Thorn Creek Watershed Based Plan Addendum

Prepared for

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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1. Introduction

Thorn Creek flows north from its origin near Monee in eastern Will County to its confluence with the Little Calumet River in South Holland in Cook County. Thorn Creek and its major tributaries — Deer Creek, Butterfield Creek, and North Creek — form a 107 square mile subwatershed of the Little Calumet River watershed, including approximately 3 square miles in Indiana. Thorn Creek itself runs through the Illinois municipalities of University Park, Park Forest, South Chicago Heights, Chicago Heights, Glenwood, Thornton, and South Holland.

In 2003, using funding from the Illinois Environmental Protection Agency (Illinois EPA), the Northeastern Illinois Planning Commission (NIPC) initiated the development of a pilot watershed based plan for the Thorn Creek Watershed. Completed in 2005, the *Thorn Creek Watershed Based Plan* (2005 Watershed Based Plan) focused on nonpoint source pollution, particularly in the 26 square mile watershed of the Thorn Creek main stem, but also identified a range of issues adversely affecting the area of study. The most pressing watershed issues emerged from early meetings with stakeholders, which were combined with additional information to develop a set of goals and objectives for the watershed that were categorized as either resource-based goals, such as habitat restoration, or watershed coordination goals, such as improved education and outreach. The Thorn Creek Watershed Based Plan focused closely on the goal of protecting and enhancing surface water quality to support uses designated for Thorn Creek by Illinois EPA. Other resource-based goals were considered, including protecting and restoring aquatic and terrestrial habitat, protecting and enhancing groundwater quality and quantity, and reducing flooding and flood-related damages. The watershed coordination goals included improving cooperation among stakeholders in the watershed, such as businesses, universities, and governments, and educating stakeholders about their role in protecting the watershed.

Water quality sampling data from several sources were analyzed to determine the extent of impairment by various contaminants. A land use pollutant loading model was also employed to relate water quality problems back to the mix of land uses and the amount of impervious surface in the watershed. Watershed stakeholders reviewed the results and concluded that the water quality constituents most in need of attention included the presence of pathogenic organisms (as indicated by fecal coliform), low dissolved oxygen, hydrologic modification, dumping and debris, and road salt runoff.

A set of Watershed Management Recommendations (WMRs) was developed to address the goals stakeholders identified as most important to them. From there, a smaller subset of WMRs directed at surface water quality was selected for further elaboration, with estimates of their effectiveness and cost to implement. Stakeholders then prioritized these water quality related WMRs.

1.1 Watershed Update Components

In 2013, the Chicago Metropolitan Agency for Planning (CMAP) received funds from Illinois EPA to update the 2005 Watershed Based Plan. Illinois EPA specifically requested a watershed-wide summary of BMPs recommended for implementation within the Thorn Creek Watershed. This information will be used, in part, to support the development of a Thorn Creek TMDL (total maximum daily load) implementation plan by Illinois EPA. This update focuses on an evaluation of nonpoint source pollution control best management practices (BMPs) appropriate to address a variety of water quality issues identified in this watershed. Major tasks undertaken to support this update included:

1. Updating nonpoint source pollutant load estimates for the watershed by land use and by subwatershed, using more-current (2010) land use data. Fecal coliform and chloride pollutant load reductions were evaluated in addition to the parameters listed in Illinois EPA's Financial

Assistance Agreement No. 604121. Chloride pollutant loads were evaluated from a source-reduction perspective.

2. Identifying a preferred suite of BMPs to be evaluated for inclusion within the watershed analysis. Appropriate pollutant removal efficiencies for each BMP type identified were validated based on current literature and other sources, such as the International BMP Database[1].
3. Conducting a focused assessment of the Thorn Creek Watershed to evaluate other types of watershed improvement projects identified in the 2005 Watershed Based Plan, such as opportunities for buffer establishment in agricultural areas and streambank stabilization. This assessment combined desktop data analysis and on-the-ground evaluation of sites on Thorn Creek and its tributaries. The results were used to develop watershed-wide estimates for the total extent of each type of BMP opportunity.
4. Compiling appropriate criteria for BMP designs at the site-scale that were then extrapolated to the implementation of BMPs at the subwatershed and watershed scales.
5. Developing and analyzing a BMP implementation scenario and estimating pollutant load reductions and implementation costs of this scenario at the subwatershed scale. The total extent of the recommended BMPs (e.g., total acres of recommended bioretention areas, etc.), the total estimated pollutant load reductions and the implementation costs at the subwatershed and watershed scales are summarized as a part of this update.

