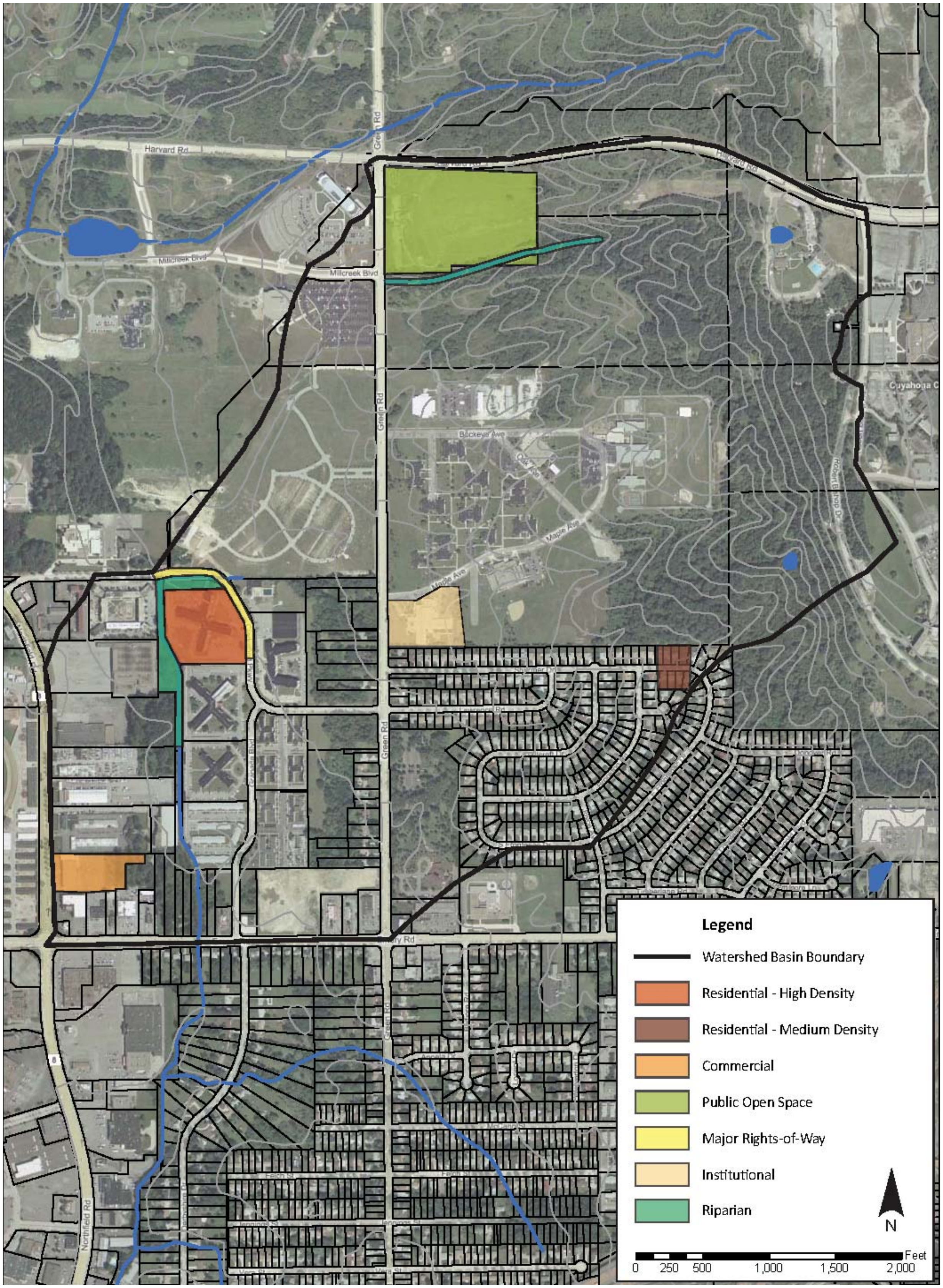


Figure 6. Example Sites within Each Precinct Selected for Further Analysis

High Density Residential

High density residential areas include apartment, townhouse, and condominium buildings and their surrounding properties. Within the subwatershed, the high density residential precinct includes mainly high-rise apartment buildings with large surface parking lots and landscaped lawns around the buildings. The rooftops of these buildings are relatively low per unit area, making green roofs less of a priority to manage stormwater on these sites. Parking lots in these areas are excellent opportunities for permeable pavement and biofiltration swales or cells to manage stormwater runoff. The areas around buildings that are landscaped with non-native plantings or turf grass could be retrofitted to biofiltration or converted to native planting. Residents in dense developments often have less open space for recreation than lower density residences. Therefore, if existing lawn areas are well-used, they may be maintained as turf but converted to sustainably managed turf. Where forests or open space landscapes border apartment developments and are below the grade of the parking lot, stormwater runoff may be directed to these areas for infiltration into the surrounding landscape (as long as the runoff does not degrade the adjacent area or impact other properties).

These retrofits are shown in the example of the apartment property located in the western portion of the subwatershed along Clarkwood Parkway (Figure 7). A green roof is not shown on the main apartment building due to uncertainty about the owner’s willingness to fund and maintain the roof in addition to uncertainty about the existing structure. However, the smaller storage/garage structures shown in the parking lot could be retrofitted with green roofs as they are more accessible and more easily retrofitted to a load-bearing structure. Biofiltration is recommended for the existing landscape area surrounding the building that is presumably un-used for recreation as well as portions of the parking lot area between and at the end of parking rows. The impervious pavement could be replaced with permeable pavement in the parking spaces as these areas are less intensely driven on than the parking lot driving lanes, therefore requiring less maintenance. The two larger triangular areas in the parking lots are more likely to be used for recreation due to their size and are therefore recommended to remain as turf with sustainable management. The forested area around the edge of the parking lot may be used to allow any remaining stormwater runoff from the parking lot to infiltrate into the surrounding landscape.

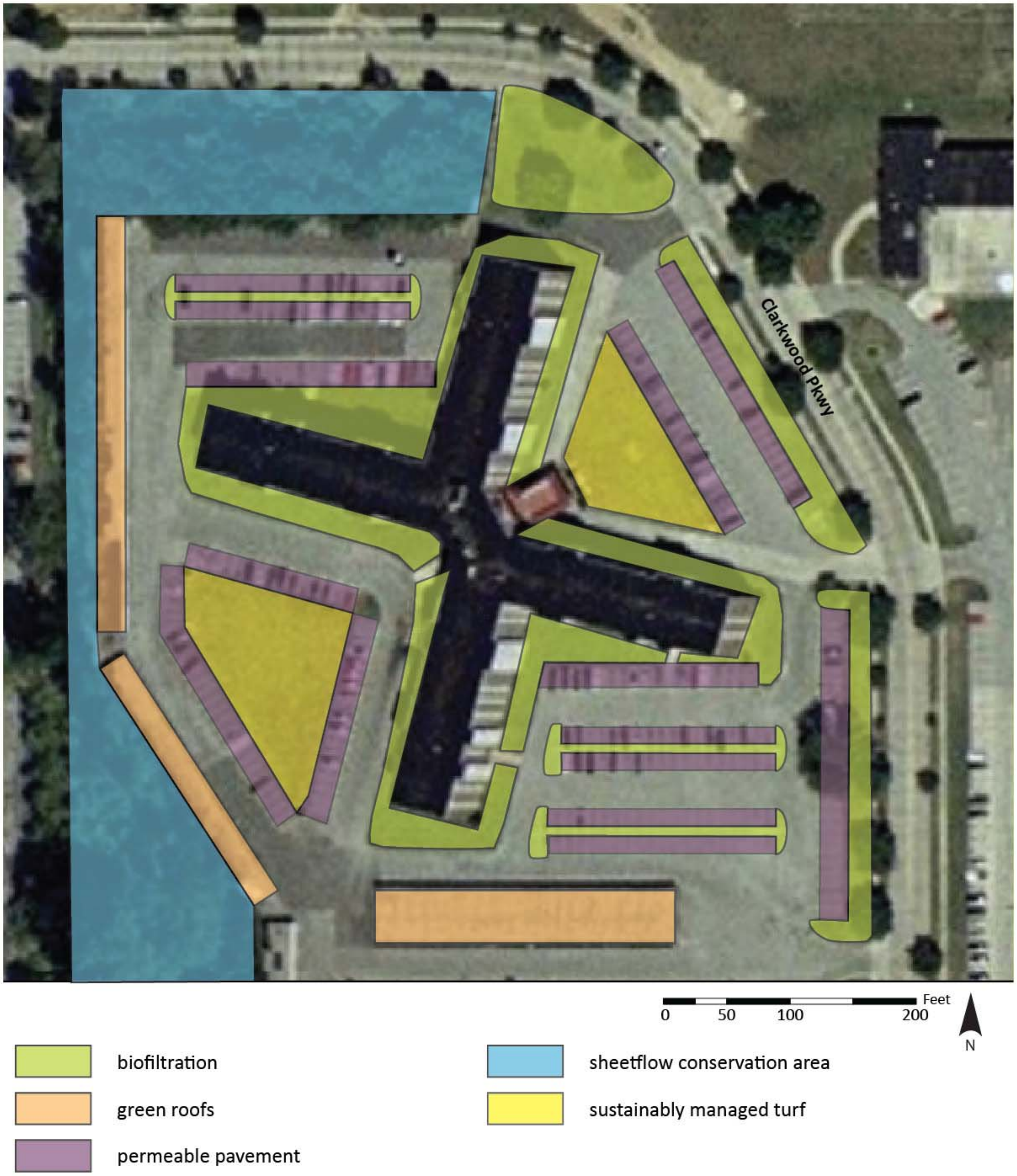


Figure 7. High Density Residential Example Site

Medium Density Residential

Medium density residential areas include single family homes and duplexes within the subwatershed (as the subwatershed is predominantly urban/sub-urban, there are no rural, low-density housing developments). These residences are typically characterized by arterial roads with sidewalks, driveways, and front- and backyards. One relatively easy retrofit for medium density residential areas is to disconnect roof downspouts to flow into landscape areas or into rain barrels. Rain barrels are most appropriate at this scale as residents are likely to use harvested rainwater for irrigation or other non-potable uses. Yard areas with the potential to collect significant amounts of stormwater runoff from rooftops or other surrounding impervious surfaces should be retrofitted for biofiltration such as rain gardens while other landscape areas could be converted to native planting. Areas of turf grass used heavily could be sustainably managed to limit their contribution of pollutants to stormwater runoff as well as their water and energy demand. The use of fertilizer, herbicides, and pesticides should be eliminated or minimized to avoid nutrient and pollutant runoff. Integrated pest management offers some techniques to minimize use of pesticides. By replacing certain typical turf grass species with other native, more drought tolerant, or low-mow species, the demand for irrigation and mowing energy can be lowered.

Driveways, sidewalks, and patios could be replaced with permeable pavement such as porous concrete or pavers as the traffic impacts to these surfaces would require less maintenance and load-bearing structure than roads. Existing turf or landscape areas in between sidewalks and roads or at the center of cul-de-sacs could be retrofitted to biofiltration such as bioswales or bioinfiltration cells.

A single family residential cluster on Shurmer Drive on the eastern edge of the subwatershed is shown as an example of potential retrofits in this precinct (Figure 8). Rain barrels would harvest rainwater from the rooftops that could then be re-used to irrigate gardens and lawns. Portions of the yards, which are mostly turf grass, could be converted to biofiltration or native planting. Areas adjacent to impervious surfaces could be retrofitted to rain gardens or other biofiltration. Landscape strips between the sidewalk and road could become bioswales which infiltrate road runoff. Driveways and sidewalks could be replaced with pervious pavement.

Figure 8. Medium Density Residential Example Site

Commercial

Commercial precinct areas are found mainly in the southern and western areas of the subwatershed. These include a variety of businesses such as office parks, restaurants, and car dealerships. This precinct is dominated by large, single story buildings and even larger impervious parking areas. The commercial precinct has very little landscaped area compared to the other precincts and offers the greatest opportunity to limit impervious surface through retrofitting. Green roof retrofits are ideal for the massive, flat-roof structures common to these areas. Paved areas and ornamental landscaping immediately surrounding buildings could be replaced with biofiltration to capture rooftop runoff. Replacing as much of the asphalt parking with biofiltration islands and permeable pavement as possible could have a huge stormwater management benefit. Biofiltration islands are easily integrated in the center of existing parking rows and at the ends of these rows. Permeable pavement is most appropriate in parking space areas which have a lower traffic impact. When turf grass or forest areas exist adjacent to commercial areas, there is potential to restore or convert these areas to native planting, especially forest or riparian vegetation.

In the example of the commercial property on Northfield Road (Figure 9), a green roof is recommended for the entire rooftop area. Permeable pavement should replace all parking space areas with biofiltration between the rows. A grass area on the eastern edge of the property offers an opportunity for landscape conversion.

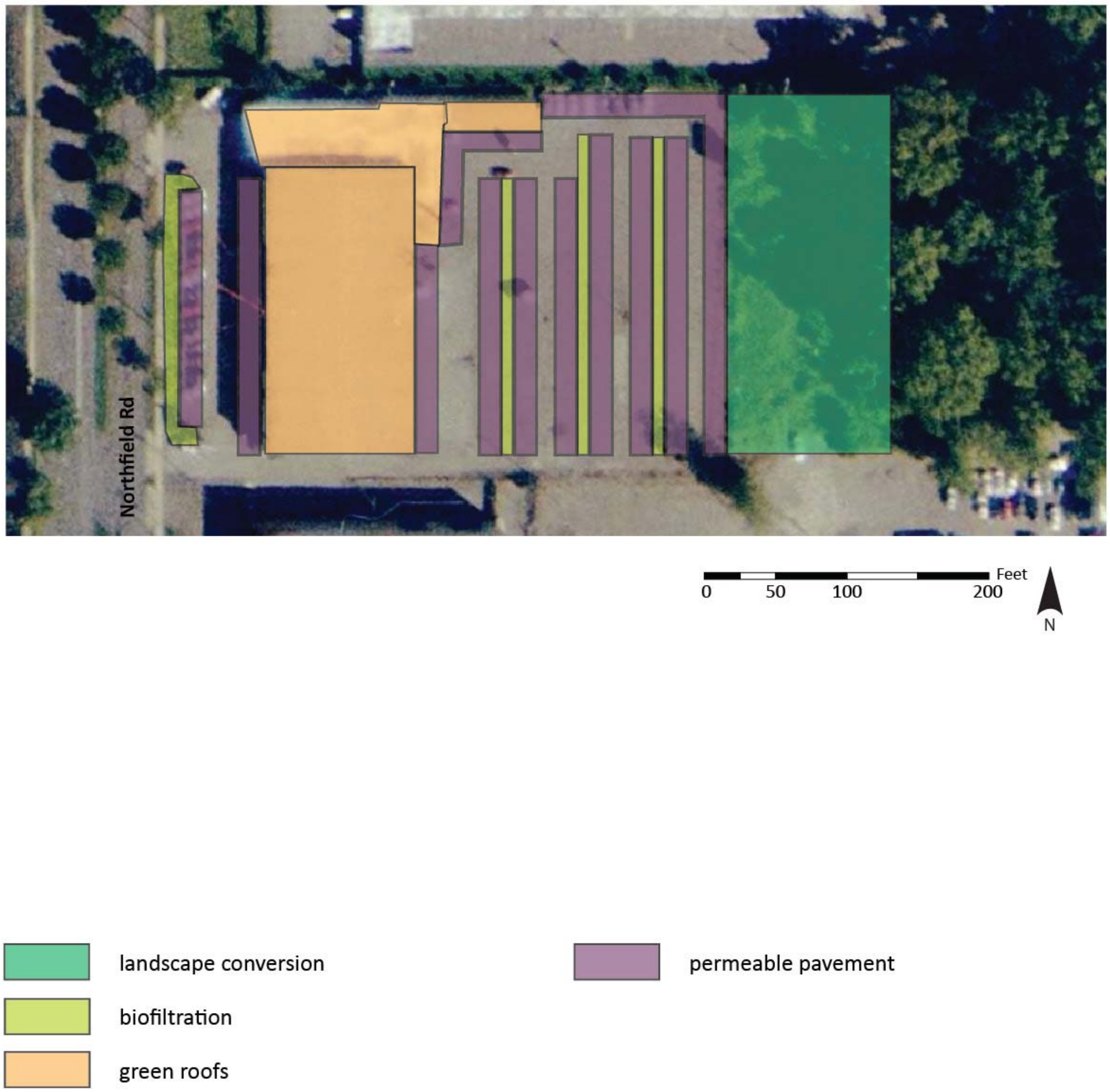


Figure 9. Commercial Example Site

Public Open Space

The public open space precinct includes publicly-accessible open spaces such as the cemetery, the driving range, a camp, and park areas. This precinct has the least amount of impervious surface and is predominantly turf grass. There is an opportunity for biofiltration retrofits along edges adjacent to roads and parking lots. Parking areas may be converted to permeable pavement. Existing turf grass areas which are not heavily used for recreation and other non-turf landscape areas can be converted to native landscapes. In some instances, streams or drainage channels may flow through open space properties. In these cases, the stream or channel should be restored with riparian vegetation.