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[1] *International BMP Database*, 2012. http://www.bmpdatabase.org/

2. Existing Conditions Analyses

Collecting and analyzing existing information for the Thorn Creek Watershed is an important element in reducing uncertainty in the recommendations provided in this plan update. Existing land use information is summarized in the following section to serve as the basis for the recommendations included in the remaining sections of the plan update. In this analysis of existing conditions, nonpoint sources of total nitrogen, total phosphorus, total suspended solids (TSS), fecal coliform, and chloride to the Thorn Creek watershed were evaluated and are discussed in subsequent subsections.

2.1 Thorn Creek Watershed Land Use

CMAP supplied its preliminary 2010 land use data for the Cook and Will County portions of the Thorn Creek Watershed for this report. CMAP also provided the Northwestern Indiana Regional Planning Commission's 2010 land use data for the Indiana portion of the watershed. In 2010, land use within the Thorn Creek Watershed was comprised primarily of urban land (57%).[2] The remaining land was classified as agriculture (19%), open space (16%), or vacant or under construction (7%). Urban land use was primarily comprised of low- and mid-density residential areas (46%), followed by areas categorized as transportation, communication, utilities or waste (29%).

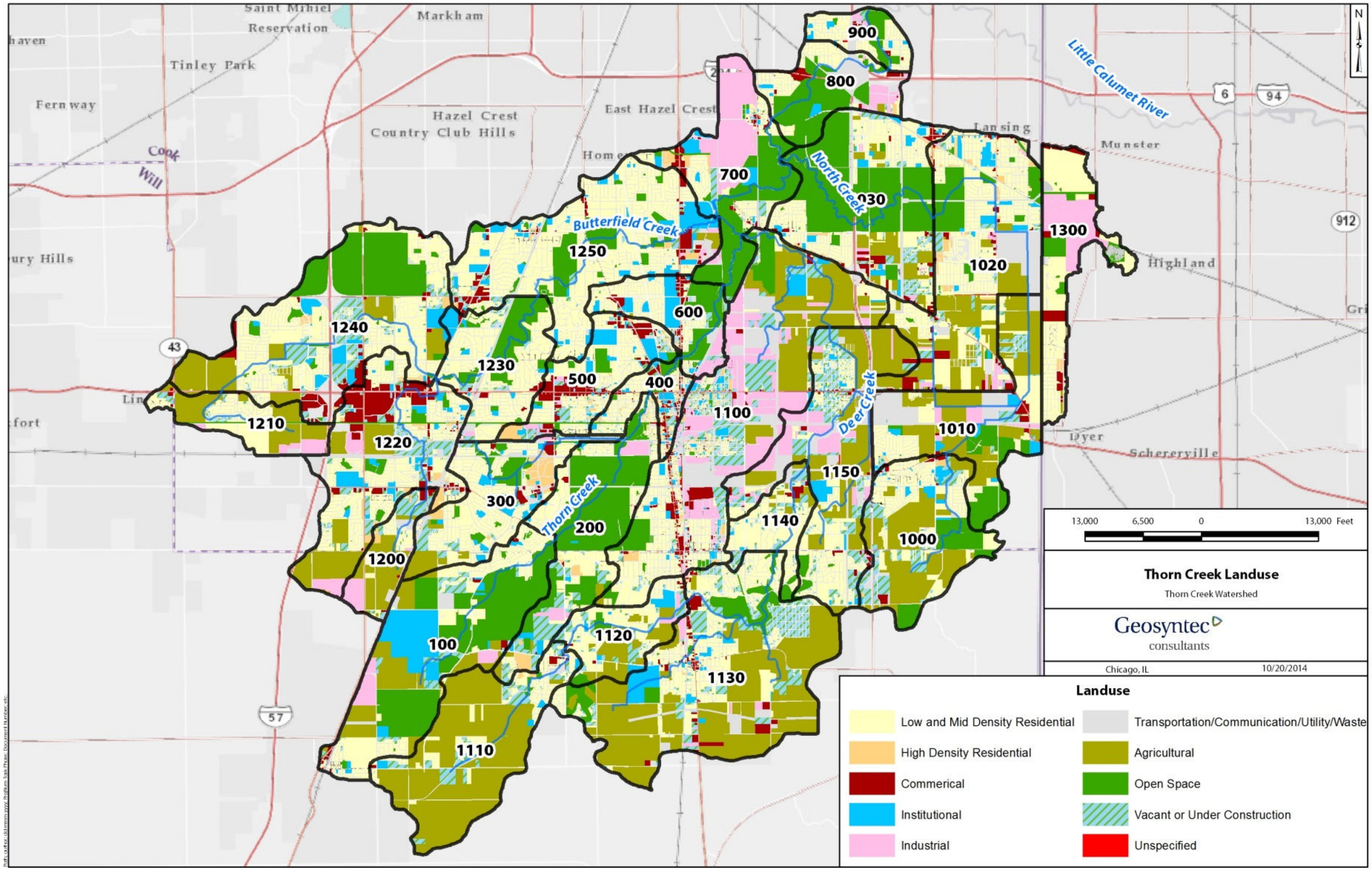
Table 2.1 and Figure 2.1 provide a "snapshot" of land use within the watershed based on the most recent (2010) publicly available information. This same information was also incorporated into the watershed plan development process, such as developing pollutant load estimates (Section 2.4). Appendix A provides a breakdown of the land use by subwatershed.

Table 2.1 Land Use within Thorn Creek Watershed.

Land Use	Acres	Percent of Watershed
Low- and Mid-Density Residential	18,169	26%
Agriculture	13,304	19%
Transportation, Communication, Utility or Waste	11,385	16%
Open Space	11,241	16%
Vacant or Under Construction	4,823	7%
Industrial	3,590	5%
Institutional	3,255	5%
Commercial	2,232	3%
High-Density Residential	891	1%
Not Classifiable	149	<1%
Total	**69,041**	**100%**

[2] Urban uses include the following land use types: Residential; Commercial; Institutional; Industrial; and Transportation, Communication, Utilities or Waste.

Figure 2.1 Land Use within Thorn Creek Watershed.



2.2 Existing Conditions Pollutant Load Analysis

A critical step in providing recommendations within this plan is the identification of the different pollutant sources within the watershed and the relative magnitude of pollutant loads from those sources. In this analysis, nonpoint sources of total nitrogen, total phosphorus, total suspended solids (sediment), and fecal coliform are quantified as pollutant loads. (A chloride analysis is provided in Section 2.3.)

In an effort to refine the pollutant load estimates for the watershed, the pollutant load estimates were developed at the subwatershed level using delineated watershed boundaries, which separates the Thorn Creek watershed into 26 subwatersheds (Figure 2.2). Estimating the pollutant loads at the subwatershed level, as well as at the watershed level, provides the opportunity to evaluate subwatersheds on a relative pollutant load contribution basis and to better target the recommendations included in this plan and in future planning efforts within the Thorn Creek Watershed.

Total nitrogen, total phosphorus, total suspended solids, and fecal coliform pollutant load calculations were performed in a Microsoft Excel® spreadsheet model.[3] The model is a simple planning tool with common limitations. It is not an in-stream response model and is an un-calibrated tool that only estimates watershed pollutant loading based on coarse data, such as event mean concentrations. Other considerations and limitations of the spreadsheet model include the following:

- annual nutrient loading based on the runoff volume and runoff pollutant concentrations is based on land use;
- a single event mean concentration is utilized to represent pollutant concentration for all storm events;
- pollutant loads are estimated for storm events only and are based on average rainfall amount;
- stream channel erosion is not accounted for as a pollutant source;
- drain tiles are not included as a pollutant source; and
- construction sites are not included as a pollutant sources.