The driving range on the corner of Green Road and Harvard Road is one example of public open space within the subwatershed (**Figure 10). Possible retrofits for this property include biofiltration along the north and west edges of the property along the road rights-of-way, replacing existing parking lot paving with permeable paving, converting the landscape along the drainage channel running through the property to native or riparian vegetation, and sustainably managing the turf area.**

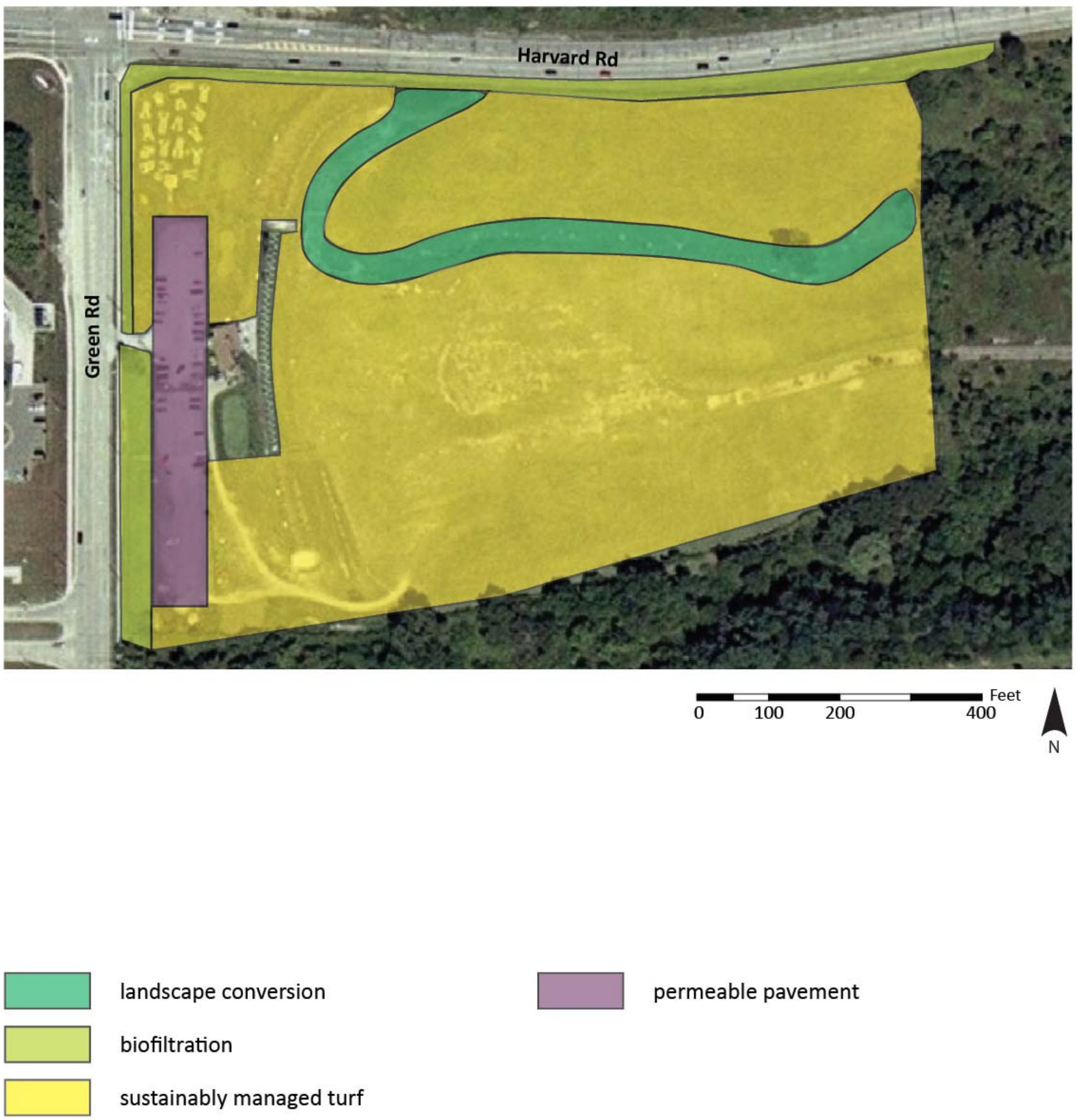


Figure 10. Public Open Space Example Site

Major Rights-of-Way

Major rights-of-way (ROWs) are two to four lane arterial streets through the subwatershed including Clarkwood Parkway, Green Road, Emery Road, Harvard Road, Granada Boulevard, and Robert Bishop Drive. None of these ROWs currently has planted medians. Most of these ROWs have sidewalks although some are not continuous. Those with sidewalks typically have a strip of landscape area between the road and the sidewalk. The main retrofit for these ROWs is to convert existing landscape strips between the sidewalks and road, landscape adjacent to the road, or central median areas to biofiltration, especially bioswales. In areas where the road runoff may be drained to larger areas of adjacent landscape, there may be non-structural retrofits. Along Clarkwood Parkway (Figure 11), bioswales may be used to treat stormwater runoff from the road section.

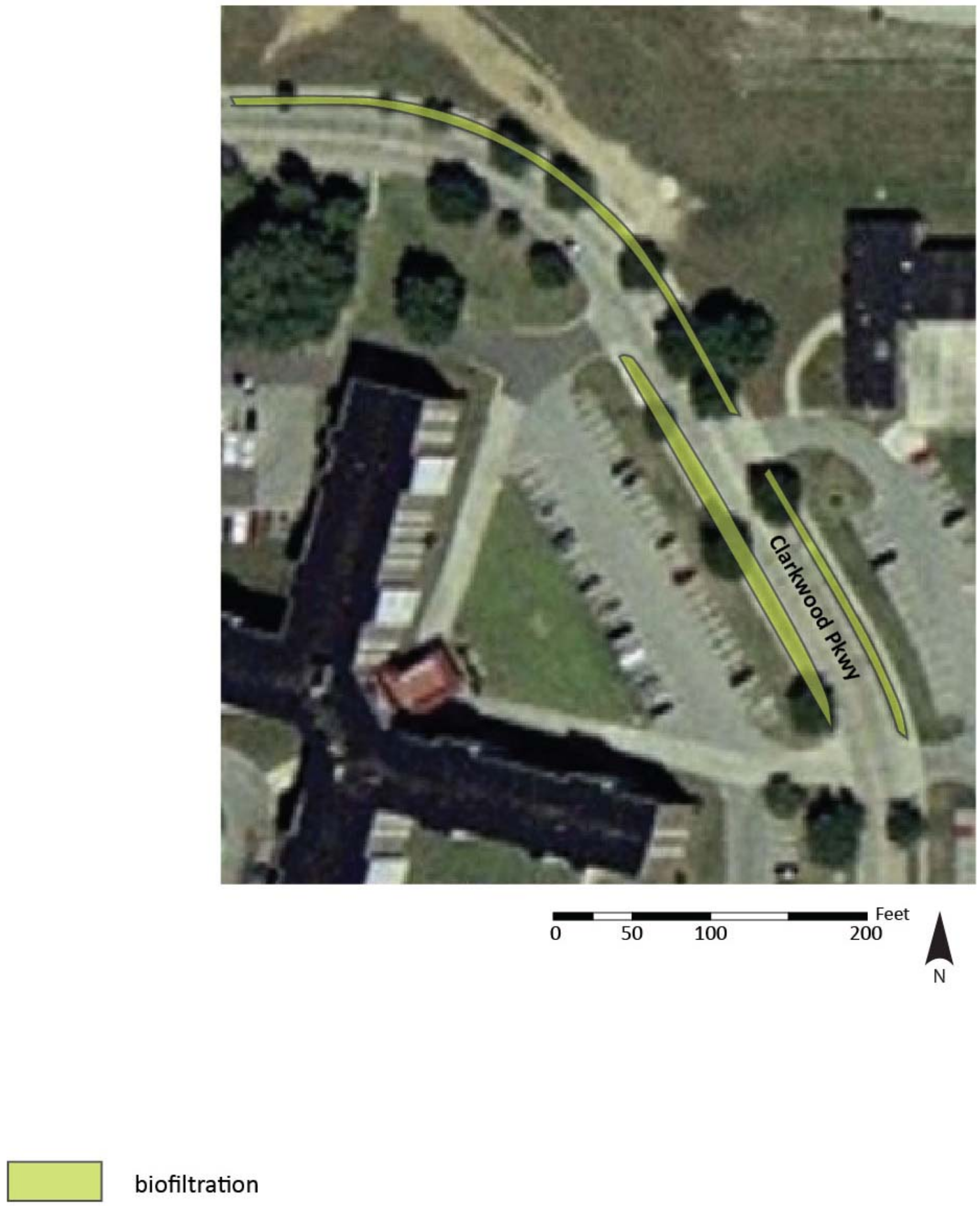


Figure 11. Major Rights-of-Way Example Site

Institutional

The institutional precinct includes the Cuyahoga County Developmental Disabilities facility and the adjacent youth correctional facility. Green roofs are recommended to retrofit as many institutional facility buildings as possible. Areas around impervious surfaces such as landscape between buildings, sidewalks, and parking should be converted to biofiltration. Areas within the parking lots such as existing landscape islands or areas between rows of parking spaces also provide the opportunity for biofiltration retrofits. Sidewalks, patios, building entryways, sport courts, and parking spaces could all be replaced with permeable pavement, especially if they are in a degraded condition currently. Any turf grass areas which are not heavily used for recreation could be converted to forest or other native landscape planting.

The school building on the corner of Green Road and Maple Avenue, which is part of the Cuyahoga County Developmental Disabilities campus, is one example of an institutional property (Figure 12). Recommended retrofits include adding a green roof to the portions of the roof that do not contain building utility elements (although additional green roof area could be planned around these elements). The landscape strips between the building and walkway, existing parking lot islands, and strips between rows of parking are recommended for biofiltration retrofits. The northern main building entry sidewalk and parking spaces could be replaced with permeable paving. As the campus offers many other recreational turf areas, the landscape on the western edge of this property could be converted to forest or other native vegetation. The turf area on the south side of the property next to the patio could be sustainably managed.

Figure 12. Institutional Example Site

Riparian

The riparian precinct is along Bear Creek in the southwest portion of the subwatershed. Portions of Bear Creek are eroded, channelized, and lack vegetation. The underlying cause of the stream degradation is uncontrolled stormwater runoff from upstream, coupled with encroachment into the stream corridor by adjacent development. The riparian area along Bear Creek, and along smaller drainage channels and tributaries in the subwatershed, should be stabilized and restored with a variety of techniques. Restoring riparian vegetation in and around waterways can slow and filter stormwater while preventing sedimentation from erosion. Grading and structural techniques may be necessary to help stabilize portions of the creek.

The proposed retrofits for the example riparian site in the southwestern portion of the subwatershed (Figure 13 and Figure 14), adjacent to potential future redevelopment on Northfield Road, include stabilizing eroded banks, reestablishing slopes, protecting trees and shrubs, and enhancing surrounding forest vegetation. This approach will stabilize eroding banks in the upper reach with a rock plunge pool that will dissipate energy at the culvert, use cross vanes to maintain slope/grade, and provide boulder bank protection with trees and shrubs. The creation of an oxbow wetland, scrub/shrub floodplain, wet meadow, and a bioretention facility are also recommended. Enhancing the existing forest with integrated trails and interpretive signage could promote watershed-health to visitors.

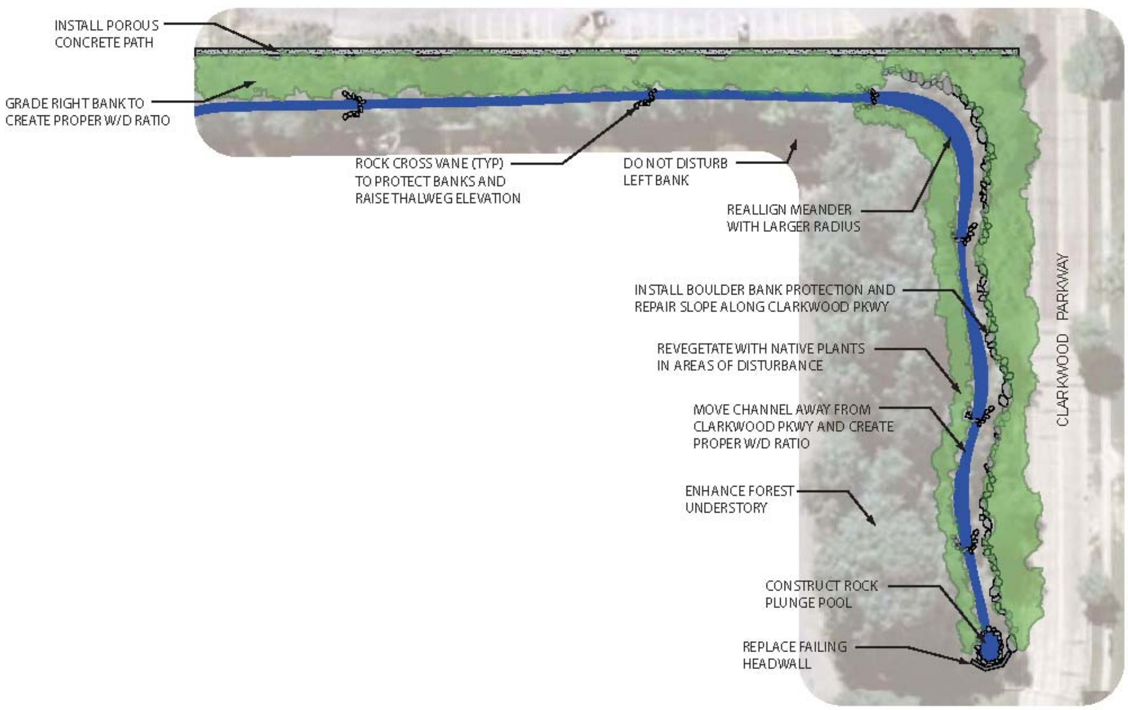


Figure 13. Upstream Section of the Riparian Example Site

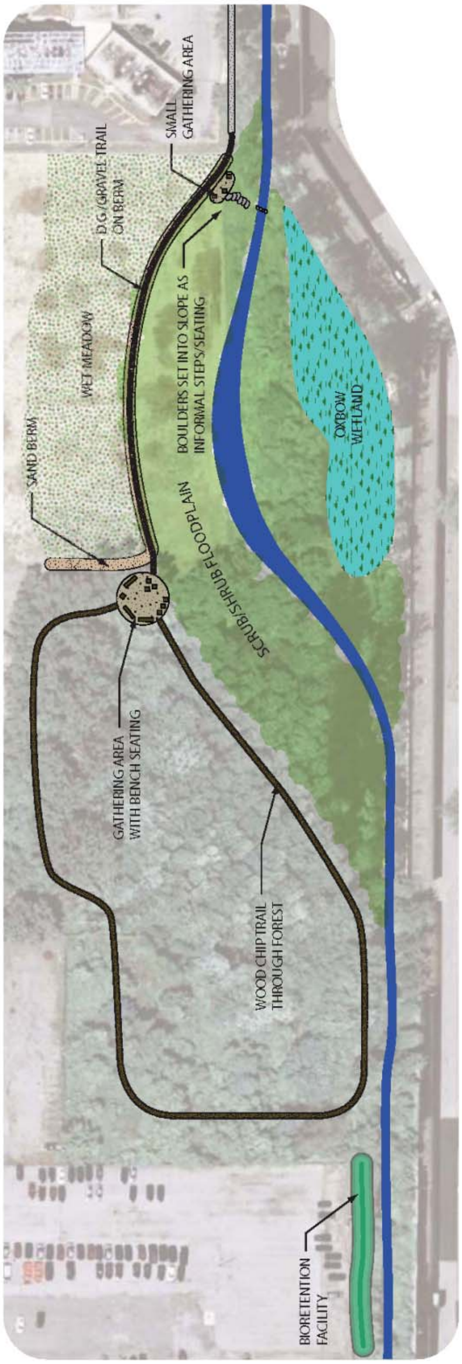


Figure 14. Downstream Section of the Riparian Example Site

Potential Effectiveness of BMPs in the Bear Creek Subwatershed

Planning-level estimates of the potential effectiveness of the green infrastructure strategy were developed for each example site. These estimates were then extrapolated across the corresponding precinct. This analysis focuses on the potential reduction of TP. The three-step process used to conduct this analysis is detailed in Attachment C.

For each precinct example site, Biohabitats first estimated current pollutant loads (Table 7).

Table 7. Existing Annual TP Load from Example Site

Precinct Example Site	Total	Estimated Annual TP Load from Example Site (lbs/year)
High Density Residential	7.1 acres	5.5
Medium Density Residential	1.9 acres	1.4
Commercial	3.8 acres	2.9
Public Open Space	19.0 acres	5.2
Major Rights-of-Way	1.8 acres	1.4
Institutional	5.2 acres	4.0
Riparian Corridor		
Riparian Buffer	3.0 acres	0.2
Stream Channel	2,000 feet	7.0
TOTAL		**27.6**

Biohabitats then estimated the annual TP load reduction that may be achieved by the precinct example site's proposed green infrastructure strategy (Table 8). These estimates are aggressive as they assume full application of all identified green infrastructure opportunities.

Table 8. Potential Annual TP Load Reduction by each Type of BMP in each Example Site

Precinct Example Site	BMP Type	Total Surface Area Available (ft^2)	Estimated Drainage Area (ft^2)	Annual TP Load Removed (lbs/year)
High Density Residential	Biofiltration	63,800	142,700	1.85
	Green Roofs	22,700	22,700	0.21
	Permeable Pavement	44,800	44,800	0.56
	Sheetflow to Conservation Area	67,600	14,000	0.13
	Sustainably Managed Turf	23,200	23,200	0.09
Medium Density Residential	Landscape Conversion	4,800	4,800	0.02
	Biofiltration	5,500	9,300	0.13
	Permeable Pavement	13,600	13,600	0.18
	Downspout Disconnection to Rain Barrels	4,900	4,900	0.04
	Sustainably Managed Turf	41,500	41,500	0.17
Commercial	Landscape Conversion	29,200	29,200	0.11
	Biofiltration	7,160	33,900	0.44
	Green Roofs	29,300	29,300	0.28
	Permeable Pavement	35,100	35,100	0.44
Public Open Space	Landscape Conversion	56,100	56,100	0.08
	Biofiltration	56,000	112,000	0.50
	Sustainably Managed Turf	632,000	632,000	0.85
	Permeable Pavement	41,800	41,800	0.18
Major Rights-of-Way	Biofiltration	6,600	37,200	0.46
Institutional	Landscape Conversion	39,400	39,400	0.15
	Biofiltration	18,600	89,000	1.15
	Green Roofs	33,900	33,900	0.32
	Permeable Pavement	18,800	18,800	0.23
	Sustainably Managed Turf	12,700	12,700	0.05
Riparian Corridor	Stream / Riparian Rehabilitation	N/A	Estimated stream channel length 2,000 feet	7.00
TOTAL		**1,309,060**	**1,521,900**	**15.6**

The total potential TP reduction at each example site was determined by summing the reductions associated with each type of BMP. The effective treatment – or total percentage reduction of TP – was then computed for each example site (Table 9).

Table 9. TP Reduction at each Example Site

Precinct Example Site	Estimated Annual TP Load from Example Site (lbs/year)	Annual TP Load Removed for Example Site (lbs/year)	Fraction of Annual TP Load Removed for Example Site (%)
High Density Residential	5.5	2.8	52%
Medium Density Residential	1.4	0.5	37%
Commercial	2.9	1.3	44%
Public Open Space	5.2	1.6	31%
Major Rights-of-Way	1.4	0.5	33%
Institutional	4.0	1.9	48%
Riparian Corridor	7.2	7.0	97%

The results for each example site were then extrapolated across the corresponding precinct. The existing annual TP load for each precinct was computed. This value was then multiplied by the effective treatment determined for the example site to project the annual TP load that may be removed by applying green infrastructure across the precinct (Table 10).

Table 10. Potential Annual TP Load Reduction Across the Precinct

Precinct	Total	Annual TP Load from Precinct (lbs/year)	Fraction of Annual TP Load Removed for Example Site (%)	Projected, Potential Annual TP Load Removed for Precinct (lbs/year)
High Density Residential	50.0 acres	38.7	52%	20.0
Medium Density Residential	75.1 acres	58.2	37%	21.5
Commercial	48.5 acres	37.5	44%	16.3
Public Open Space	103.2 acres	28.2	31%	8.7
Major Rights-of-Way	27.3 acres	21.1	33%	6.9
Institutional	122.3 acres	94.7	48%	45.3
Riparian Corridor				0.0
Riparian Buffer	7.7 acres	0.5	N/A	0.0
Stream Channel	4,610 feet	16.1	97%	15.7
TOTAL	**434.0**	**294.9**		**134.6**

Planning-Level Design and Construction Cost Estimates for the Example Sites

Planning-level design and construction cost estimates of the identified green infrastructure opportunities for each example site were developed. The cost of retrofitting the urban environment with green infrastructure can be highly variable depending on specific site conditions and constraints. Therefore, these estimates are presented as a potential range. For each type of green infrastructure practice, the potential upper and lower unit construction cost, based on drainage area treated was identified. These unit costs were then multiplied by area treated. Based on professional experience, the planning-level design/permitting/survey cost was assumed to be 40 percent of the construction costs. The planning-level cost estimates are detailed in Attachment D and summarized in Table 11.