The Microsoft Excel® spreadsheet model is based on the following equation:

Export coefficient (lb/ac/yr) = P × CF × Rv × C × F

where P = Annual precipitation (in/yr)

CF = Correction factor adjusting for storms with no runoff

Rv = Runoff coefficient = 0.05 + (0.009 × I)

I = Percent impervious

C = Event mean concentration (mg/l for chemical constituents or colonies/100 mL for bacteria.

F = Unit conversion factor of 0.226 for chemical constituents and 1.03E-3 for bacteria.

Export coefficients for total nitrogen, total phosphorus, and total suspended solids were calculated for each subwatershed. Inputs to these calculations included CMAP's land use inventory for 2005 (area per land use), an annual rainfall of 39.6 inches per year, and a correction factor of 0.9. Land use-specific event

[3] The model was developed by Geosyntec in large part based on a study performed in 1993 by Tom Price of NIPC for the Lake County Stormwater Management Commission. A similar approach was used in the 2005 Thorn Creek Watershed Based Plan.

mean concentrations for these three chemical constituents were back-calculated and adopted from the 2005 Thorn Creek Watershed Based Plan. Similarly, impervious percentages of land-use categories were adopted from the 2005 Watershed Based Plan.

Similarly, fecal coliform export coefficients were estimated for each subwatershed in the Thorn Creek Watershed. However, event mean concentrations were evaluated and adopted from various literature sources including another regional watershed, the North Mill Creek/Dutch Gap Canal Subwatershed in Lake County, Illinois.[4] An event mean concentration for the transportation land use category was not available for the North Mill Creek/Dutch Gap Canal Subwatershed. Therefore, this value was estimated to be 1800 colonies per 100 mL based on the literature review. The total annual pollutant loading for each constituent in the Thorn Creek Watershed is equal to the sum of the pollutant loadings in the subwatersheds (Table 2.2). Visual representations of the total nitrogen, total phosphorus, total suspended solids, and fecal coliform pollutant loads on subwatershed basis are illustrated figures presented in Appendix A. These results indicate that based on existing watershed conditions, urban land is the largest nonpoint source contributor of sediment (92%), total phosphorus (86%), total nitrogen (89%) and fecal coliform (94%).

[4] North Mill Creek/Dutch Gap Canal Watershed-Based Plan, Lake County, Illinois and Kenosha County, Wisconsin. November 2011. Prepared by NorthWater Consultants on behalf of Lake County Stormwater Management Commission. Available at http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/NorthMillCreek.aspx.

Figure 2.2 Thorn Creek Subwatersheds.

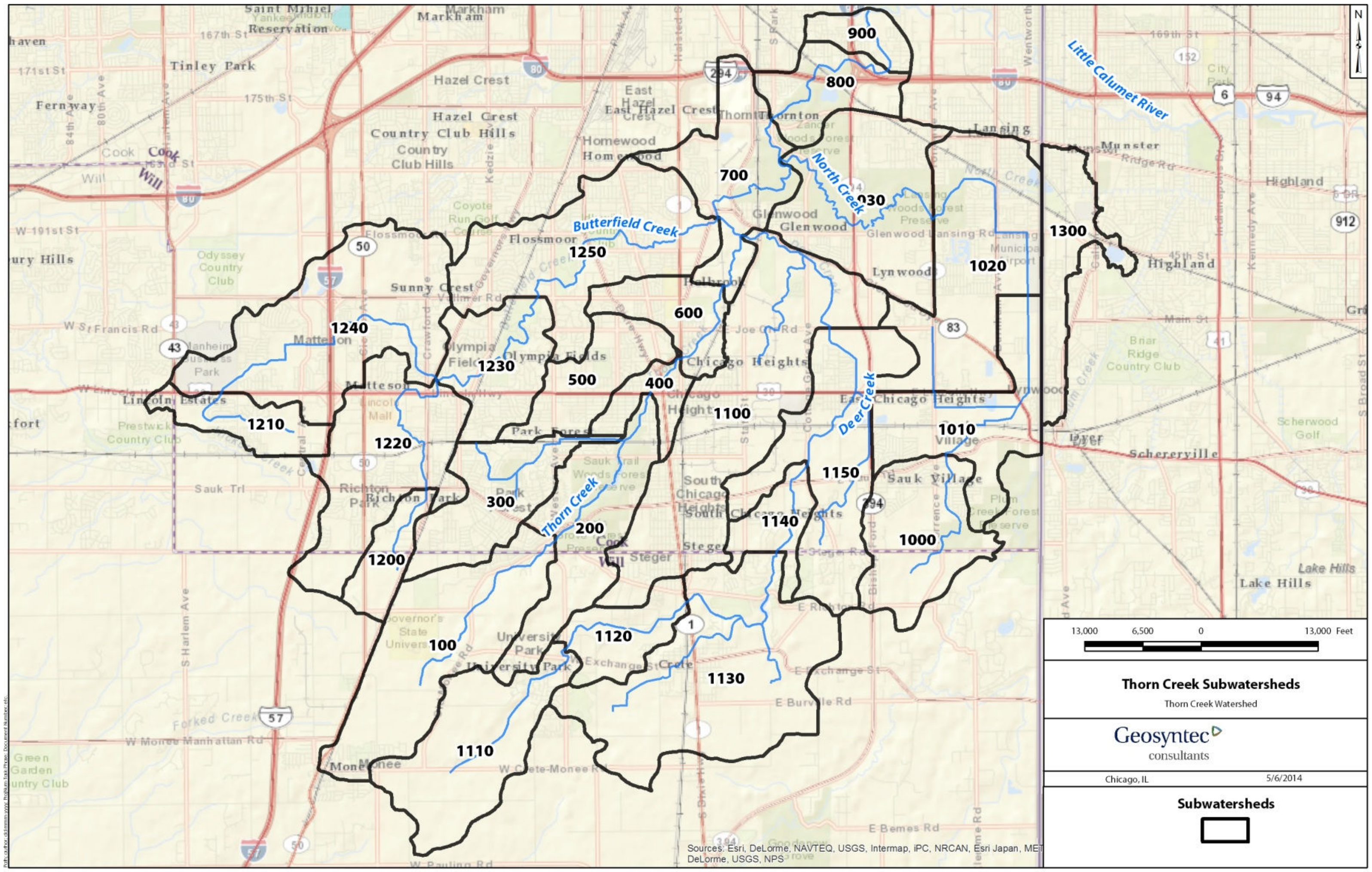


Table 2.2 Existing Conditions Nonpoint Source Pollutant Load Estimates (per acre per year)

Subwatershed	Total Nitrogen Load Estimate (lb/ac/yr)	Total Phosphorus Load Estimate (lb/ac/yr)	Sediment Load Estimate (t/ac/yr)	Fecal Coliform Load Estimate (billion colonies/ac/yr)
(Indiana)	11.5	1.2	0.4	45.0
100	6.1	0.9	0.3	16.7
200	5.1	0.8	0.3	19.6
300	9.3	1.2	0.5	35.9
400	10.6	1.3	0.6	35.2
500	11.4	1.3	0.6	37.7
600	9.6	1.3	0.5	27.5
700	9.3	1.2	0.5	30.6
800	8.2	1.2	0.5	24.2
900	8.4	1.2	0.5	30.4
1000	5.6	0.7	0.3	18.4
1010	7.1	0.9	0.4	20.3
1020	8.4	1.1	0.5	29.3
1030	5.9	0.9	0.3	18.5
1100	9.8	1.2	0.6	30.3
1110	4.4	0.5	0.2	13.4
1120	6.5	0.8	0.3	24.0
1130	5.9	0.7	0.3	17.5
1140	7.8	1.0	0.4	32.1
1150	8.2	1.0	0.5	25.2
1200	7.7	0.9	0.4	25.1
1210	7.0	0.8	0.3	26.3
1220	10.3	1.2	0.5	31.0
1230	7.8	1.1	0.4	28.9
1240	7.2	1.0	0.4	23.9
1250	9.2	1.2	0.5	33.9

2.3 Chloride Loading Analysis

It is expected that a significant portion of the chloride loading in the Thorn Creek Watershed is from roadway, parking lot, and sidewalk deicing activities. Because municipalities are responsible for purchasing and applying the significant amounts of chloride-based deicers, chloride loads are estimated for each municipality in the watershed. However, no data are readily available on the amount of chloride-based deicing compounds currently being used throughout the watershed. Therefore, Geosyntec obtained survey information collected by the DuPage River Salt Creek Workgroup for several local municipalities to estimate the current amount of chloride-based deicers applied.