Table 11. Planning-Level Design and Construction Cost Estimates for Example Sites

Precinct Example Site	BMP Type	Estimated Drainage Area (acres)	Planning-Level Design & Construction Cost Estimate ($)	
			Lower End	Upper End
High Density Residential	Biofiltration	3.3	$116,492	$917,264
	Green Roofs	0.5	$20,428	$145,914
	Permeable Pavement	1.0	$187,181	$626,336
	Sheetflow to Conservation Area	0.3	$3,375	$5,714
	Sustainably Managed Turf	0.5	$5,592	$9,470
Medium Density Residential	Landscape Conversion	0.1	$1,157	$1,959
	Biofiltration	0.2	$7,592	$59,780
	Permeable Pavement	0.3	$56,823	$190,138
	Downspout Disconnection to Rain Barrels	0.1	$0	$46,930
	Sustainably Managed Turf	1.0	$10,003	$16,939
Commercial	Landscape Conversion	0.7	$7,039	$11,919
	Biofiltration	0.8	$27,674	$217,906
	Green Roofs	0.7	$26,367	$188,338
	Permeable Pavement	0.8	$146,653	$490,723
Public Open Space	Landscape Conversion	1.3	$13,523	$22,898
	Biofiltration	2.6	$91,431	$719,927
	Sustainably Managed Turf	14.5	$152,342	$257,965
	Permeable Pavement	1.0	$174,646	$584,394
Major Rights-of-Way	Biofiltration	0.9	$30,368	$239,118
Institutional	Landscape Conversion	0.9	$9,497	$16,082
	Biofiltration	2.0	$72,655	$572,084
	Green Roofs	0.8	$30,507	$217,906
	Permeable Pavement	0.4	$78,549	$262,837
	Sustainably Managed Turf	0.3	$3,061	$5,184
TOTAL		**35**	**$1,272,955**	**$5,827,725**

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Attachment A
Green Infrastructure as a Sustainable Design Approach

Biohabitats' green infrastructure approach stresses the importance of a functioning natural system as an integral element in the developed landscape. Having green infrastructure as the foundation for development requires transitioning from more conventional landscape planning, engineering, and management practices that may contribute to the degradation of the natural environment, to practices that perform important ecological functions while providing users with functional spaces. In practice this means embracing the notion that ecological preservation and conservation practices can be an integral part of the built landscape and that the design of those practices is directly informed by the natural processes and functions occurring on a site.

Green infrastructure has several different meanings. In the disciplines of landscape ecology and conservation biology it is defined as "strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations." (The Conservation Fund at greeninfrastructure.net, 2010) The EPA however focuses its definition on stormwater management defining green infrastructure as an approach to "wet weather management using designs and technologies that infiltrate, evapotranspire, capture and reuse stormwater in order to maintain or restore natural hydrologies." (EPA, 2010)

The major difference between these two definitions is the issue of scale. Rather than seeing this as a divisive point, Biohabitats sees the divergence in definitions as an opportunity to explore a more nuanced definition of green infrastructure as a regenerative design and planning approach which recognizes the importance of functioning natural systems at multiple scales while providing a myriad of benefits. It is important to consider the contributions that green infrastructure can provide both at the site scale as well as within the broader ecological region. Green infrastructure provides a foundation for the restoration of more resilient natural systems. This multilayered approach provides benefits that include receiving, retaining, and filtering stormwater in a way that may preserve or mimic natural hydrological patterns (treating water as a resource, not as a problem), providing improved wildlife habitat and corridor connections to broader habitat areas in the vicinity for migratory animals, providing local native food sources for humans and wildlife, and providing many benefits to the human user and surrounding community.

Developing a strong and resilient green infrastructure network involves examining, interpreting and building upon the inherent patterns in the landscape. Building a site's capacity for regeneration requires:

- a strong focus on connectivity
- designing for stacked benefits at multiple scales
- an appreciation for historic function
- an understanding that in highly urbanized areas natural function may not return in its original form

Green infrastructure is an inherently place-based process contributing to the health and long-term success of both the physical landscape as well as the socio-cultural landscape. While it provides functional habitat for native wildlife it should also contribute to the physical and mental health and well being of the human user. A functioning green infrastructure approach should foster stewardship and learning, developing stronger relationships between people and the natural resources that provide the foundation for functioning living systems. The residents who understand and appreciate the benefits of green infrastructure within their community are often those who are most likely to become the long-term stewards of the site.

Within the Great Lakes ecosystem these benefits are particularly important in terms of sustaining and strengthening ecosystem health and resilience. The Great Lakes basin, which covers 20,000 square miles, has an incredible level of biodiversity. The Great Lakes ecosystem contains one fifth of the world's freshwater supply, with its rivers and streams providing important spawning habitats and migration corridors for songbirds and waterfowl. Native ecological systems of note include: prairie, forests including beech-maple, oak-hickory, mixed forest, as well as unique post-glacial landscapes that include bogs, fens, wetlands and kettle lakes which provide important habitat to wildlife as well as recreational and respite activities for residents. Ohio's relationship to the Great Lakes, as water resource and economic driver, also highlights the importance of the overall sustainability of the Great Lakes ecosystem.

Green infrastructure calls for the integration of many of the following practices: planting and design decisions including converting turf to natural vegetation; managing, preserving, and restoring healthy forest stands and ecological corridors along streams and waterways; maintenance decisions; the integration of stormwater management features as part of a "functional landscape"; integrating vegetation into building architecture in green roofs and living walls; integrating cisterns and other water capture and reuse systems; permeable pavement and other alternatives to impervious surface; natural outfall designs; onsite treatment of wastewater; the integration of renewable energy and transportation planning; carbon sequestration as a consideration in management of vegetation; and the inclusion of edible landscapes or urban agriculture as well as other programming decisions. Green infrastructure designs that incorporate these practices can scale up to the landscape ecological perspective and scale down to the site specific treatment of the landscape, delivering natural capital and goods and services for a more sustainable future.

As a holistic approach to site planning and design, green infrastructure provides a multitude of benefits including: reducing and delayed stormwater runoff volume, enhanced groundwater recharge, reduced stormwater pollutants, increased carbon sequestration, urban heat island mitigation and reduced energy demands, improved air quality, additional wildlife habitat and recreational space, improved human health, increased land values, providing natural cooling mechanisms to mitigate the effects of urban heat island, lowering water consumption and treating more waste onsite, lessening maintenance costs, improving air quality, creating natural habitat for diverse ecosystems; providing educational opportunities; contributing to overall sustainability initiatives; and reducing overall operation and maintenance burden.

The biological and natural resource richness of the Great Lakes basin is tied to the integrity of the many smaller watersheds that are found within. Disturbances in one location may have many unintended effects elsewhere. By the same token restored functionality in the Cleveland area may have important implications for improved ecosystem health in other parts of the basin, and beyond. There are many opportunities to integrate green infrastructure into site planning. For example, efforts to restore landscapes like the native prairie or to include native prairie vegetation in the design of a stormwater best management practice (BMP) can help strengthen ecological connections and provide improved habitat opportunities, while speaking the unique story of place in the region.

Attachment B
Green Infrastructure BMPs Applicable to the Tinkers Creek Watershed

This effort is focused on the application of green infrastructure BMPs to provide stormwater management benefits. BMPs are often defined as engineered, structural practices that provide stormwater runoff treatment and management through infiltration, filtration, or detention. However, BMPs can range in complexity from simply changing maintenance practices to the more structural designs. For example, landscape conversion and sustainable turf management are relatively simple conversions of existing landscapes while functional landscapes, such as biofiltration swales or cells, include elements that require a greater level of design to provide benefits and functions such as stormwater treatment. Treatment features such as bioretention, rain gardens, and street tree pits are examples of functional landscapes that are designed to be integrated into landscape areas to receive and filter stormwater runoff. In all stormwater BMPs, restoring the natural hydrology of the site through infiltrating stormwater into the ground is ideal. However, the ability to infiltrate is dependent on soil characteristics and landscape position.

Opportunities can be categorized by where they are found in the landscape (i.e., landscape position) as well as how they fit into existing or planned development. These practices can also be used as a model for similar landscape types and positions found across the watershed.

This section gives further explanation of the palette of BMPs that are appropriate for the Tinkers Creek watershed.

Palette of Stormwater BMPs

Disconnection

In urbanized areas, rooftops and other impervious surfaces typically drain into a storm sewer system. Rooftop downspouts may be connected directly to the storm sewer or flow into curb and gutter systems. Other impervious surfaces may drain directly into storm drains. These areas can all be disconnected from this direct drainage to divert stormwater into the various BMPs listed below.

Downspout disconnection is one of the more simple stormwater retrofit BMPs. Downspouts may be retrofitted to either flow into a landscape area to infiltrate or may be harvested in a rain barrel or cistern for re-use.

Other disconnection of impervious surfaces such as roads and parking lots can divert flows into stormwater BMPs.

Sheetflow to Conservation Area

When disconnecting impervious surfaces from storm sewer drainage infrastructure, stormwater drainage may be redirected to adjacent forest or other conservation areas as long as the runoff will not negatively impact the conservation area.

Forest Management, Restoration, and Preservation

Forests are an important element of green infrastructure for stormwater management. Forest canopies, understory, and soils may absorb stormwater more effectively than any other BMP. Therefore, managing, restoring, and preserving forest resources are major goals for natural resource sustainability. Forest resources have many additional stacked benefits including providing habitat; open space and recreational areas; connections to the regional ecosystem; cultural opportunities; air filtration; and the mitigation of urban heat island. A vigorous forest cover is also critical to maintaining healthy stream ecosystems and flood control. Forests made up of native tree and understory species have a higher ecological function than invasive exotic tree and understory species. There are many unique and valuable forests in this area and the riparian corridors along the Tinkers Creek are an important asset to the region, as long as interior forest can be maintained for migratory birds and invasive plants are kept under control.

Landscape Conversion

Landscape conversion is the conversion of a generally high maintenance landscape (e.g., turf) to a landscape cover that is more desirable from a stormwater quality perspective (e.g., xeriscaping – plantings that reflect a need for less irrigation like native meadow and grassland palettes, or reforestation). There are three primary applications:

- Reforestation of turf grass areas near riparian corridors;
- Conversion of turf to native vegetative cover;
- Conversion of high maintenance, non-native landscape plantings to native vegetative cover.

Converting turf to native plantings has multiple benefits including: increasing soil permeability, reducing overall mowing maintenance, reducing potable irrigation water demand, increasing canopy cover for rainfall interception and heat island mitigation. In this region, prairie plantings and meadows are one attractive and beneficial alternative to turf.

Although the resulting retrofit may appear similar to other vegetated BMPs, these practices are non-structural, using typical soil without underdrains, as opposed to some other biofiltration retrofit practices.

Sustainable Turf Management

While landscape conversion or other BMPs are ideal treatment for existing turf grass areas which are not well-used, in poor condition, or prone to flooding, existing turf areas which are heavily used for recreation or events can be managed sustainably to limit their contribution of pollutants to stormwater runoff as well as their water and energy demand. The use of fertilizer, herbicides, and pesticides should be eliminated or minimized to avoid nutrient and pollutant runoff. Integrated pest management offers some techniques to minimize use of pesticides. By replacing certain typical turf grass species with other native, more drought tolerant, or low-mow species, the demand for irrigation and mowing energy can be lowered.

Biofiltration

Bioswale conveyances are vegetated swales and channels which convey and filter stormwater runoff. These opportunities are generally found where more conventional drainage ditches or eroding swales are conveying stormwater and present opportunities for improvement. In more urban areas or in poorly draining soil, bioswales may use soil amendments or layers of engineered soil to encourage infiltration. In some instances, an underdrain or overflow drain may collect water which is not absorbed by vegetation in situations where water can't be infiltrated into the soil (e.g., sink hole prone areas).

Bioretention and bioinfiltration cells are vegetated, depressed landscape areas which collect and either retain or infiltrate stormwater. In constrained urban areas such as sidewalks, street rights-of-way, or parking lots, these cells may be only a few square feet in area. In situations where more space is available, the cells may be larger but are meant to be integrated into the landscape, capturing runoff from immediately surrounding impervious areas rather than becoming centralized detention basins. Extended tree pits, foundation planters, curb-cut bump-outs, and rain gardens are a few design examples of bioretention and biofiltration cells. In urban areas with soil drainage constraints, overflow drainage structure may be necessary.

Permeable Pavement

Permeable pavement functions as typical pavement (although load bearing and maintenance characteristics may vary) yet allows stormwater to infiltrate through to the structure into soil. Permeable pavement includes porous concrete, porous asphalt, geoweb, reinforced turf, and other paver systems. Existing paved areas such as roads, parking lots, sidewalks, walkways, and courtyards are retrofit opportunities, particularly if repaving is needed in the future. As soil conditions may not be favorable for significant infiltration, careful planning and design is warranted for this type of application. Areas that are less intensely used, such as parking spaces (versus parking lot driving lanes) may gain more benefit while limiting cost and maintenance. More permeable systems such as reinforced turf are ideal for areas which are only occasionally used such as overflow parking or fire access.

Underground Filters

Underground filters may include underground sand filters or some sort of proprietary filter placed in an existing catch basin. These are recommended for areas that have the potential to contribute high pollutant loads but are limited in space (e.g., loading docks behind buildings).

Outfall Treatment

Conveying stormwater through pipes or concrete channels degrades the surrounding environment by speeding up flows, causing erosion, and denying infiltration. Outfall treatment is recommended for existing outfalls and drainage chutes where there is erosion and space available for improvements.

Regenerative Stormwater Conveyance (RSC) is recommended for these areas, which would convey, filter, and infiltrate runoff. This is not simply outfall stabilization (e.g., with riprap), but rather a vegetative regenerative design that creates a more stable stream-like system to help convey, filter, and provide habitat. RSC uses stream restoration techniques to create open channel flow at stormwater outfalls or in daylit sections of streams, allowing sediment to settle in pools, aeration in riffle structures, and restored ecological function. RSC is used to convey water down slopes from impervious areas or pipe outfalls. It is often composed of a sand seepage bed, riffle weirs made of boulders and cobbles, a mulch and compost layer, and native plants. RSC is less intrusive than other conveyance stabilization techniques. It dissipates energy by slowing the flows, provides infiltration through the sand bed, and has a natural appearance. These vegetated channels create opportunities for aesthetically valuable green infrastructure.

Rainwater Harvesting

Rather than treating stormwater as a waste product to be disposed of, rainwater harvesting captures and re-uses this valuable resource. Harvested rainwater may be collected from any impervious area such as a rooftop, plaza, or parking lot. Water can be stored in above-ground cisterns or underground storage tanks with capacities up to 10,000 gallons. In smaller scale applications, building downspouts can be retrofitted and redirected into rain barrels. The water collected can be used for lawn and garden watering or indoor uses such as toilet flushing. In some cases it is used to provide aesthetic-driven water features. Storing rainwater also conserves potable water and reduces water utility costs. Gravity flow or pumps can be used to distribute the water. Underground detention (large-capacity subsurface cisterns) would be appropriate at the athletics fields and under certain parking lots. This is similar to the farm pond approach – collect the water, store and use for irrigation close to the source. This might only be pragmatic in the Athletics precinct.

Green Roofs

Green roofs include layers of waterproofing materials, well-suited soil media, and well-adapted plant species to vegetate flat or gently sloped rooftops. While the largest benefit of green roofs is typically absorbing, slowing, and evapotranspirating stormwater, green roofs offer additional benefits such as lessening urban heat island, cooling buildings, providing some bird and beneficial insect habitat, and improving the aesthetics of visible rooftops. There are two types of green roofs – extensive and intensive. Extensive green roofs have shallow media and are planted with mostly sedum species while intensive green roofs may use deeper media, a wider diversity of planting, and may be useable recreation space. While it is easier to engineer the structural load of green roofs into new buildings, many existing buildings have enough structural roof support for at least an extensive green roof. When structure, budget, or other uses constrain building a typical green roof, other types of vegetated rooftops using trellises, canopies, or planter boxes can mitigate urban heat island, provide some stormwater management, allow urban agriculture, and improve aesthetics. Living walls, or vertical gardens on building facades, can also play a role in slowing stormwater from rooftops, especially combined with green roofs. These living structures can range from simple wire trellis' supporting vines to more intensive frames and fabrics hosting a variety of plant species. Added benefits of living walls include education, food growing, and habitat patches.

Stormwater Ponds/Wetlands

Stormwater ponds or wetlands can be created or retrofitted to enhance water quality treatment. These more conventional practices can be designed in a way that responds to the natural processes and contours in the landscape, providing the stormwater treatment needed as a functional landscape while offering aesthetic effect, and habitat function. The edges of these practices are as important in design as the handling capacity, with the integration of native vegetation both for further filtration as well as habitat benefit.

Stream/Riparian Rehabilitation

Finally, stream rehabilitation opportunities are an important part of a holistic approach to green infrastructure planning and design.

Opportunities by Landscape Position

Six landscape positions are commonly found in the landscape, each of which present multiple opportunities for innovative stormwater management strategies utilizing a combination of BMPs and other regenerative practices. Together, they have the potential to form the backbone of an integrated green infrastructure. Descriptions and illustrative images of these six areas are presented below.

Rooftops – Rooftop runoff can be treated using rain gardens, stormwater planters, infiltration trenches, cisterns, or small-scale detention devices. These practices are placed adjacent to buildings and should be designed to complement or enhance the existing landscape plantings and design. Green roofs can also provide an opportunity to absorb and slow stormwater runoff from rooftops. Additionally, a planted roof can lower summer cooling needs, provide a reduction in urban heat island effects, provide habitat for certain species, and provide a useable space for study, gardening, food growing, or other activities. Green roofs capture rainwater and provide a reduction of heat island effects, as well as provide habitat for certain species.

Streets/Roads – Road runoff can be captured in stormwater tree pits or rain gardens located in curb extensions or within the right-of-way. These features also promote traffic calming, improving safety for drivers, pedestrians, and bicyclists. Porous pavement can be considered for bike lanes, parking lanes, or infrequently-used roads.

Parking lots – Runoff from parking lots can be treated by rain gardens placed around the perimeter or in linear bioretention islands within the parking lots. If space allows, grass filter strips placed between the parking lot and rain gardens will promote additional infiltration and reduce the pollutant load and velocity of water entering the rain gardens. Increasing tree canopy both within bioretention islands, and along the perimeter of the lots and combining these areas with stormwater receiving zones to filter water and support plant life provide multiple benefits: decreasing the effects of urban heat islands, capturing and treating runoff from these expansive impervious areas, and providing habitat connections to neighboring forest patches. Replacing all or part of a parking lot with porous pavement or paver blocks is another option. Pavers or colored porous concrete can be used to visually demarcate special parking areas.

Turf – Converting turf to native plantings has multiple benefits including: increasing soil permeability by creating deeper macropores in soil structure, reducing overall mowing maintenance, reducing potable irrigation water demand, increasing canopy cover for rainfall interception and heat island mitigation, and reducing carbon footprints through sequestration and the reduction of fossil fuel use in maintenance regimes. Alternatives to conventional turf may also include low-mow options.

 

Courtyards/Public Plazas – Courtyards and public plazas often incorporate landscape elements including lawns and garden plantings in combination with hardscape paths, plazas, and seating areas. The peripheral areas of these spaces offer an opportunity for conversion from turf to depressional areas for stormwater collection. These areas can be planted with native vegetation that provide aesthetic accents, vibrant colors and texture, and spatial organization. Even when depressional areas are not feasible for bioretention, the turf edge along a courtyard may be converted to a natural meadow planting, providing more microhabitat and a reduction in maintenance needs. Hardscape areas can be replaced or augmented with permeable/porous pavement to minimize impervious surfaces, and can incorporate vegetated stormwater planters.

Riparian – Riparian areas are an integral part of existing ecological systems and also often provide a buffer between creeks, rivers, wetlands, and neighboring developed areas. Riparian corridors are key to ecological systems, providing linkages between ecological patches or as linkages for wildlife movement. Through restorative and regenerative practices, riparian corridors can provide habitat, as well as act as a natural amenity for passive recreation and a natural boundary marking the edge of developed areas. Riparian corridor opportunities can include ecological restoration and native vegetative enhancement, as well as stormwater practices like regenerative stormwater conveyance and bioretention gardens.

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Attachment C
Total Phosphorus Accounting Methodology

A spreadsheet-based approach was used to develop total phosphorus (TP) load reduction estimates for each precinct in the Bear Creek subwatershed. The approach has three steps, discussed below. Detailed tables displaying the computations follow the discussion.

Step 1. Calculate existing TP load (lbs/yr) from each example site

This step uses a combination of unit loading and assumed stream channel erosion values to quantify the existing TP pollutant load from example site.

Step 1 proceeds as follows:

a) Determine the existing pollutant unit load for each land use (Table 1).

Table 1 Loading Rates for Various Land Uses (Kratt, 2010)		
GWLF Land Use	**Comparable Precinct**	**TP Loading Rate (lb/ac/yr)**
Forest	Riparian Buffer	0.061
Turf Grass	Public Open Space	0.273
High Intensity Developed	Commercial High Density Residential Medium Density Residential Major Rights of Way Institutional	0.774

b) Apply the unit load to each example site to compute the existing pollutant load.

c) To account for the TP resulting from stream channel erosion, a unit value of 0.0035 lbs/foot/year was multiplied by the length of the stream channel (CWP, 2005).

Step 2. Calculate annual TP reduction for each example site

This step calculates the potential annual TP load reduction associated with the green infrastructure BMP strategy for each example site. In most cases, the reduction is determined by multiplying the annual TP load, calculated in Step 1, by a TP removal percentage. The green infrastructure BMPs were assigned a TP removal percentage

Step 2 proceeds as follows:

a) Estimate the total drainage area to each type of green infrastructure BMP proposed for the example site.

b) Determine the fraction of the example site that may be treated by each type of BMP. This was computed by dividing the total drainage area to each type of green infrastructure BMP by the total area of the example site.

c) Determine the TP removal effectiveness of each type of BMP (Table 2).

Table 2 Total Phosphorus Removal Values by Practice		
BMP	**TP Removal Effectiveness (%)**	**Reference**
Biofiltration	73%	CWP, 2008
Downspout Disconnection to Rain Barrels	38%	CWP, 2008
Green Roofs	53%	CWP, 2008
Landscape Conversion	22%	CWP, 2005
Permeable Pavement	70%	CWP, 2008
Sheetflow to Conservation Area	53%	CWP, 2008
Sustainably Managed Turf	22%	CWP, 2005
Stream / Riparian Rehabilitation	0.0035 lbs/foot/year	CWP, 2005

d) Determine the effective treatment (%) provided by each type of BMP. This was computed by multiplying fraction of the example site that may be treated by the pollutant removal effectiveness of the type of BMP.

e) Multiply the existing TP load for the example site by the effective treatment provided by each type of BMP. The product equals the annual TP reduction associated with each type of BMP.

f) Sum the annual TP reductions associated with each type of BMP to determine the total potential annual TP reduction for the example site.

Note: For stream / riparian rehabilitation, a presumptive effectiveness of 0.0035 lbs/foot/year was used (CWP, 2005).

Step 3. Extrapolate the annual TP reduction for each example site to the precinct

This step extrapolates the pollutant reduction potential computed for each example site to the entire precinct. Step 3 proceeds as follows:

a) Compute the total percent TP reduction for each example site. The potential annual load of TP removed was divided by the existing TP load.

b) Compute the existing TP load (lbs/yr) from each precinct, using the method outlined in Step 1.

c) Apply the total percent reduction that was computed for each example site to the entire precinct to predict planning-level, potential TP reduction.

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EXISTING ANNUAL TP LOADING FROM THE EXAMPLE SITES

Precinct Example Site	Total Area (acres)	Total Area (square feet)	Total Lenth (feet)	Unit Load (lbs/acre/year)	Unit Load (lbs/feet)	Annual TP Load from Example Site (lbs/year)
High Density Residential	7.1	308,840		0.774		5.5
Medium Density Residential	1.9	76,660		0.774		1.4
Commercial	3.8	163,790		0.774		2.9
Public Open Space	19.0	845,940		0.273		5.2
Major Rights-of-Way	1.8	83,200		0.774		1.4
Institutional	5.2	224,770		0.774		4.0
Riparian Corridor						
Riparian Buffer	3.0	128,820		0.061		0.2
Stream Channel			2,000		0.0035	7.0
TOTAL	**41.7**	**1,832,020**				**27.6**

POTENTIAL ANNUAL TP REDUCTION FOR EACH EXAMPLE SITE

Precinct Example Site	Total Site Area (square feet)	Estimated Existing Annual TP Load (lbs/year)	BMP Type	Total Surface Area Available (square feet)	Estimated Drainage Area (square feet)	Estimated Stream Channel Length (feet)	Fraction of Total Site Area Treated (%)	TP Removal Effectiveness	Effective Treatment	Annual TP Load Removed (lbs/year)	Annual TP Load Removed for Example Site (lbs/year)	Fraction of Annual TP Load Removed for Example Site (%)
High Density Residential Example Site	308,840	5.5	Biofiltration	63,800	142,700		46%	73%	34%	1.85	2.84	52%
			Green Roofs	22,700	22,700		7%	53%	4%	0.21		
			Permeable Pavement	44,800	44,800		15%	70%	10%	0.56		
			Sheetflow to Conservation Area	67,600	14,000		5%	53%	2%	0.13		
			Sustainably Managed Turf	23,200	23,200		8%	22%	2%	0.09		
Medium Density Residential Example Site	76,660	1.4	Landscape Conversion	4,800	4,800		6%	22%	1%	0.02	0.54	37%
			Biofiltration	5,500	9,300		12%	73%	9%	0.13		
			Permeable Pavement	13,600	13,600		18%	70%	12%	0.18		
			Downspout Disconnection to Rain Barrels	4,900	4,900		6%	38%	2%	0.04		
			Sustainably Managed Turf	41,500	41,500		54%	22%	12%	0.17		
Commercial Example Site	163,790	2.9	Landscape Conversion	29,200	29,200		18%	22%	4%	0.11	1.27	44%
			Biofiltration	7,160	33,900		21%	73%	15%	0.44		
			Green Roofs	29,300	29,300		18%	53%	9%	0.28		
			Permeable Pavement	35,100	35,100		21%	70%	15%	0.44		
Public Open Space Example Site	845,940	5.2	Landscape Conversion	56,100	56,100		7%	22%	1%	0.08	1.61	31%
			Biofiltration	56,000	112,000		13%	73%	10%	0.50		
			Sustainably Managed Turf	632,000	632,000		75%	22%	16%	0.85		
			Permeable Pavement	41,800	41,800		5%	70%	3%	0.18		
Major Rights-of-Way Example Site	83,200	1.4	Biofiltration	6,600	37,200		45%	73%	33%	0.46	0.46	33%
Institutional Example Site	224,770	4.0	Landscape Conversion	39,400	39,400		18%	22%	4%	0.15	1.91	48%
			Biofiltration	18,600	89,000		40%	73%	29%	1.15		
			Green Roofs	33,900	33,900		15%	53%	8%	0.32		
			Permeable Pavement	18,800	18,800		8%	70%	6%	0.23		
			Sustainably Managed Turf	12,700	12,700		6%	22%	1%	0.05		
Riparian Corridor Example Site	128,820	7.2	Stream / Riparian Rehabilitation			2,000		0.0035 lbs/foot		7.00	7.00	97%
TOTAL	**1,832,020**	**27.6**		**1,309,060**	**1,521,900**	**2,000**					**15.6**	**57%**

EXISTING ANNUAL TP LOAD AND EXTRAPOLATED ANNUAL TP REDUCTION FOR EACH PRECINCT

Precinct	Total Area (acres)	Total Area (square feet)	Total Lenth (feet)	Unit Load (lbs/acre/year)	Unit Load (lbs/feet)	Annual TP Load from Precinct (lbs/year)	Fraction of Annual TP Load Removed for Example Site (%)	Projected, Potential Annual TP Load Removed for Precinct (lbs/year)
High Density Residential	50.0	2,176,258	[redacted]	0.774	[redacted]	38.7	52%	20.0
Medium Density Residential	75.1	3,272,663	[redacted]	0.774	[redacted]	58.2	37%	21.5
Commercial	48.5	2,112,660	[redacted]	0.774	[redacted]	37.5	44%	16.3
Public Open Space	103.2	4,493,214	[redacted]	0.273	[redacted]	28.2	31%	8.7
Major Rights-of-Way	27.3	1,189,624	[redacted]	0.774	[redacted]	21.1	33%	6.9
Institutional	122.3	5,328,695	[redacted]	0.774	[redacted]	94.7	48%	45.3
Riparian Corridor								0.0
Riparian Buffer	7.7	333,234	[redacted]	0.06	[redacted]	0.5	N/A	0.0
Stream Channel	[redacted]	[redacted]	4,610	[redacted]	0.0035	16.1	97%	15.7
TOTAL	**434.0**	**18,906,347**				**294.9**		**134.6**

Attachment D
Planning-Level Design and Construction Cost Estimates for the Example Sites

Precinct Example Site	BMP Type	Estimated Drainage Area (acres)	Construction Unit Cost - Lower End ($/ac treated)	Construction Unit Cost - Upper End ($/ac treated)	Construction Cost - Lower End ($)	Construction Cost - Upper End ($)	Design Cost - Lower End ($)	Design Cost - Upper End ($)	Total Cost– Lower End ($)	Total Cost – Upper End ($)
High Density Residential	Biofiltration	3.3	$25,400	$200,000	$83,209	$655,188	$33,284	$262,075	$116,492	$917,264
	Green Roofs	0.5	$28,000	$200,000	$14,591	$104,224	$5,837	$41,690	$20,428	$145,914
	Permeable Pavement	1.0	$130,000	$435,000	$133,701	$447,383	$53,480	$178,953	$187,181	$626,336
	Sheetflow to Conservation Area	0.3	$7,500	$12,700	$2,410	$4,082	$964	$1,633	$3,375	$5,714
	Sustainably Managed Turf	0.5	$7,500	$12,700	$3,994	$6,764	$1,598	$2,706	$5,592	$9,470
Medium Density Residential	Landscape Conversion	0.1	$7,500	$12,700	$826	$1,399	$331	$560	$1,157	$1,959
	Biofiltration	0.2	$25,400	$200,000	$5,423	$42,700	$2,169	$17,080	$7,592	$59,780
	Permeable Pavement	0.3	$130,000	$435,000	$40,588	$135,813	$16,235	$54,325	$56,823	$190,138
	Downspout Disconnection to Rain Barrels	0.1	$-	$298,000	$-	$33,522	$-	$13,409	$-	$46,930
	Sustainably Managed Turf	1.0	$7,500	$12,700	$7,145	$12,099	$2,858	$4,840	$10,003	$16,939
Commercial	Landscape Conversion	0.7	$7,500	$12,700	$5,028	$8,513	$2,011	$3,405	$7,039	$11,919
	Biofiltration	0.8	$25,400	$200,000	$19,767	$155,647	$7,907	$62,259	$27,674	$217,906
	Green Roofs	0.7	$28,000	$200,000	$18,834	$134,527	$7,534	$53,811	$26,367	$188,338
	Permeable Pavement	0.8	$130,000	$435,000	$104,752	$350,517	$41,901	$140,207	$146,653	$490,723
Public Open Space	Landscape Conversion	1.3	$7,500	$12,700	$9,659	$16,356	$3,864	$6,542	$13,523	$22,898
	Biofiltration	2.6	$25,400	$200,000	$65,308	$514,233	$26,123	$205,693	$91,431	$719,927
	Sustainably Managed Turf	14.5	$7,500	$12,700	$108,815	$184,261	$43,526	$73,704	$152,342	$257,965
	Permeable Pavement	1.0	$130,000	$435,000	$124,747	$417,424	$49,899	$166,970	$174,646	$584,394

Precinct Example Site	BMP Type	Estimated Drainage Area (acres)	Construction Unit Cost - Lower End ($/ac treated)	Construction Unit Cost - Upper End ($/ac treated)	Construction Cost - Lower End ($)	Construction Cost - Upper End ($)	Design Cost - Lower End ($)	Design Cost - Upper End ($)	Total Cost– Lower End ($)	Total Cost – Upper End ($)
Major Rights-of-Way	Biofiltration	0.9	$25,400	$200,000	$21,691	$170,799	$8,677	$68,320	$30,368	$239,118
Institutional	Landscape Conversion	0.9	$7,500	$12,700	$6,784	$11,487	$2,713	$4,595	$9,497	$16,082
	Biofiltration	2.0	$25,400	$200,000	$51,896	$408,632	$20,758	$163,453	$72,655	$572,084
	Green Roofs	0.8	$28,000	$200,000	$21,791	$155,647	$8,716	$62,259	$30,507	$217,906
	Permeable Pavement	0.4	$130,000	$435,000	$56,107	$187,741	$22,443	$75,096	$78,549	$262,837
	Sustainably Managed Turf	0.3	$7,500	$12,700	$2,187	$3,703	$875	$1,481	$3,061	$5,184

Attachment E
Water Quality Benefits of Individual Wetlands

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WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
1	-81.3646997	41.2009756	1.176	2.3	0.3	470	522	487.5	509
2	-81.3637223	41.2012329	1.387	2.8	0.4	422	478	443	459
3	-81.3713463	41.2020119	27.266	54.4	6.9	27	97	54	53
6	-81.3731639	41.1999655	18.855	37.6	4.8	39	126	35.5	66
7	-81.3684803	41.1972022	2.204	4.4	0.6	308	379	330	351
8	-81.3654391	41.1963100	4.745	9.5	1.2	156	247	182.5	192
10	-81.3728661	41.1951603	1.418	2.8	0.4	419	475	439.5	456
11	-81.3804311	41.1970831	16.462	32.8	4.2	47	173	75	73
12	-81.3630038	41.1918465	4.743	9.5	1.2	157	136	183.5	193
13	-81.3559566	41.1906602	5.694	11.4	1.4	133	28	160.5	163
14	-81.3605927	41.1790180	0.749	1.5	0.2	619	656	628.5	652
15	-81.3626208	41.1790100	0.500	1.0	0.1	715	745	721	742
16	-81.3619331	41.1813350	1.023	2.0	0.3	511	557	527	547
17	-81.3603551	41.1825799	2.521	5.0	0.6	278	140	301	321
18	-81.3572661	41.1823819	0.741	1.5	0.2	625	661	633.5	657
19	-81.3611997	41.1884264	2.597	5.2	0.7	266	340	290	309
20	-81.3372634	41.2269068	8.116	16.2	2.1	97	26	84	125
21	-81.3348273	41.2276578	0.737	1.5	0.2	627	663	635	659
22	-81.3333605	41.2266873	8.715	17.4	2.2	89	23	76.5	118
23	-81.3349037	41.2239048	3.907	7.8	1.0	180	30	206.5	217
24	-81.3360583	41.2315171	0.096	0.2	0.0	927	936	930	939
25	-81.3464746	41.2259982	2.316	4.6	0.6	299	370	320.5	341
26	-81.3526485	41.2281228	1.043	2.1	0.3	502	550	517.5	538
27	-81.3517152	41.2294792	2.708	5.4	0.7	259	333	284	302
28	-81.3424258	41.2277601	2.340	4.7	0.6	294	365	316	336
29	-81.3410832	41.2289768	1.814	3.6	0.5	351	416	373	393
30	-81.3423893	41.2268186	0.555	1.1	0.1	696	728	702.5	725
31	-81.3503214	41.2349573	5.320	10.6	1.3	143	236	117.5	173
32	-81.3597601	41.2325987	7.766	15.5	2.0	102	202	87.5	132
33	-81.3596520	41.2346564	34.147	68.1	8.7	20	95	18.5	41
34	-81.3691239	41.2314537	8.042	16.0	2.0	98	199	127	127
35	-81.3656170	41.2293586	14.633	29.2	3.7	53	176	82.5	79
36	-81.3755211	41.2310867	9.606	19.2	2.4	79	20	68.5	46
37	-81.3702592	41.2319273	36.081	72.0	9.1	19	9	17.5	40
38	-81.3753074	41.2340240	13.121	26.2	3.3	58	16	50.5	36
39	-81.3755798	41.2375318	37.630	75.1	9.5	17	7	15.5	10
40	-81.3793594	41.2365811	3.606	7.2	0.9	190	31	217.5	95
41	-81.3783088	41.2358818	17.670	35.2	4.5	45	15	72.5	25
42	-81.3779322	41.2375569	17.727	35.4	4.5	44	14	40.5	24
43	-81.3770667	41.2298490	11.200	22.3	2.8	68	17	96.5	96
44	-81.3792275	41.2339821	20.640	41.2	5.2	37	169	64	63
45	-81.3809652	41.2385536	5.974	11.9	1.5	129	226	157	158
46	-81.3813792	41.2378579	2.593	5.2	0.7	268	342	292	311
47	-81.3800280	41.2300445	3.011	6.0	0.8	229	156	255	269
48	-81.3798854	41.2256789	1.125	2.2	0.3	483	533	500	522
49	-81.3764761	41.2273758	2.384	4.8	0.6	289	361	229	332
50	-81.3750482	41.2256343	15.724	31.4	4.0	51	127	45	77
51	-81.3735990	41.2245875	3.637	7.3	0.9	189	275	216.5	224
52	-81.3580558	41.2267437	1.032	2.1	0.3	509	145	525	545
53	-81.3563672	41.2265450	1.686	3.4	0.4	367	432	390	411
54	-81.3602395	41.2272305	2.759	5.5	0.7	253	329	277	296
55	-81.3625264	41.2238217	1.729	3.4	0.4	361	426	383.5	404
56	-81.3368835	41.2580954	1.101	2.2	0.3	490	144	506	529
57	-81.3364404	41.2535733	2.200	4.4	0.6	309	380	331	353
58	-81.3407972	41.2558893	1.796	3.6	0.5	355	420	283	397
59	-81.3425256	41.2562870	1.600	3.2	0.4	390	141	412	432
60	-81.3435829	41.2571673	0.756	1.5	0.2	612	118	620.5	644
61	-81.3674588	41.2394009	1.033	2.1	0.3	505	553	522	542
62	-81.3669244	41.2418724	3.539	7.1	0.9	193	278	157	228
63	-81.3683272	41.2407928	7.708	15.4	2.0	103	203	131.5	133
64	-81.3648393	41.2407394	6.851	13.7	1.7	111	211	95	141
65	-81.3654360	41.2441549	2.925	5.8	0.7	240	318	192.5	281
66	-81.3623821	41.2425867	2.102	4.2	0.5	318	388	339.5	362
67	-81.3620532	41.2417052	3.565	7.1	0.9	192	277	220	227
69	-81.3620868	41.2460535	2.037	4.1	0.5	325	393	346.5	369
70	-81.3619043	41.2443047	3.272	6.5	0.8	208	289	169.5	245
71	-81.3586588	41.2443696	0.932	1.9	0.2	541	584	463	579
76	-81.3742679	41.2485939	9.584	19.1	2.4	80	191	69.5	108
77	-81.3688371	41.2503524	3.452	6.9	0.9	197	155	224	235
78	-81.3711565	41.2505803	0.884	1.8	0.2	565	160	577.5	599
79	-81.3700441	41.2499288	1.442	2.9	0.4	417	158	437.5	454
80	-81.3768777	41.2407895	17.915	35.7	4.5	42	170	38.5	70
81	-81.3784014	41.2421411	25.951	51.8	6.6	31	92	28.5	56
82	-81.3812860	41.2451188	20.103	40.1	5.1	38	13	66	22
83	-81.3816376	41.2408249	6.876	13.7	1.7	110	210	94	140
84	-81.3785399	41.2505029	2.712	5.4	0.7	258	332	282.5	301
85	-81.3827102	41.2495846	0.881	1.8	0.2	567	606	579	289
86	-81.3815345	41.2507064	1.087	2.2	0.3	491	540	507	230
87	-81.3496920	41.2462122	3.095	6.2	0.8	221	301	247.5	259
88	-81.3479842	41.2489039	1.019	2.0	0.3	513	559	529	549
89	-81.3573489	41.2717309	0.666	1.3	0.2	656	689	662	688
90	-81.3715511	41.2745074	0.501	1.0	0.1	714	744	719.5	428