Usable responses of the surveys were received from the following Illinois units of local government: Addison, Bloomingdale, Bolingbrook, DuPage County, Hanover Park, Naperville, West Chicago, and Woodridge. For the winter of 2011-2012, they reported using between 230 and 1,070 pounds of salt per lane-mile per salt application event. The reported mean, standard deviation, and median were 490, 313, and 327 pounds of salt per lane-mile per salt application event, respectively. Therefore, an analysis of the current chloride load to the Thorn Creek Watershed was performed assuming applications of 300, 400, 500, and 800 pounds per lane-mile per salt application event as displayed in Table 2.3.

Table 2.3 Chloride Loading Scenarios.

	Lane Miles[1]	**@ 300 lb/lane-mile** (tons/year)	**@ 400 lb/lane-mile** (tons/year)	**@ 500 lb/lane-mile** (tons/year)	**@ 800 lb/lane-mile** (tons/year)
County Roads	199	543	724	905	1,447
Chicago Heights	287	784	1,045	1,307	2,091
Country Club Hills	15	41	55	68	109
Crete	111	303	405	506	809
Flossmoor	83	226	301	377	603
Ford Heights	36	98	130	163	261
Frankfort	4	10	14	17	28
Glenwood	65	179	238	298	476
Homewood	62	169	225	281	450
Lansing	114	311	415	519	830
Lynwood	101	276	368	460	737
Matteson	214	585	780	974	1,559
Monee	28	77	103	129	206
Olympia Fields	94	257	343	429	686
Park Forest	153	418	557	696	1,114
Richton Park	91	248	331	414	663
Sauk Village	80	218	290	363	581
South Chicago Height	45	124	165	206	330
South Holland	50	137	182	228	364
Steger	102	278	371	464	742
Thornton	42	114	153	191	305
University Park	62	169	226	282	452
	Total	**5,565**	**7,421**	**9,276**	**14,841**

1) The quantity of lane-mile in each of the 21 municipalities within Thorn Creek Watershed were identified in an Illinois Department of Transportation Geographic Information System (GIS) layer (http://gis.dot.illinois.gov/gist2/).

3. Stream Assessment

Geosyntec conducted a limited stream assessment in April 2014 of Thorn Creek and its tributaries. The streams were generally assessed at bridges or other structures crossing Thorn Creek or its major tributaries: Butterfield, Deer, and North Creeks. Where possible, information also was gathered at major confluences or headwater locations. Data collected included a visual assessment of stream condition, adjacent land use, and environmental factors that could be attributed to altered flows and nonpoint source pollution. Sixty (60) locations were evaluated during the reconnaissance. Prior to the field reconnaissance, the stream channels were evaluated remotely through a desktop analysis. Aerial photography was used to identify possible large scale issues within the watershed, such as stream alterations, land uses that could contribute to nonpoint source pollution impairments, presence or absence of stream buffers, evidence of streambank erosion, in-channel impoundments, or other features of interest. The findings of the desktop analysis, field notes, and photographs of conditions at each location visited were compiled as a part of the evaluation. General conclusions on concerns and opportunities in the Thorn Creek Watershed are noted in this section of the watershed plan update.

3.1 General Stream Observations

Figure 3.1 Thorn Creek main stem showing typical bank scour and erosion.