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
91	-81.3746950	41.2746826	15.079	30.1	3.8	52	175	46	29
92	-81.3785231	41.2703330	20.798	41.5	5.3	36	85	33.5	21
93	-81.3815811	41.2701439	27.247	54.3	6.9	28	167	25.5	15
94	-81.3774228	41.2692963	3.370	6.7	0.9	204	285	165.5	100
95	-81.3411665	41.2661004	1.971	3.9	0.5	330	397	352	373
96	-81.3426715	41.2705538	1.631	3.3	0.4	381	446	404	424
97	-81.3502787	41.2808017	3.010	6.0	0.8	230	309	184.5	270
99	-81.3782102	41.2772445	6.309	12.6	1.6	120	218	149.5	64
100	-81.3810742	41.2771237	4.262	8.5	1.1	171	259	195.5	80
102	-81.3782254	41.2787372	12.874	25.7	3.3	61	180	53.5	37
103	-81.3850784	41.2771873	244.868	488.4	62.0	1	1	1	1
109	-81.3912221	41.2613379	1.246	2.5	0.3	452	142	470.5	489
110	-81.3891073	41.2596155	3.727	7.4	0.9	184	270	212.5	220
111	-81.3897119	41.2577111	3.058	6.1	0.8	225	305	251.5	263
112	-81.3896970	41.2569055	10.375	20.7	2.6	72	188	102.5	103
113	-81.3841345	41.2439400	45.142	90.0	11.4	12	5	11.5	33
114	-81.3842402	41.2472731	10.873	21.7	2.8	70	18	99.5	101
115	-81.3872195	41.2478112	5.377	10.7	1.4	139	233	114.5	168
117	-81.3863832	41.2530212	0.560	1.1	0.1	692	725	699	722
118	-81.3863300	41.2523802	0.842	1.7	0.2	580	618	591.5	613
119	-81.3867546	41.2514893	1.625	3.2	0.4	384	448	406	426
120	-81.3884916	41.2525285	1.583	3.2	0.4	391	454	413.5	433
121	-81.3906933	41.2494386	9.514	19.0	2.4	82	130	110	109
122	-81.3898845	41.2445203	0.749	1.5	0.2	620	657	629.5	653
123	-81.3885794	41.2383415	0.448	0.9	0.1	743	774	748.5	777
124	-81.3917398	41.2315656	0.490	1.0	0.1	718	748	724	751
125	-81.3900740	41.2319116	1.810	3.6	0.5	352	417	374	394
126	-81.3892914	41.2308369	0.560	1.1	0.1	693	726	700	723
127	-81.3840573	41.2295847	2.088	4.2	0.5	320	157	341.5	363
128	-81.3880153	41.2291661	0.688	1.4	0.2	645	161	652.5	676
129	-81.3898821	41.2298696	1.250	2.5	0.3	450	503	468	487
130	-81.3857853	41.2230827	2.786	5.6	0.7	251	139	274	294
131	-81.3875764	41.2212261	2.915	5.8	0.7	243	321	266	284
132	-81.3910254	41.2138090	1.843	3.7	0.5	347	150	369.5	388
133	-81.3885681	41.2140579	1.985	4.0	0.5	329	396	351	372
134	-81.3892171	41.2170230	0.381	0.8	0.1	779	806	781.5	807
135	-81.3905047	41.2169044	1.005	2.0	0.3	518	564	533.5	553
136	-81.3883816	41.2175089	2.334	4.7	0.6	297	368	318.5	339
137	-81.3862712	41.2159973	13.349	26.6	3.4	56	128	48.5	83
138	-81.3833847	41.2184235	0.818	1.6	0.2	590	628	599.5	622
139	-81.3860633	41.2091441	7.132	14.2	1.8	106	206	90.5	136
140	-81.3837864	41.2078405	1.674	3.3	0.4	368	433	391	413
141	-81.3856396	41.2071404	6.307	12.6	1.6	121	219	101.5	148
142	-81.3826389	41.2059030	1.626	3.2	0.4	383	447	304	425
143	-81.3706637	41.2132491	13.348	26.6	3.4	57	129	49.5	35
144	-81.3670091	41.2106778	45.096	90.0	11.4	13	6	12.5	8
145	-81.3688188	41.2090188	29.743	59.3	7.5	23	10	21.5	13
146	-81.3694005	41.2087489	4.864	9.7	1.2	153	244	179	76
147	-81.3616063	41.2104888	0.400	0.8	0.1	768	55	772	524
148	-81.3695564	41.2187466	33.183	66.2	8.4	22	96	20.5	44
149	-81.3703798	41.2152646	10.708	21.4	2.7	71	187	61	102
150	-81.3642643	41.2127952	3.934	7.8	1.0	178	29	204.5	88
151	-81.3657813	41.2197299	3.184	6.4	0.8	214	294	239.5	251
152	-81.3646464	41.2152175	10.047	20.0	2.5	75	190	64.5	45
153	-81.3589526	41.2145028	12.486	24.9	3.2	65	183	57	90
154	-81.3625715	41.2210499	5.020	10.0	1.3	151	243	176.5	184
155	-81.3749365	41.2191955	1.604	3.2	0.4	389	453	309	431
156	-81.3744927	41.2189230	12.894	25.7	3.3	60	179	52.5	85
157	-81.3826121	41.2126771	0.232	0.5	0.1	862	154	862.5	884
158	-81.3805640	41.2188634	0.290	0.6	0.1	834	858	835.5	858
159	-81.3808804	41.2225868	0.937	1.9	0.2	536	579	550.5	574
160	-81.3792552	41.2238008	2.976	5.9	0.8	235	313	260	274
161	-81.3580615	41.2217136	5.146	10.3	1.3	149	105	174.5	182
162	-81.3616172	41.2227739	3.495	7.0	0.9	195	280	222.5	232
163	-81.3573440	41.2186395	9.174	18.3	2.3	84	132	73	114
164	-81.3767574	41.2222086	0.376	0.8	0.1	782	810	785	812
165	-81.3606202	41.2042192	4.072	8.1	1.0	174	262	200.5	210
167	-81.3527884	41.2071199	1.232	2.5	0.3	455	507	475	493
168	-81.3527246	41.2065342	0.947	1.9	0.2	528	573	542.5	567
169	-81.3493150	41.2092541	1.272	2.5	0.3	445	499	463.5	483
170	-81.3480380	41.2077106	1.453	2.9	0.4	415	472	435.5	452
171	-81.3451194	41.2086791	0.546	1.1	0.1	698	731	705	728
172	-81.3472968	41.2106017	2.487	5.0	0.6	281	353	303.5	323
173	-81.3371435	41.2239574	2.727	5.4	0.7	257	35	281	300
174	-81.3407274	41.2234360	1.152	2.3	0.3	475	526	492	514
175	-81.3410606	41.2185972	3.656	7.3	0.9	187	273	153	222
176	-81.3705223	41.2806812	2.746	5.5	0.7	255	330	279	116
177	-81.3660610	41.2827324	1.223	2.4	0.3	458	510	379	215
178	-81.3681278	41.2795625	4.182	8.3	1.1	172	260	141.5	81
179	-81.3614987	41.2842523	1.350	2.7	0.3	432	487	350	470
180	-81.3628854	41.2834505	1.552	3.1	0.4	400	462	318.5	442
181	-81.3596499	41.2799897	2.466	4.9	0.6	283	355	224.5	325

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
182	-81.3548575	41.2839268	2.790	5.6	0.7	250	327	273	293
183	-81.3554715	41.2755985	1.556	3.1	0.4	398	460	317	440
184	-81.3768015	41.2816632	80.391	160.4	20.4	4	120	4	4
185	-81.3734248	41.2857272	64.833	129.3	16.4	6	121	6	6
186	-81.3666767	41.2876395	0.318	0.6	0.1	811	834	812	609
187	-81.3801602	41.2908749	18.724	37.3	4.7	40	98	36.5	67
188	-81.3841138	41.2938196	0.707	1.4	0.2	635	671	642	667
189	-81.3817017	41.2949296	2.036	4.1	0.5	326	394	347.5	370
190	-81.3793957	41.2957551	1.193	2.4	0.3	466	518	483.5	505
191	-81.3814975	41.2965134	2.355	4.7	0.6	293	364	315	335
192	-81.3824348	41.2978422	4.489	9.0	1.1	161	250	188	196
193	-81.3856179	41.2990861	40.153	80.1	10.2	16	165	40.5	39
194	-81.3797831	41.2982603	0.430	0.9	0.1	756	785	760	786
195	-81.3795330	41.2990265	0.188	0.4	0.0	883	899	883.5	901
196	-81.3772042	41.2989102	1.038	2.1	0.3	503	551	518.5	539
197	-81.3814754	41.3048551	6.514	13.0	1.7	117	215	146.5	145
198	-81.3824654	41.3028088	0.714	1.4	0.2	633	669	640	665
199	-81.3802792	41.3022051	3.254	6.5	0.8	209	290	235	246
200	-81.3780418	41.3043421	1.893	3.8	0.5	341	407	364	383
201	-81.3776971	41.3023146	9.770	19.5	2.5	78	93	67.5	106
202	-81.3804612	41.3059939	0.664	1.3	0.2	657	690	663.5	689
203	-81.3852691	41.3062398	5.971	11.9	1.5	130	227	158	159
204	-81.3774298	41.3090002	6.014	12.0	1.5	127	224	107	156
205	-81.3775650	41.3075370	0.677	1.4	0.2	650	685	572.5	683
206	-81.3769268	41.3072503	0.827	1.6	0.2	584	624	507.5	619
207	-81.3769026	41.2977170	0.878	1.8	0.2	570	609	582	604
208	-81.3689831	41.3077139	1.393	2.8	0.4	421	477	441.5	458
209	-81.3728780	41.3116738	0.358	0.7	0.1	789	816	791.5	818
210	-81.3803186	41.3124150	18.026	36.0	4.6	41	99	37.5	69
211	-81.3790035	41.3109341	3.136	6.3	0.8	216	296	175	253
212	-81.3769909	41.3152937	1.067	2.1	0.3	497	545	512.5	534
213	-81.3817520	41.3154590	0.963	1.9	0.2	527	572	541.5	564
214	-81.3471105	41.3030899	0.906	1.8	0.2	551	592	564	587
215	-81.3450677	41.3033919	0.670	1.3	0.2	654	688	660	686
216	-81.3578109	41.3050628	0.445	0.9	0.1	745	775	699	778
217	-81.3577442	41.3079318	0.504	1.0	0.1	712	742	717.5	740
218	-81.3586209	41.3007716	4.335	8.6	1.1	168	106	192.5	204
219	-81.3483420	41.2855451	0.843	1.7	0.2	579	617	497.5	612
220	-81.3481463	41.2879961	0.809	1.6	0.2	596	634	605	628
221	-81.3485564	41.2946004	0.885	1.8	0.2	564	605	482.5	598
222	-81.3650686	41.3377522	1.225	2.4	0.3	457	509	377.5	495
223	-81.3651362	41.3415853	1.207	2.4	0.3	461	513	479.5	500
224	-81.3596324	41.3201384	0.469	0.9	0.1	731	762	737	765
225	-81.3543372	41.3184770	0.923	1.8	0.2	545	587	558.5	583
226	-81.3561714	41.3232631	0.757	1.5	0.2	611	649	535	643
227	-81.3568535	41.3195849	3.643	7.3	0.9	188	274	154	223
228	-81.3571990	41.3235122	0.742	1.5	0.2	623	659	542	655
229	-81.3607917	41.3287240	0.121	0.2	0.0	910	921	910	924
230	-81.3640383	41.3308938	0.183	0.4	0.0	885	901	885.5	903
231	-81.3695379	41.3385671	1.625	3.2	0.4	385	449	305.5	427
232	-81.3735537	41.3402928	0.815	1.6	0.2	593	632	603	626
233	-81.3787075	41.3384522	1.165	2.3	0.3	472	143	489.5	511
234	-81.3761493	41.3426826	29.700	59.2	7.5	24	123	50	48
235	-81.3796096	41.3400353	4.301	8.6	1.1	169	257	193.5	205
236	-81.3815975	41.3410476	6.410	12.8	1.6	119	217	148.5	147
237	-81.3829540	41.3485766	15.753	31.4	4.0	49	100	79.5	75
238	-81.3767959	41.3358677	1.368	2.7	0.3	427	483	447.5	465
239	-81.3808000	41.3383723	0.788	1.6	0.2	601	639	524.5	633
240	-81.3824166	41.3374364	1.336	2.7	0.3	433	488	351.5	471
241	-81.3772335	41.3347373	1.692	3.4	0.4	365	430	388	409
242	-81.3736105	41.3340394	0.313	0.6	0.1	816	839	816.5	840
243	-81.3734124	41.3353566	0.159	0.3	0.0	897	912	897	914
244	-81.3761601	41.3324471	2.242	4.5	0.6	304	375	326	347
245	-81.3716879	41.3316674	1.008	2.0	0.3	517	563	532.5	552
246	-81.3791101	41.3336417	6.285	12.5	1.6	124	133	152.5	151
247	-81.3724915	41.3370783	1.154	2.3	0.3	474	525	397.5	513
248	-81.3693147	41.3369446	0.105	0.2	0.0	920	928	920	932
249	-81.3704694	41.3363053	0.210	0.4	0.1	872	890	872	891
250	-81.3690130	41.3355540	0.173	0.3	0.0	889	906	890.5	908
251	-81.3677102	41.3334469	0.214	0.4	0.1	871	889	871	890
252	-81.3633104	41.3241743	1.355	2.7	0.3	431	90	348.5	469
253	-81.3677793	41.3231682	1.297	2.6	0.3	441	495	362	479
254	-81.3727169	41.3244085	5.185	10.3	1.3	148	241	122.5	181
255	-81.3799756	41.3236625	1.498	3.0	0.4	411	468	431.5	448
256	-81.3781073	41.3240925	1.957	3.9	0.5	333	400	355	376
257	-81.3811820	41.3256762	0.575	1.1	0.1	686	718	692	716
258	-81.3812113	41.3244348	0.080	0.2	0.0	936	942	935.5	945
259	-81.3743495	41.3208246	6.288	12.5	1.6	122	220	102.5	149
260	-81.3697207	41.3169447	0.723	1.4	0.2	630	666	551	662
261	-81.3755560	41.3406121	7.804	15.6	2.0	101	201	130	131
262	-81.3771698	41.3404389	2.525	5.0	0.6	277	350	300	320
263	-81.3865662	41.3383754	1.033	2.1	0.3	506	554	523	543

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
264	-81.3844275	41.3409649	5.478	10.9	1.4	138	232	166	167
265	-81.3840578	41.3394821	0.414	0.8	0.1	764	792	767	792
266	-81.3835329	41.3383554	1.444	2.9	0.4	416	473	436.5	453
267	-81.3828025	41.3391834	0.319	0.6	0.1	809	119	810	833
268	-81.3890394	41.3377213	3.448	6.9	0.9	198	282	225	236
269	-81.3888538	41.3212990	4.411	8.8	1.1	165	254	190.5	201
270	-81.3846042	41.3187819	1.356	2.7	0.3	430	486	450.5	468
271	-81.3859477	41.3203919	0.472	0.9	0.1	730	760	735	763
272	-81.3840327	41.3206990	0.448	0.9	0.1	744	773	747.5	776
273	-81.3840323	41.3194768	0.324	0.6	0.1	807	831	808	831
275	-81.3912764	41.3193706	1.129	2.3	0.3	482	159	499	521
276	-81.3837060	41.3172083	0.527	1.1	0.1	703	734	708.5	733
277	-81.3872851	41.3149958	7.935	15.8	2.0	100	200	128.5	129
278	-81.3962488	41.3153961	42.341	84.5	10.7	15	81	39	9
279	-81.3878711	41.3104554	50.281	100.3	12.7	9	80	9	28
280	-81.3896401	41.3061584	13.525	27.0	3.4	55	178	85.5	82
281	-81.3842561	41.3075009	4.295	8.6	1.1	170	258	194.5	206
282	-81.3864898	41.3036717	45.381	90.5	11.5	11	164	36	32
283	-81.3904621	41.3010799	3.101	6.2	0.8	220	300	246.5	258
284	-81.3914000	41.3021329	1.803	3.6	0.5	353	419	376	396
286	-81.3900293	41.2997025	5.373	10.7	1.4	140	234	167.5	169
287	-81.3859818	41.2974414	1.170	2.3	0.3	471	523	488.5	510
288	-81.3898092	41.2850724	0.566	1.1	0.1	690	722	696	390
289	-81.3857062	41.2875817	17.804	35.5	4.5	43	171	39.5	23
291	-81.3864857	41.2891485	6.686	13.3	1.7	114	213	97	60
292	-81.3634832	41.3122323	0.676	1.3	0.2	652	686	658	684
293	-81.3554862	41.3244852	1.205	2.4	0.3	463	516	385	503
294	-81.3702595	41.2773060	3.007	6.0	0.8	232	310	186	107
295	-81.3907408	41.3541802	2.474	4.9	0.6	282	354	304.5	324
296	-81.3922253	41.3492051	0.389	0.8	0.1	774	802	777.5	802
297	-81.3910890	41.3489009	2.056	4.1	0.5	322	149	344	365
298	-81.3886006	41.3484807	0.358	0.7	0.1	790	162	790.5	817
299	-81.3871330	41.3485145	0.611	1.2	0.2	673	706	680	704
301	-81.3947074	41.3494809	1.321	2.6	0.3	436	491	455.5	474
302	-81.4985349	41.4649516	0.449	0.9	0.1	741	772	746.5	775
303	-81.5552493	41.3992377	0.279	0.6	0.1	840	862	840.5	861
304	-81.5546605	41.3995561	0.262	0.5	0.1	849	870	850.5	869
305	-81.5359075	41.4023743	1.033	2.1	0.3	507	151	429.5	541
306	-81.5582298	41.3934060	0.606	1.2	0.2	675	708	602	706
307	-81.5056115	41.4035057	1.528	3.0	0.4	406	465	426.5	445
308	-81.5172332	41.3927209	0.905	1.8	0.2	553	594	565.5	589
309	-81.5268482	41.3879705	0.314	0.6	0.1	813	836	813.5	837
310	-81.5305480	41.3857416	0.538	1.1	0.1	701	51	640.5	403
311	-81.5099385	41.3807657	0.439	0.9	0.1	747	53	751	490
312	-81.5082393	41.3841128	2.866	5.7	0.7	247	34	270	113
313	-81.4896514	41.3950185	0.291	0.6	0.1	832	856	833.5	857
314	-81.4820811	41.4001581	1.150	2.3	0.3	477	528	494	516
315	-81.4804126	41.4001756	0.162	0.3	0.0	893	909	893.5	911
316	-81.4910015	41.3914123	1.882	3.8	0.5	343	409	365.5	385
317	-81.4948874	41.3917915	0.430	0.9	0.1	757	786	713	787
318	-81.5017400	41.3835908	1.627	3.2	0.4	382	39	303	176
319	-81.4981992	41.3813971	1.528	3.0	0.4	407	41	323.5	187
320	-81.4958779	41.3796700	0.350	0.7	0.1	795	57	760.5	565
321	-81.4906856	41.3828510	0.677	1.4	0.2	651	684	571.5	682
322	-81.4922685	41.3862156	0.486	1.0	0.1	721	751	727	754
323	-81.4899719	41.3867566	0.749	1.5	0.2	621	655	627.5	651
324	-81.4911149	41.3897409	0.781	1.6	0.2	604	642	613	635
325	-81.4926074	41.3902657	0.352	0.7	0.1	794	819	795	820
326	-81.4866127	41.3872793	0.245	0.5	0.1	856	876	856.5	877
327	-81.4865320	41.3866236	0.330	0.7	0.1	802	826	803	826
328	-81.4864701	41.3820704	0.325	0.6	0.1	806	830	807	830
329	-81.4771332	41.3862211	1.654	3.3	0.4	374	439	397	171
330	-81.4734060	41.3832378	0.268	0.5	0.1	844	867	845.5	866
333	-81.4573155	41.4028912	1.561	3.1	0.4	396	458	418.5	438
334	-81.4653430	41.3995301	1.137	2.3	0.3	479	530	496	518
335	-81.4555426	41.3964953	0.505	1.0	0.1	711	741	716.5	739
336	-81.4477058	41.3960087	0.438	0.9	0.1	749	778	753	781
338	-81.4478454	41.3900379	1.859	3.7	0.5	345	411	367	387
339	-81.4557327	41.3885545	1.077	2.1	0.3	494	543	510	532
340	-81.4551374	41.3888426	0.314	0.6	0.1	814	837	814.5	838
341	-81.4545978	41.3888480	0.436	0.9	0.1	751	780	755	783
342	-81.4638027	41.3868287	0.295	0.6	0.1	828	851	828.5	852
343	-81.4552088	41.3853390	0.313	0.6	0.1	817	841	818.5	842
344	-81.4542561	41.3838214	0.429	0.9	0.1	758	787	761.5	788
345	-81.4965837	41.4577254	1.460	2.9	0.4	413	470	433.5	450
346	-81.4764103	41.4390609	1.555	3.1	0.4	399	461	420.5	441
347	-81.4662214	41.4339478	0.568	1.1	0.1	689	721	695	719
348	-81.4788597	41.4339138	0.489	1.0	0.1	719	749	725	752
349	-81.4768501	41.4314380	0.401	0.8	0.1	767	795	770	796
350	-81.4732367	41.4284758	0.297	0.6	0.1	825	849	826.5	850
351	-81.4679995	41.4291561	0.997	2.0	0.3	519	565	534.5	555
352	-81.4820441	41.4386847	0.340	0.7	0.1	799	823	799.5	823

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
353	-81.4831503	41.4370396	0.487	1.0	0.1	720	750	726	753
354	-81.4879052	41.4368718	0.109	0.2	0.0	918	927	917.5	931
355	-81.4895377	41.4370499	0.716	1.4	0.2	632	668	639	664
356	-81.4889724	41.4385555	0.190	0.4	0.0	880	897	880.5	899
357	-81.4929945	41.4396982	0.215	0.4	0.1	870	888	870	889
358	-81.4857239	41.4335332	0.498	1.0	0.1	716	746	722	749
359	-81.4839616	41.4320920	0.457	0.9	0.1	738	768	742.5	771
360	-81.4820519	41.4306804	0.819	1.6	0.2	588	626	598	620
361	-81.4869924	41.4302031	0.104	0.2	0.0	921	929	921	933
362	-81.4880836	41.4298513	0.115	0.2	0.0	916	926	917.5	930
363	-81.4872998	41.4287325	1.482	3.0	0.4	412	469	329	449
364	-81.4989527	41.4312554	0.259	0.5	0.1	852	872	852.5	871
365	-81.5057953	41.4426358	0.350	0.7	0.1	796	820	796.5	821
366	-81.5186850	41.4368779	1.162	2.3	0.3	473	524	490.5	512
367	-81.5825356	41.3629623	2.267	4.5	0.6	301	372	323	343
368	-81.5406494	41.3712521	0.313	0.6	0.1	818	840	817.5	841
369	-81.5398682	41.3712736	0.096	0.2	0.0	928	934	928	937
370	-81.5337466	41.3755134	5.213	10.4	1.3	146	239	120.5	179
371	-81.5304680	41.3754074	0.102	0.2	0.0	922	930	922	934
372	-81.5170116	41.3694169	0.987	2.0	0.3	521	567	536	557
373	-81.5098713	41.3734178	0.827	1.6	0.2	585	623	595.5	618
374	-81.5087163	41.3745116	0.182	0.4	0.0	886	902	886.5	904
375	-81.5074165	41.3756983	0.560	1.1	0.1	694	724	698	721
376	-81.5058572	41.3718324	0.295	0.6	0.1	829	853	830.5	854
377	-81.5049383	41.3677533	0.091	0.2	0.0	932	938	932	941
378	-81.4971155	41.3673844	1.827	3.6	0.5	349	414	278	391
379	-81.4952543	41.3781714	1.532	3.1	0.4	405	40	425.5	186
380	-81.4928225	41.3776820	8.121	16.2	2.1	95	25	82	55
381	-81.4902027	41.3764515	1.301	2.6	0.3	440	43	360	207
382	-81.4893882	41.3762771	1.068	2.1	0.3	496	45	419.5	234
383	-81.4882058	41.3781435	0.408	0.8	0.1	766	794	769	794
384	-81.4894169	41.3748453	0.527	1.1	0.1	704	52	709.5	408
385	-81.4868302	41.3766508	0.261	0.5	0.1	851	871	851.5	870
386	-81.4940314	41.3761741	0.287	0.6	0.1	837	58	837.5	646
387	-81.4862442	41.3679039	0.129	0.3	0.0	907	919	907	922
388	-81.4899544	41.3617712	0.314	0.6	0.1	815	838	815.5	839
389	-81.5231886	41.3642536	0.512	1.0	0.1	710	740	715.5	738
390	-81.5104433	41.3591899	0.262	0.5	0.1	850	869	849.5	868
391	-81.5121355	41.3569069	0.971	1.9	0.2	524	569	539	561
392	-81.5165761	41.3525192	0.399	0.8	0.1	771	798	774	799
393	-81.5178444	41.3530189	0.613	1.2	0.2	671	704	678	702
394	-81.5182955	41.3545130	0.479	1.0	0.1	727	758	733	759
395	-81.4921341	41.3550115	0.735	1.5	0.2	628	664	636	660
396	-81.4887099	41.3525881	0.268	0.5	0.1	845	866	844.5	865
397	-81.4866693	41.3611793	1.364	2.7	0.3	428	485	449.5	467
398	-81.4728423	41.3498407	1.753	3.5	0.4	359	424	286.5	401
399	-81.4723696	41.3563808	2.936	5.9	0.7	238	316	190.5	279
400	-81.4726404	41.3613104	2.635	5.3	0.7	264	338	211	307
401	-81.4687693	41.3594168	2.425	4.8	0.6	285	357	307.5	328
402	-81.4643140	41.3595011	0.895	1.8	0.2	560	601	573	594
403	-81.4747333	41.3669081	0.699	1.4	0.2	638	674	645	670
404	-81.4760510	41.3680454	0.696	1.4	0.2	639	676	647.5	671
405	-81.4788358	41.3667394	1.841	3.7	0.5	348	413	277	389
406	-81.4774766	41.3680369	1.204	2.4	0.3	465	517	386.5	504
407	-81.4803988	41.3687991	1.409	2.8	0.4	420	476	338.5	457
408	-81.4771513	41.3706191	1.124	2.2	0.3	484	534	501	523
410	-81.4585109	41.3721750	0.738	1.5	0.2	626	662	544.5	658
411	-81.4575662	41.3734038	0.694	1.4	0.2	641	677	648.5	672
412	-81.4559625	41.3757806	1.501	3.0	0.4	410	42	430.5	447
413	-81.4641251	41.3551795	0.934	1.9	0.2	538	581	552.5	576
414	-81.4565492	41.3583132	0.297	0.6	0.1	826	848	825.5	849
415	-81.4541385	41.3583566	2.198	4.4	0.6	310	381	246	354
416	-81.4543932	41.3526406	3.240	6.5	0.8	211	292	236.5	248
417	-81.4464873	41.3650863	0.517	1.0	0.1	709	739	654	737
418	-81.4310396	41.3753130	0.193	0.4	0.0	878	896	878.5	897
419	-81.4288226	41.3750112	1.504	3.0	0.4	409	467	429.5	446
420	-81.4247081	41.3565106	2.146	4.3	0.5	313	383	335	357
421	-81.4150857	41.3602260	1.252	2.5	0.3	449	502	467	486
422	-81.4169487	41.3533135	1.192	2.4	0.3	467	519	484.5	506
423	-81.4105221	41.3618327	2.209	4.4	0.6	307	378	329	350
424	-81.4133825	41.3634708	0.933	1.9	0.2	539	582	553.5	577
425	-81.4048532	41.3582540	7.097	14.2	1.8	107	207	137	137
426	-81.4032426	41.3583599	0.099	0.2	0.0	925	932	925	936
427	-81.4048804	41.3517493	1.926	3.8	0.5	339	405	269	382
431	-81.3946777	41.3495722	2.669	5.3	0.7	263	337	287.5	305
432	-81.3967843	41.3505212	3.124	6.2	0.8	218	298	244.5	256
433	-81.5203387	41.4090079	0.883	1.8	0.2	566	117	484	600
434	-81.5210720	41.4110252	0.819	1.6	0.2	589	627	511	621
435	-81.5216660	41.4220817	0.833	1.7	0.2	582	620	503.5	615
436	-81.4758528	41.4275596	0.300	0.6	0.1	822	845	822.5	846
437	-81.4744557	41.4256754	0.298	0.6	0.1	823	846	823.5	847
438	-81.4700005	41.4276289	0.121	0.2	0.0	911	922	911	925

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
439	-81.4740431	41.4167113	0.392	0.8	0.1	773	800	775.5	530
440	-81.4707192	41.4143493	0.200	0.4	0.1	877	895	877	743
441	-81.4697517	41.4148340	0.400	0.8	0.1	769	797	773	798
442	-81.4643486	41.4163139	0.571	1.1	0.1	688	720	694	718
443	-81.4640303	41.4176036	0.485	1.0	0.1	722	753	728.5	756
444	-81.4630340	41.4182884	0.389	0.8	0.1	775	801	776.5	801
445	-81.4618353	41.4129734	0.546	1.1	0.1	699	730	704	399
446	-81.4760045	41.4045893	0.224	0.4	0.1	865	884	865.5	727
447	-81.4803571	41.4129825	0.209	0.4	0.1	873	892	874	893
448	-81.4796727	41.4144921	0.627	1.3	0.2	667	700	674	698
449	-81.4873943	41.4131701	0.263	0.5	0.1	848	868	824.5	867
450	-81.4669095	41.4043066	0.717	1.4	0.2	631	667	552	663
451	-81.4565656	41.4063023	0.329	0.7	0.1	803	827	804	827
452	-81.4568024	41.4072966	0.327	0.7	0.1	804	828	805	828
453	-81.4514699	41.4054152	0.604	1.2	0.2	676	709	682.5	707
454	-81.4773092	41.4279259	1.244	2.5	0.3	453	505	471.5	491
455	-81.5729693	41.3835358	0.201	0.4	0.1	876	894	876	896
456	-81.5500251	41.4002071	0.428	0.9	0.1	759	789	715.5	789
457	-81.5014609	41.4032829	0.135	0.3	0.0	904	916	904	919
458	-81.4458354	41.3936519	0.086	0.2	0.0	934	940	933.5	943
459	-81.5057653	41.3734813	0.756	1.5	0.2	613	650	621.5	645
460	-81.5767959	41.3793323	2.011	4.0	0.5	328	38	349.5	146
461	-81.5201634	41.4434216	2.586	5.2	0.7	269	343	215	312
462	-81.5102978	41.4509290	0.980	2.0	0.2	522	152	537	559
463	-81.5110300	41.4491804	1.109	2.2	0.3	487	537	409.5	527
464	-81.5066736	41.4337904	0.658	1.3	0.2	658	691	665	690
465	-81.4849777	41.4431186	0.400	0.8	0.1	770	796	771	797
466	-81.4920248	41.4536474	1.055	2.1	0.3	498	546	514	535
467	-81.4960594	41.4506942	2.747	5.5	0.7	254	108	278	297
468	-81.4965236	41.4479933	1.615	3.2	0.4	387	451	409	429
469	-81.4889923	41.4382301	0.277	0.6	0.1	841	863	841.5	862
470	-81.4898276	41.4319039	1.660	3.3	0.4	372	437	297	417
471	-81.4908436	41.4293512	1.957	3.9	0.5	334	110	356	377
472	-81.4725324	41.4347065	0.296	0.6	0.1	827	850	827.5	851
473	-81.4715738	41.4346793	0.584	1.2	0.1	683	715	689	713
474	-81.5214517	41.4055265	7.184	14.3	1.8	105	205	89.5	135
475	-81.5023299	41.4272140	3.296	6.6	0.8	207	288	233	243
476	-81.4898480	41.4278820	0.334	0.7	0.1	800	824	801	824
477	-81.4882497	41.4272283	0.816	1.6	0.2	591	630	601	624
478	-81.4832423	41.4263143	1.288	2.6	0.3	443	497	461.5	481
479	-81.4768587	41.4201311	1.324	2.6	0.3	435	490	355	473
480	-81.4583381	41.4131929	0.173	0.3	0.0	890	905	889.5	746
481	-81.4731857	41.4085767	0.518	1.0	0.1	707	737	712.5	412
482	-81.4771029	41.4082348	0.254	0.5	0.1	854	874	854.5	874
483	-81.4786859	41.4042981	3.934	7.8	1.0	179	266	205.5	216
484	-81.4756189	41.4050386	0.364	0.7	0.1	785	812	787	554
485	-81.4848225	41.4107263	4.550	9.1	1.2	160	249	131	195
486	-81.5337170	41.4039404	2.168	4.3	0.5	312	382	247.5	356
487	-81.5167315	41.3847228	0.681	1.4	0.2	648	49	570.5	352
488	-81.5178352	41.3838894	0.913	1.8	0.2	548	46	469.5	278
489	-81.5141554	41.3836927	0.596	1.2	0.2	679	50	608	381
490	-81.5119742	41.3933967	3.046	6.1	0.8	226	306	181	265
491	-81.5127978	41.3966979	5.850	11.7	1.5	132	228	110.5	161
492	-81.4893553	41.3822049	0.940	1.9	0.2	534	577	548.5	571
493	-81.4940660	41.3877936	1.655	3.3	0.4	373	438	396	418
494	-81.4775335	41.3828625	0.649	1.3	0.2	661	694	668	693
495	-81.4748842	41.3933761	0.434	0.9	0.1	752	782	757	494
496	-81.4754548	41.3950436	0.917	1.8	0.2	547	589	560.5	276
497	-81.4777638	41.4027982	0.945	1.9	0.2	530	574	544.5	264
498	-81.4773907	41.4037530	0.696	1.4	0.2	640	675	646.5	345
499	-81.4557579	41.3864321	3.192	6.4	0.8	213	148	238.5	250
500	-81.4542915	41.3858443	1.652	3.3	0.4	375	440	398	419
501	-81.4516594	41.3814184	0.669	1.3	0.2	655	153	661	687
503	-81.5358337	41.3652066	2.230	4.4	0.6	306	377	243	349
504	-81.5358517	41.3683731	3.104	6.2	0.8	219	299	245.5	257
505	-81.5358441	41.3698272	0.419	0.8	0.1	762	791	765	791
506	-81.5346982	41.3723985	0.389	0.8	0.1	776	803	778.5	803
507	-81.5130973	41.3710823	0.380	0.8	0.1	780	807	782.5	808
508	-81.5191796	41.3670137	0.479	1.0	0.1	728	757	732	758
509	-81.4864286	41.3744834	5.611	11.2	1.4	137	231	165	166
510	-81.4846211	41.3725062	1.387	2.8	0.4	423	479	341.5	460
511	-81.4886719	41.3632647	0.434	0.9	0.1	753	781	756	784
512	-81.4896051	41.3556287	0.289	0.6	0.1	836	859	836.5	859
513	-81.4839722	41.3557180	0.690	1.4	0.2	643	679	650.5	674
514	-81.4734837	41.3575314	2.931	5.8	0.7	239	317	191.5	280
515	-81.4656672	41.3621731	4.865	9.7	1.2	152	147	125	189
516	-81.4662891	41.3629998	1.933	3.9	0.5	337	403	359	380
517	-81.4638272	41.3640165	2.053	4.1	0.5	323	391	257.5	366
518	-81.4615460	41.3631734	0.334	0.7	0.1	801	825	802	825
519	-81.4564123	41.3599959	1.294	2.6	0.3	442	496	460.5	480
520	-81.4612748	41.3553583	0.933	1.9	0.2	540	583	554.5	578
521	-81.4621328	41.3669750	1.614	3.2	0.4	388	452	410	430

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
522	-81.4579007	41.3705197	0.879	1.8	0.2	569	608	581	603
523	-81.4819853	41.3679629	1.578	3.1	0.4	392	455	414.5	434
524	-81.4827398	41.3729729	0.379	0.8	0.1	781	808	744	809
525	-81.4817739	41.3726339	1.559	3.1	0.4	397	459	316	439
526	-81.4798371	41.3712764	4.573	9.1	1.2	158	248	185	194
527	-81.4809525	41.3709854	0.927	1.8	0.2	543	585	464.5	581
528	-81.4298977	41.3695219	10.038	20.0	2.5	76	102	65.5	104
529	-81.4286374	41.3690608	6.287	12.5	1.6	123	221	103.5	150
530	-81.4358657	41.3672025	1.943	3.9	0.5	335	401	357	378
531	-81.4360130	41.3658513	3.010	6.0	0.8	231	107	256.5	271
532	-81.4285267	41.3634433	12.747	25.4	3.2	63	101	55.5	87
533	-81.4204707	41.3635481	0.968	1.9	0.2	525	570	540	563
534	-81.4070365	41.3622497	3.073	6.1	0.8	223	303	249.5	261
535	-81.4073976	41.3562258	2.140	4.3	0.5	315	385	337	359
540	-81.4126844	41.3519445	1.130	2.3	0.3	481	532	498	520
541	-81.5854898	41.3619972	1.382	2.8	0.4	424	480	444.5	461
542	-81.5216028	41.3649566	2.519	5.0	0.6	279	351	221.5	322
543	-81.5083186	41.4515464	0.652	1.3	0.2	659	692	666	691
544	-81.4908547	41.4400449	0.816	1.6	0.2	592	629	513	623
545	-81.4917561	41.4443760	11.015	22.0	2.8	69	186	98.5	97
546	-81.4924950	41.4524981	3.851	7.7	1.0	182	268	149.5	218
547	-81.4869941	41.4458437	44.641	89.0	11.3	14	122	13.5	34
548	-81.4827962	41.4287949	0.942	1.9	0.2	531	115	545.5	569
549	-81.4755974	41.4346568	1.815	3.6	0.5	350	415	372	392
550	-81.4760353	41.4211004	9.807	19.6	2.5	77	103	66.5	105
551	-81.4715809	41.4150495	2.573	5.1	0.7	273	346	296	123
552	-81.4800153	41.4066841	5.234	10.4	1.3	145	238	171.5	178
553	-81.4713633	41.4071875	1.034	2.1	0.3	504	552	520.5	540
554	-81.4696448	41.4116975	1.536	3.1	0.4	403	464	424.5	185
555	-81.4650216	41.4110660	0.230	0.5	0.1	863	882	863.5	885
556	-81.4976730	41.3981970	4.449	8.9	1.1	163	252	134.5	198
557	-81.4995321	41.3879380	0.234	0.5	0.1	861	881	861.5	883
558	-81.4962055	41.3890514	1.269	2.5	0.3	446	500	368	484
559	-81.4904725	41.3881003	2.577	5.1	0.7	271	344	294	314
560	-81.5176469	41.3802756	3.395	6.8	0.9	202	32	228.5	98
561	-81.5057135	41.3827929	2.374	4.7	0.6	290	36	230	134
562	-81.5040456	41.3838762	3.395	6.8	0.9	203	33	229.5	99
563	-81.5038504	41.3736551	1.074	2.1	0.3	495	544	511	533
564	-81.5117830	41.3623543	0.895	1.8	0.2	561	602	574	595
565	-81.5006857	41.3633873	6.284	12.5	1.6	125	222	105	152
566	-81.4972502	41.3625152	4.095	8.2	1.0	173	261	143	208
567	-81.4944128	41.3509670	3.402	6.8	0.9	200	283	162	239
568	-81.4844293	41.3525023	28.447	56.7	7.2	26	124	24	51
569	-81.4910863	41.3636862	2.562	5.1	0.6	274	347	297	316
570	-81.4912119	41.3623002	0.750	1.5	0.2	617	654	626.5	650
571	-81.4866574	41.3698852	3.494	7.0	0.9	196	281	159.5	233
572	-81.4775442	41.3653993	2.339	4.7	0.6	295	366	233.5	337
573	-81.4746227	41.3683772	2.331	4.6	0.6	298	369	319.5	340
574	-81.4762469	41.3658851	3.245	6.5	0.8	210	291	171	247
575	-81.4526782	41.3511191	5.928	11.8	1.5	131	134	109.5	160
576	-81.4581397	41.3639385	9.347	18.6	2.4	83	131	112.5	111
577	-81.4559445	41.3646223	3.181	6.3	0.8	215	295	241	252
578	-81.4507461	41.3662421	2.066	4.1	0.5	321	390	343	364
579	-81.4915242	41.3792930	9.000	18.0	2.3	86	21	117	49
580	-81.4781956	41.3836336	1.796	3.6	0.5	356	421	377.5	162
581	-81.4639189	41.3688718	0.639	1.3	0.2	663	696	670	695
582	-81.4318995	41.3549602	16.398	32.7	4.2	48	174	76	74
583	-81.4189259	41.3582853	22.543	45.0	5.7	35	168	32.5	58
584	-81.4111140	41.3592721	8.726	17.4	2.2	88	194	119.5	117
585	-81.4157038	41.3667184	2.419	4.8	0.6	287	359	310	330
586	-81.3970938	41.3538063	1.219	2.4	0.3	459	511	477.5	497
587	-81.3935738	41.3526224	2.131	4.3	0.5	316	386	338	360
589	-81.4027920	41.3484808	1.649	3.3	0.4	376	441	399	420
590	-81.4084547	41.3474664	0.219	0.4	0.1	867	886	867	888
592	-81.4069089	41.3464895	0.596	1.2	0.2	680	712	607	710
594	-81.4129141	41.3429127	0.891	1.8	0.2	562	603	575	596
595	-81.4128987	41.3439889	0.913	1.8	0.2	549	590	561.5	585
596	-81.4155317	41.3431775	0.556	1.1	0.1	695	727	701.5	724
598	-81.4011931	41.3436628	3.657	7.3	0.9	186	272	214.5	221
599	-81.3982216	41.3443956	2.974	5.9	0.8	236	314	261	275
600	-81.3960574	41.3436910	6.916	13.8	1.8	108	208	138	138
601	-81.3931167	41.3416126	1.282	2.6	0.3	444	498	462.5	482
602	-81.3926366	41.3421588	1.691	3.4	0.4	366	431	389	410
603	-81.3921587	41.3381523	4.020	8.0	1.0	176	264	202	212
604	-81.3955471	41.3387117	17.587	35.1	4.5	46	172	73.5	71
605	-81.3980543	41.3396330	2.251	4.5	0.6	303	374	325	346
606	-81.3967696	41.3413783	2.363	4.7	0.6	291	362	313	333
607	-81.3981768	41.3419041	2.771	5.5	0.7	252	328	275.5	295
608	-81.4118710	41.3399460	12.990	25.9	3.3	59	146	51.5	84
609	-81.4118598	41.3392344	0.896	1.8	0.2	558	599	571	593
610	-81.4077629	41.3366717	2.461	4.9	0.6	284	356	306	326
611	-81.4074104	41.3344282	0.322	0.6	0.1	808	832	809	605

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
612	-81.4043742	41.3303277	7.242	14.4	1.8	104	204	134.5	57
613	-81.4047808	41.3320308	1.917	3.8	0.5	340	406	362	154
614	-81.4032320	41.3273891	5.129	10.2	1.3	150	242	175.5	72
615	-81.4054618	41.3222971	1.639	3.3	0.4	378	443	401	175
616	-81.4047981	41.3244888	27.058	54.0	6.9	30	125	27.5	17
617	-81.4092651	41.3226843	10.268	20.5	2.6	74	189	63.5	43
618	-81.4127828	41.3207893	2.419	4.8	0.6	288	360	311	130
619	-81.4140408	41.3241654	23.054	46.0	5.8	34	84	31.5	20
620	-81.4001517	41.3268089	0.876	1.7	0.2	571	610	583	290
621	-81.3973273	41.3229874	52.004	103.7	13.2	8	94	8	7
622	-81.3994968	41.3264207	9.558	19.1	2.4	81	192	70.5	47
623	-81.3950731	41.3264000	1.054	2.1	0.3	499	547	515	238
624	-81.3935112	41.3257290	0.847	1.7	0.2	578	616	590	299
625	-81.3942376	41.3266612	0.058	0.1	0.0	944	947	944	898
626	-81.3933024	41.3267445	1.102	2.2	0.3	489	539	505	226
627	-81.3916806	41.3235843	2.673	5.3	0.7	262	336	286.5	120
628	-81.3944168	41.3207753	8.440	16.8	2.1	92	196	123	52
629	-81.3930028	41.3200357	1.015	2.0	0.3	515	561	530.5	244
630	-81.3982518	41.3190948	4.555	9.1	1.2	159	137	186	78
631	-81.4016060	41.3184916	2.093	4.2	0.5	319	389	340.5	142
632	-81.4023420	41.3194917	1.188	2.4	0.3	468	520	485.5	219
633	-81.4041990	41.3148977	65.514	130.7	16.6	5	4	5	5
634	-81.4049953	41.3202131	10.290	20.5	2.6	73	19	62.5	42
635	-81.4029201	41.3135339	0.481	1.0	0.1	724	755	730.5	463
636	-81.3928388	41.3181530	1.619	3.2	0.4	386	450	408	177
637	-81.3945282	41.3173531	6.717	13.4	1.7	112	212	141.5	59
638	-81.3920819	41.3146241	0.428	0.9	0.1	760	788	762.5	499
639	-81.3929097	41.3139413	0.347	0.7	0.1	797	821	797.5	566
641	-81.3978032	41.3117803	6.458	12.9	1.6	118	216	147.5	62
642	-81.3937608	41.3123310	2.491	5.0	0.6	280	352	302.5	126
643	-81.3992066	41.3102510	1.927	3.8	0.5	338	404	360	153
644	-81.4002098	41.3104986	1.371	2.7	0.3	426	482	446.5	199
645	-81.3968134	41.3099199	29.294	58.4	7.4	25	82	23	14
646	-81.3937181	41.3076592	15.751	31.4	4.0	50	86	44	27
647	-81.3989863	41.3047680	1.847	3.7	0.5	346	412	368.5	157
648	-81.3994945	41.3042797	0.967	1.9	0.2	526	571	449	255
649	-81.4023382	41.3059494	0.650	1.3	0.2	660	693	667	692
650	-81.4030704	41.3071545	1.568	3.1	0.4	394	457	416.5	436
651	-81.4097033	41.3110392	6.008	12.0	1.5	128	225	156	65
652	-81.4123642	41.3129170	1.082	2.2	0.3	493	542	509	231
653	-81.4112679	41.3131455	2.868	5.7	0.7	246	324	269	112
654	-81.4362587	41.3313981	0.676	1.3	0.2	653	687	659	685
655	-81.4441189	41.3290769	1.372	2.7	0.3	425	481	445.5	464
656	-81.4462684	41.3291230	1.318	2.6	0.3	437	492	456.5	475
657	-81.4476195	41.3298886	0.786	1.6	0.2	603	641	611.5	634
658	-81.4476214	41.3286825	0.540	1.1	0.1	700	732	706	729
659	-81.4472157	41.3273597	0.295	0.6	0.1	830	854	831.5	855
660	-81.4466238	41.3273711	0.751	1.5	0.2	615	652	623.5	648
661	-81.4462587	41.3275261	0.521	1.0	0.1	706	736	711.5	735
662	-81.4473508	41.3266429	0.376	0.8	0.1	783	809	784	811
663	-81.4429453	41.3275509	6.702	13.4	1.7	113	104	143	143
664	-81.4441848	41.3253788	1.647	3.3	0.4	377	442	400	421
665	-81.4425074	41.3237302	1.151	2.3	0.3	476	527	493	515
666	-81.4475356	41.3237246	0.684	1.4	0.2	646	681	654	677
667	-81.4472950	41.3221185	0.796	1.6	0.2	598	636	607	630
668	-81.4477384	41.3227255	0.360	0.7	0.1	788	815	789.5	816
669	-81.4462846	41.3191519	1.364	2.7	0.3	429	484	448.5	466
670	-81.4393061	41.3177373	2.260	4.5	0.6	302	373	324	344
671	-81.4364914	41.3168281	1.937	3.9	0.5	336	402	358	379
672	-81.4368483	41.3190603	0.649	1.3	0.2	662	695	669	694
673	-81.4345544	41.3171867	3.522	7.0	0.9	194	279	221.5	229
674	-81.4311826	41.3152183	0.924	1.8	0.2	544	586	557.5	582
675	-81.4353466	41.3137504	0.422	0.8	0.1	761	790	764	790
676	-81.4360725	41.3090729	2.022	4.0	0.5	327	395	348.5	371
677	-81.4493531	41.3279319	2.357	4.7	0.6	292	363	314	334
678	-81.4519307	41.3295657	1.017	2.0	0.3	514	560	435	550
679	-81.4516956	41.3308460	2.924	5.8	0.7	242	320	265	283
680	-81.4501904	41.3304530	0.065	0.1	0.0	942	946	942	949
681	-81.4498405	41.3308662	0.116	0.2	0.0	915	925	915	928
682	-81.4494266	41.3315738	0.491	1.0	0.1	717	747	723	750
683	-81.4524656	41.3320238	1.334	2.7	0.3	434	489	454	472
684	-81.4536196	41.3320575	0.581	1.2	0.1	684	716	690	714
685	-81.4487654	41.3330331	0.462	0.9	0.1	735	765	739.5	768
686	-81.4476485	41.3345885	0.887	1.8	0.2	563	604	576	597
687	-81.4452634	41.3355269	0.251	0.5	0.1	855	875	855.5	875
688	-81.4520547	41.3346834	0.613	1.2	0.2	672	705	679	703
689	-81.4532054	41.3344251	0.298	0.6	0.1	824	847	824.5	848
690	-81.4553823	41.3369519	0.691	1.4	0.2	642	678	649.5	673
691	-81.4554687	41.3358610	1.573	3.1	0.4	393	456	415.5	435
692	-81.4553950	41.3359551	5.357	10.7	1.4	141	89	168.5	170
693	-81.4570030	41.3317689	0.561	1.1	0.1	691	723	697	720
694	-81.4582819	41.3302374	0.532	1.1	0.1	702	733	707.5	730

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
695	-81.4562349	41.3309372	0.170	0.3	0.0	891	907	891.5	909
696	-81.4552676	41.3305977	0.626	1.2	0.2	668	701	675	699
697	-81.4553681	41.3298923	0.880	1.8	0.2	568	607	580	602
698	-81.4557502	41.3289180	0.906	1.8	0.2	552	593	472.5	588
699	-81.4538653	41.3297397	0.592	1.2	0.1	681	714	687.5	712
700	-81.4540739	41.3301844	1.314	2.6	0.3	439	494	458.5	477
701	-81.4535260	41.3309002	0.474	0.9	0.1	729	759	734	762
702	-81.4549926	41.3240872	0.186	0.4	0.0	884	900	884.5	902
705	-81.4576620	41.3441339	1.428	2.8	0.4	418	474	336	455
706	-81.4597051	41.3455108	0.273	0.5	0.1	843	865	843.5	864
707	-81.4586610	41.3458281	0.319	0.6	0.1	810	833	811	834
708	-81.4617369	41.3458213	0.318	0.6	0.1	812	835	783	835
709	-81.4623653	41.3460711	0.235	0.5	0.1	860	880	860.5	882
710	-81.4641049	41.3488558	0.362	0.7	0.1	787	814	788.5	815
711	-81.4677215	41.3489659	1.133	2.3	0.3	480	531	497	519
712	-81.4759486	41.3489231	1.113	2.2	0.3	486	536	407.5	526
713	-81.4791140	41.3495068	1.025	2.0	0.3	510	556	526	546
714	-81.4956324	41.3441073	1.244	2.5	0.3	454	506	472.5	492
715	-81.4781918	41.3327322	0.607	1.2	0.2	674	707	681	705
716	-81.4770322	41.3337437	0.939	1.9	0.2	535	578	549.5	572
717	-81.4750321	41.3339958	1.084	2.2	0.3	492	541	508	531
718	-81.4743062	41.3196028	0.467	0.9	0.1	733	763	686.5	766
719	-81.4819926	41.3148603	1.207	2.4	0.3	462	514	480.5	501
720	-81.4813502	41.3135911	1.048	2.1	0.3	500	548	516	536
721	-81.4540992	41.3103131	0.433	0.9	0.1	754	783	758	785
722	-81.4542656	41.3096865	0.307	0.6	0.1	819	843	820.5	844
723	-81.4622192	41.2897744	0.032	0.1	0.0	949	950	949	950
724	-81.4548947	41.2854263	0.929	1.9	0.2	542	116	556	580
725	-81.4542941	41.2853138	1.550	3.1	0.4	402	113	422.5	443
726	-81.4533859	41.2847029	0.794	1.6	0.2	599	637	608	631
727	-81.4440464	41.2784723	1.142	2.3	0.3	478	529	495	517
728	-81.4252077	41.2783556	0.751	1.5	0.2	616	653	624.5	649
729	-81.4218907	41.2773290	0.972	1.9	0.2	523	568	538	560
730	-81.4211870	41.2775174	0.160	0.3	0.0	895	911	896	913
731	-81.4208115	41.2772202	0.449	0.9	0.1	742	771	745.5	774
732	-81.4203132	41.2774672	0.295	0.6	0.1	831	852	829.5	853
733	-81.4215539	41.2787090	2.816	5.6	0.7	249	326	201	292
734	-81.4185391	41.2791133	4.398	8.8	1.1	166	255	137	202
735	-81.4127199	41.2817453	2.574	5.1	0.7	272	345	295	315
736	-81.4112035	41.2800831	0.989	2.0	0.3	520	566	442	556
737	-81.4121084	41.2810810	6.879	13.7	1.7	109	209	93	139
738	-81.4139202	41.2856240	0.395	0.8	0.1	772	799	733	800
739	-81.4179310	41.2868530	1.267	2.5	0.3	447	501	465	485
740	-81.4242433	41.2882763	0.840	1.7	0.2	581	619	499.5	614
741	-81.4195799	41.2913907	2.851	5.7	0.7	248	325	271	288
742	-81.4222715	41.2939011	1.728	3.4	0.4	362	427	384.5	405
743	-81.4207238	41.2945446	3.071	6.1	0.8	224	304	250.5	262
744	-81.4227119	41.2957443	34.138	68.1	8.6	21	166	19.5	12
745	-81.4252197	41.2978671	4.835	9.6	1.2	154	245	126.5	190
746	-81.4238458	41.2993075	2.107	4.2	0.5	317	387	252	361
747	-81.4275050	41.3005943	12.243	24.4	3.1	66	184	58	92
748	-81.4258645	41.2998680	0.630	1.3	0.2	664	697	671	696
749	-81.4222278	41.2984459	3.323	6.6	0.8	205	286	231.5	241
750	-81.4205560	41.2984651	0.291	0.6	0.1	833	855	832.5	856
751	-81.4184311	41.2964278	0.432	0.9	0.1	755	784	759	496
752	-81.4173317	41.2968948	0.106	0.2	0.0	919	71	919	822
753	-81.4157956	41.2983054	2.188	4.4	0.6	311	37	333	355
754	-81.4139800	41.2956847	6.666	13.3	1.7	115	27	144.5	61
755	-81.4152505	41.2963913	36.443	72.7	9.2	18	8	16.5	11
756	-81.4228989	41.3016622	0.703	1.4	0.2	636	672	643	668
757	-81.4240326	41.3016416	1.205	2.4	0.3	464	515	481.5	502
758	-81.4261515	41.3018832	0.754	1.5	0.2	614	651	622.5	647
759	-81.4290870	41.3041571	0.480	1.0	0.1	726	756	676.5	757
760	-81.4295933	41.3046618	0.629	1.3	0.2	666	699	673	697
761	-81.4289093	41.3014304	0.411	0.8	0.1	765	793	768	793
762	-81.4302955	41.3019841	2.271	4.5	0.6	300	371	322	342
763	-81.4329553	41.3021266	0.767	1.5	0.2	610	648	619	641
764	-81.4346706	41.3026923	1.182	2.4	0.3	469	521	486.5	507
765	-81.4321614	41.3006763	1.668	3.3	0.4	370	435	392.5	415
766	-81.4328946	41.3041447	0.897	1.8	0.2	555	596	568	591
767	-81.4334752	41.3048440	0.702	1.4	0.2	637	673	644	669
768	-81.4330189	41.3065983	0.226	0.5	0.1	864	883	864.5	886
769	-81.4324849	41.3060508	1.045	2.1	0.3	501	549	425.5	537
770	-81.4321423	41.3054793	0.810	1.6	0.2	595	633	604	627
771	-81.4311825	41.3051780	1.635	3.3	0.4	379	444	402.5	422
772	-81.4296360	41.3059171	0.161	0.3	0.0	894	910	891.5	912
773	-81.4248245	41.3056750	2.337	4.7	0.6	296	367	317.5	338
774	-81.4253782	41.3049274	0.849	1.7	0.2	576	614	588	610
775	-81.4243142	41.3042764	0.860	1.7	0.2	574	612	585.5	607
776	-81.4142020	41.3021508	8.584	17.1	2.2	91	195	78.5	121
777	-81.4098440	41.3009230	0.592	1.2	0.1	682	713	686.5	711
778	-81.4086514	41.2999782	0.848	1.7	0.2	577	615	589	611

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779	-81.4078237	41.3014443	2.043	4.1	0.5	324	392	345.5	367
780	-81.4073280	41.2997408	1.964	3.9	0.5	332	399	354	375
781	-81.4044252	41.2995651	1.884	3.8	0.5	342	408	272.5	384
782	-81.3944820	41.2999331	27.190	54.2	6.9	29	11	26.5	16
783	-81.3957509	41.2989503	8.792	17.5	2.2	87	22	118.5	50
784	-81.3932820	41.2998229	24.130	48.1	6.1	33	12	30.5	19
785	-81.3926348	41.2934545	8.417	16.8	2.1	93	24	80	54
786	-81.3929956	41.2947742	1.231	2.5	0.3	456	508	375.5	214
787	-81.3940545	41.2873343	0.216	0.4	0.1	869	887	869	732
788	-81.3944007	41.2899343	3.787	7.6	1.0	183	269	211	91
789	-81.3985411	41.2937917	0.787	1.6	0.2	602	640	610.5	317
790	-81.3987529	41.2986019	3.664	7.3	0.9	185	271	213.5	93
791	-81.3978906	41.2978317	0.742	1.5	0.2	624	660	632.5	331
792	-81.3977064	41.2962194	1.516	3.0	0.4	408	466	428.5	188
793	-81.3994278	41.2968789	0.630	1.3	0.2	665	698	672	368
794	-81.3979621	41.2971980	2.913	5.8	0.7	244	322	267.5	110
795	-81.4021592	41.2982773	0.603	1.2	0.2	677	710	683.5	708
796	-81.4032043	41.2971289	0.827	1.6	0.2	586	622	594.5	617
797	-81.4016696	41.2967165	2.964	5.9	0.8	237	315	262	277
798	-81.4022477	41.2978864	5.333	10.6	1.4	142	235	169.5	172
799	-81.4024714	41.2954968	2.743	5.5	0.7	256	331	280	298
800	-81.4027154	41.2947771	4.036	8.1	1.0	175	263	145	211
801	-81.4027033	41.2930294	1.454	2.9	0.4	414	471	434.5	451
802	-81.4010047	41.2926926	0.450	0.9	0.1	739	770	744.5	773
803	-81.3975388	41.2917066	14.416	28.8	3.7	54	177	84	31
804	-81.3956332	41.2866165	2.925	5.8	0.7	241	319	193.5	282
805	-81.3960831	41.2871426	3.079	6.1	0.8	222	302	178.5	260
806	-81.4057549	41.2935989	6.581	13.1	1.7	116	214	145.5	144
807	-81.4005405	41.2955610	0.257	0.5	0.1	853	873	853.5	872
808	-81.4001121	41.2947411	0.290	0.6	0.1	835	857	834.5	642
809	-81.4038596	41.2912761	0.773	1.5	0.2	605	645	616	638
810	-81.3893133	41.2899776	98.143	195.8	24.9	3	3	3	3
812	-81.3992778	41.2803483	11.770	23.5	3.0	67	185	94.5	94
813	-81.3980403	41.2839958	1.767	3.5	0.4	358	423	380.5	400
814	-81.3970573	41.2842656	0.897	1.8	0.2	556	598	570	592
815	-81.3985345	41.2818899	0.374	0.7	0.1	784	811	786	813
816	-81.3987610	41.2836593	9.065	18.1	2.3	85	193	116	115
817	-81.3950767	41.2807299	0.239	0.5	0.1	859	879	859.5	881
818	-81.3937983	41.2809332	1.033	2.1	0.3	508	555	524	544
819	-81.3943807	41.2735836	4.456	8.9	1.1	162	251	133.5	197
820	-81.3926428	41.2824018	195.150	389.3	49.4	2	2	2	2
821	-81.3928986	41.2681902	12.834	25.6	3.3	62	181	54.5	86
822	-81.3928168	41.2705265	1.632	3.3	0.4	380	445	301.5	423
823	-81.4119922	41.2676145	0.714	1.4	0.2	634	670	641	666
824	-81.4002789	41.2964737	0.941	1.9	0.2	532	575	546.5	266
825	-81.3998130	41.2984059	0.823	1.6	0.2	587	625	597	306
826	-81.4114248	41.2994359	0.518	1.0	0.1	708	738	713.5	736
827	-81.4529149	41.3289508	0.681	1.4	0.2	649	683	655.5	680
828	-81.4357251	41.3201892	1.790	3.6	0.5	357	422	378.5	398
832	-81.3980256	41.3484607	2.241	4.5	0.6	305	376	327	348
833	-81.4725778	41.3079576	0.464	0.9	0.1	734	764	738.5	767
834	-81.3935456	41.2640011	8.120	16.2	2.1	96	198	83	124
835	-81.3945038	41.2612609	0.683	1.4	0.2	647	682	567	678
836	-81.3946542	41.2606726	0.866	1.7	0.2	573	611	490.5	606
837	-81.3940052	41.2598226	8.665	17.3	2.2	90	87	121	119
838	-81.3944460	41.2591661	1.218	2.4	0.3	460	512	478.5	498
839	-81.3966247	41.2544822	0.733	1.5	0.2	629	665	637	661
840	-81.3937601	41.2524352	6.078	12.1	1.5	126	223	106	155
841	-81.3925106	41.2502423	2.675	5.3	0.7	261	335	285.5	304
842	-81.4065096	41.2485417	2.580	5.1	0.7	270	109	216	313
843	-81.4316573	41.2632043	1.020	2.0	0.3	512	558	528	548
844	-81.4411438	41.2624411	3.435	6.9	0.9	199	138	226	237
845	-81.3965870	41.2580983	5.310	10.6	1.3	144	237	118.5	174
846	-81.3944841	41.2571066	0.450	0.9	0.1	740	769	743.5	772
847	-81.3942020	41.2562878	0.164	0.3	0.0	892	908	892.5	910
848	-81.3982942	41.2563237	3.314	6.6	0.8	206	287	168	242
849	-81.3951497	41.2548614	8.332	16.6	2.1	94	197	81	122
850	-81.4019854	41.2550863	0.119	0.2	0.0	912	923	912	926
851	-81.4010593	41.2563129	0.363	0.7	0.1	786	813	751	814
852	-81.4014159	41.2581418	0.132	0.3	0.0	905	917	905	920
853	-81.4023304	41.2589589	0.621	1.2	0.2	670	703	677	701
854	-81.4031299	41.2525854	0.220	0.4	0.1	866	885	856.5	887
855	-81.4026499	41.2515674	0.087	0.2	0.0	933	939	936	942
856	-81.4015665	41.2520193	0.946	1.9	0.2	529	114	543.5	568
857	-81.4009264	41.2526987	0.182	0.4	0.0	887	903	887.5	906
858	-81.3990859	41.2531641	0.189	0.4	0.0	881	898	881.5	900
859	-81.3973426	41.2533039	0.145	0.3	0.0	900	915	901	918
860	-81.3961912	41.2529084	0.790	1.6	0.2	600	638	609	632
861	-81.3899912	41.2511898	47.611	95.0	12.1	10	163	10	30
862	-81.3982467	41.2472282	0.904	1.8	0.2	554	595	566.5	590
863	-81.3980992	41.2455329	0.307	0.6	0.1	820	842	819.5	843
864	-81.3981522	41.2444018	0.145	0.3	0.0	901	914	900	917

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
865	-81.4002266	41.2441584	0.460	0.9	0.1	737	767	741.5	769
866	-81.3987721	41.2433489	2.526	5.0	0.6	276	349	299	319
867	-81.4042864	41.2470607	0.244	0.5	0.1	857	877	857.5	878
868	-81.4076442	41.2436437	0.080	0.2	0.0	937	943	939	946
869	-81.4107681	41.2497252	0.092	0.2	0.0	931	937	931	940
870	-81.4129590	41.2498495	0.102	0.2	0.0	923	931	923	935
871	-81.4129093	41.2467821	0.275	0.5	0.1	842	864	842.5	863
872	-81.4147092	41.2516392	0.178	0.4	0.0	888	904	883	907
873	-81.4121333	41.2584014	0.746	1.5	0.2	622	658	630.5	654
874	-81.4172831	41.2613714	1.878	3.7	0.5	344	410	274	386
875	-81.4168887	41.2609687	0.553	1.1	0.1	697	729	631.5	726
876	-81.4249779	41.2603049	0.439	0.9	0.1	748	777	752	780
877	-81.4254944	41.2602604	0.772	1.5	0.2	608	646	617	639
878	-81.4334288	41.2555515	0.386	0.8	0.1	777	804	779.5	804
879	-81.4332937	41.2631395	1.803	3.6	0.5	354	418	375	395
880	-81.4332509	41.2639474	2.700	5.4	0.7	260	334	207.5	303
881	-81.4344677	41.2627856	1.114	2.2	0.3	485	535	502	525
882	-81.4358956	41.2632730	0.382	0.8	0.1	778	805	780.5	806
883	-81.4375118	41.2625477	0.598	1.2	0.2	678	711	684.5	709
884	-81.3925110	41.2492986	0.578	1.2	0.1	685	717	691	715
885	-81.3927066	41.2515969	4.418	8.8	1.1	164	253	135.5	200
886	-81.3991517	41.2438185	0.773	1.5	0.2	606	643	614	636
887	-81.4133337	41.2473545	0.936	1.9	0.2	537	580	460	575
888	-81.4178030	41.2442749	0.485	1.0	0.1	723	752	671.5	755
889	-81.4319740	41.2636699	2.881	5.7	0.7	245	323	197	287
890	-81.4398135	41.2625880	1.317	2.6	0.3	438	493	457.5	476
891	-81.3991355	41.2340952	0.941	1.9	0.2	533	576	547.5	570
892	-81.3979544	41.2174483	1.723	3.4	0.4	363	428	386	406
893	-81.3968155	41.2166669	0.918	1.8	0.2	546	588	559.5	584
894	-81.4000293	41.2185990	0.030	0.1	0.0	950	951	950	951
895	-81.3986002	41.2335346	4.765	9.5	1.2	155	246	181.5	191
896	-81.3987959	41.2320131	0.437	0.9	0.1	750	779	754	782
897	-81.3962060	41.2294633	1.708	3.4	0.4	364	429	387	407
898	-81.3969036	41.2264390	1.664	3.3	0.4	371	436	394	416
899	-81.4046504	41.2290570	1.108	2.2	0.3	488	538	504	528
900	-81.4030772	41.2270641	3.045	6.1	0.8	227	307	253	267
901	-81.4040785	41.2280462	1.744	3.5	0.4	360	425	382	402
902	-81.4008152	41.2280444	0.689	1.4	0.2	644	680	651.5	675
903	-81.3979778	41.2241317	0.204	0.4	0.1	875	893	875	895
904	-81.3971783	41.2238494	0.119	0.2	0.0	913	924	913	927
905	-81.4164760	41.2365305	0.301	0.6	0.1	821	844	821.5	845
906	-81.4158467	41.2365285	0.096	0.2	0.0	929	935	929	938
907	-81.4051822	41.2280811	0.357	0.7	0.1	791	818	793	819
908	-81.4054231	41.2273883	0.241	0.5	0.1	858	878	858.5	879
909	-81.4049091	41.2269176	2.424	4.8	0.6	286	358	308.5	329
910	-81.4022981	41.2286978	5.663	11.3	1.4	134	135	161.5	164
911	-81.3974184	41.2241502	0.909	1.8	0.2	550	591	563	586
912	-81.3959998	41.2236648	5.634	11.2	1.4	135	229	162.5	165
913	-81.3958109	41.2218285	2.145	4.3	0.5	314	384	336	358
914	-81.3945405	41.2206803	0.440	0.9	0.1	746	776	703.5	779
915	-81.3948690	41.2194005	0.622	1.2	0.2	669	702	676	700
916	-81.3950510	41.2252708	0.130	0.3	0.0	906	918	906	921
917	-81.5666809	41.3599712	0.871	1.7	0.2	572	47	488.5	291
918	-81.5608765	41.3740026	0.192	0.4	0.0	879	62	879.5	744
919	-81.5623604	41.3712362	0.353	0.7	0.1	793	56	794	562
920	-81.5615360	41.3722052	0.160	0.3	0.0	896	64	895	747
921	-81.5621568	41.3727443	0.139	0.3	0.0	903	67	903	770
922	-81.5625408	41.3774552	0.217	0.4	0.1	868	61	868	731
923	-81.5581235	41.3728452	0.750	1.5	0.2	618	48	625.5	327
924	-81.5564853	41.3693474	0.189	0.4	0.0	882	63	882.5	745
925	-81.5557503	41.3695171	0.078	0.2	0.0	938	74	937	873
926	-81.5516929	41.3705287	0.264	0.5	0.1	846	60	848	681
927	-81.5497816	41.3714986	0.144	0.3	0.0	902	66	902	761
928	-81.5503667	41.3706443	0.146	0.3	0.0	899	65	899	760
929	-81.5491238	41.3714046	0.115	0.2	0.0	917	70	916	810
930	-81.5490838	41.3709214	0.096	0.2	0.0	930	73	927	836
931	-81.5574744	41.3780870	0.418	0.8	0.1	763	54	766	508
932	-81.5638233	41.3764098	0.123	0.2	0.0	908	68	908	795
933	-81.5703340	41.3743328	0.264	0.5	0.1	847	59	847	679
934	-81.5730810	41.3736345	0.076	0.2	0.0	940	75	939	876
935	-81.5717460	41.3733818	0.046	0.1	0.0	946	77	946	915
936	-81.5721826	41.3735061	0.035	0.1	0.0	948	78	948	929
937	-81.5767969	41.3726482	3.900	7.8	1.0	181	267	207.5	89
938	-81.5762261	41.3713180	0.896	1.8	0.2	559	600	572	286
939	-81.5759604	41.3705063	0.344	0.7	0.1	798	822	798.5	573
940	-81.5723197	41.3679041	1.552	3.1	0.4	401	112	319.5	183
941	-81.5798127	41.3724624	0.078	0.2	0.0	939	944	938	947
942	-81.5801725	41.3723759	0.081	0.2	0.0	935	941	934.5	944
943	-81.5794021	41.3722129	0.122	0.2	0.0	909	920	909	923
944	-81.5847842	41.3754705	0.481	1.0	0.1	725	754	729.5	462
945	-81.5837071	41.3753715	0.055	0.1	0.0	945	948	945	905
946	-81.5737283	41.3779011	0.063	0.1	0.0	943	76	943	894

WETLAND ID	Centroid Longitude	Centroid Latitude	Area (Acres)	Nitrogen Reduction (kg/yr)	Phosphorus Reduction (kg/yr)	Water Quality Rank	Ecological Rank	Hydro Rank (Average)	Economic Rank
947	-81.5747992	41.3785195	0.100	0.2	0.0	924	72	924	829
948	-81.5469030	41.3889894	0.117	0.2	0.0	914	69	914	805
949	-81.5475106	41.3878089	1.260	2.5	0.3	448	44	466	209
950	-81.5489518	41.3820396	0.021	0.0	0.0	951	79	951	948
951	-81.6039726	41.3647953	0.357	0.7	0.1	792	817	755.5	558
952	-81.6061584	41.3644802	5.627	11.2	1.4	136	230	163.5	68
953	-81.6086035	41.3654855	0.155	0.3	0.0	898	913	898	748
954	-81.6071678	41.3671215	0.461	0.9	0.1	736	766	740.5	478
955	-81.6057901	41.3676652	0.897	1.8	0.2	557	597	569	285
956	-81.6024210	41.3704107	0.098	0.2	0.0	926	933	926	832
957	-81.6028978	41.3696013	0.046	0.1	0.0	947	949	947	916
958	-81.6022800	41.3712939	0.283	0.6	0.1	839	861	839.5	656
959	-81.6082353	41.3698762	12.599	25.1	3.2	64	182	91	38
960	-81.6026677	41.3729128	0.326	0.7	0.1	805	829	806	601
962	-81.4772295	41.3147165	1.248	2.5	0.3	451	504	469.5	488
963	-81.4576799	41.3158578	0.526	1.0	0.1	705	735	650.5	734
964	-81.4767670	41.3099464	4.008	8.0	1.0	177	265	203.5	213
965	-81.4529849	41.3047511	1.014	2.0	0.3	516	562	531.5	551
966	-81.4459878	41.3066417	5.205	10.4	1.3	147	240	121.5	180
967	-81.4280732	41.2961338	2.611	5.2	0.7	265	339	289	308
968	-81.4229081	41.2781648	2.538	5.1	0.6	275	348	219	318
969	-81.3957478	41.3282309	25.186	50.2	6.4	32	83	29.5	18
970	-81.4199189	41.3352149	3.588	7.2	0.9	191	276	219	225
971	-81.4568289	41.3468215	8.002	16.0	2.0	99	88	85.5	128
972	-81.3950480	41.2753622	1.536	3.1	0.4	404	463	423.5	444
973	-81.4088609	41.2602041	3.025	6.0	0.8	228	308	182.5	268
974	-81.4375770	41.2636553	2.596	5.2	0.7	267	341	291	310
975	-81.3932903	41.2221740	0.286	0.6	0.1	838	860	838.5	860
976	-81.3970714	41.2213628	0.469	0.9	0.1	732	761	736	764
977	-81.3969426	41.2254796	0.572	1.1	0.1	687	719	693	717
978	-81.3966999	41.2256473	0.815	1.6	0.2	594	631	602	625
979	-81.3984019	41.2269390	1.568	3.1	0.4	395	111	417.5	437
980	-81.3955718	41.2200587	0.828	1.7	0.2	583	621	593.5	616
981	-81.3967652	41.2206720	1.967	3.9	0.5	331	398	353	374
982	-81.3943128	41.2187176	3.210	6.4	0.8	212	293	237.5	249
983	-81.3999644	41.3481386	0.806	1.6	0.2	597	635	606	629
984	-81.4014354	41.3463957	2.998	6.0	0.8	233	311	258.5	272
989	-81.4006607	41.3496074	0.856	1.7	0.2	575	613	586.5	608
990	-81.4170753	41.3449941	0.209	0.4	0.1	874	891	873	892
993	-81.4099531	41.3457980	2.985	6.0	0.8	234	312	187.5	273
996	-81.4065089	41.3458872	57.131	114.0	14.5	7	91	7	26
1000	-81.4607942	41.3245327	0.773	1.5	0.2	607	644	615	637
1001	-81.4594090	41.3252650	1.671	3.3	0.4	369	434	295	414
1004	-81.5312843	41.3604909	3.401	6.8	0.9	201	284	163.5	240
1005	-81.4784971	41.3791047	0.073	0.1	0.0	941	945	940.5	880
1010	-81.3587014	41.2434598	0.502	1.0	0.1	713	743	718.5	741
1012	-81.3575113	41.2422105	3.136	6.3	0.8	217	297	243	254
1013	-81.3595427	41.2440488	0.770	1.5	0.2	609	647	531	640
1015	-81.3598407	41.2445786	4.378	8.7	1.1	167	256	138	203