Thorn Creek and its major tributaries flow through portions of Will and Cook Counties that have a wide range of land uses and development levels. Many portions of Thorn Creek are contained within county forest preserves or local parks. These areas are characterized by floodplain forests, well developed stream buffers, and few stream alterations. A large portion of the creek passes through Chicago Heights where it is mostly buffered by city parks. The upper portions of Thorn Creek consist mostly of agricultural land uses with some smaller residential developments. The main stem of Thorn Creek shows evidence of heavy stormwater flows (Figure 3.1). Much of the stream observed has a fairly well established riparian corridor, at least 25 feet from the top of the bank on both banks at many sites. However, at the majority of sites where agriculture was noted as a dominant land use, minimal riparian corridor was present. Seventy percent of the sites had clearly visible culverts discharging to the stream indicating the stream is receiving a large amount of stormwater.

Butterfield Creek: The confluence of Butterfield Creek and Thorn Creek is well buffered and dominated by floodplain forest. Further upstream, the creek appears moderately degraded and contains minimal buffering as it flows through portions of several community golf courses. Portions of stream banks appeared eroded within the golf courses, with turf grass dominating the majority of the corridor. Further upstream in Matteson, the stream receives direct runoff from residential lawns, agriculture, and commercial development. Portions of Butterfield Creek and its tributaries have been straightened and channelized to accommodate parking lots, roads, and new subdivisions. Little buffer exists in those sections of the creek.

Deer Creek: The confluence of Deer Creek and Thorn Creek is dominated by floodplain forest. Sections surrounding Ford Heights have minimal buffer and appear to have been modified by agricultural and light industrial uses. The tributaries to Deer Creek appeared to have similar characteristics. In the sections of Deer Creek located downstream from Crete, buffers are narrow but present; agriculture and two golf courses have altered portions of the riparian corridor. The portions of Deer Creek and its tributaries upstream of Crete flow mostly through agricultural areas – minimal buffering was observed in this section of the watershed. Headwater areas are also dominated by agriculture land use.

Figure 3.2 North Creek main stem on north side of Lansing Municipal Airport.

North Creek: The lower half of North Creek, running upstream from the confluence of Thorn Creek, is located within several county forest preserves with an abundant forested floodplain. The upper half of the stream appeared to be mostly channelized and modified with minimal buffering as it passes through the Lansing Municipal Airport (Figure 3.2). At Lynwood, the creek passes a large Metropolitan Water Reclamation District regional stormwater facility.

The following is a summary of the observations from the sixty locations visited during the stream assessment effort.

- A completely forested cover was noted at 30 percent of locations.
- Thirty (30) percent of the locations received agricultural runoff.
- Bank erosion and sedimentation were noted at over 50 percent of the locations.
- No riparian corridor or natural buffer was noted at 22 percent of the locations.
- Fifty (50) percent of the locations appeared to have evidence of widening to accommodate stream flows through bridges, culverts, or other roadway crossings.
- At many locations where private homes were observed, maintained lawns typically reached to the edge of the bank with little to no buffer.
- Locations that intersected a golf course appeared to be severely channelized with minimal buffering.

3.2 Stream-Related Water Quality Improvement Opportunities

Results from the desktop analysis and stream assessment were compiled to form a set of possible opportunities for improvement. These improvement areas are focused to address nonpoint source pollution sources and stream restoration. The primary opportunities observed were stream buffer enhancement, streambank stabilization, and stream channel restoration. These possible water quality improvement opportunities were geo-located within the watershed and estimates of the overall amounts of each opportunity were developed as summarized in Table 3.1. It is important to note that these are estimates and the feasibility of implementing any of the identified BMPs is contingent on stakeholder participation, availability of funding, governmental approvals, and technical feasibility.

Table 3.1 Observed Stream-Related BMP Opportunities.

Observed Opportunities	Approximate Quantity Observed
Buffer Enhancement (urban)	24 miles
Buffer Enhancement (ag)	14 miles
Streambank Stabilization	1.5 miles
Stream Restoration	27 miles

Watershed-wide, Thorn Creek and its tributaries would benefit from a comprehensive program to address in-channel debris. An annual watershed “stream sweep,” focused on the removal of trash, litter, and debris, would help alleviate blockages and fish passage impediments, but would also serve as an opportunity to educate stakeholders on important issues in this watershed. Additionally, implementing a stream maintenance program, which is discussed in more detail in Section 4.4, could help correct small issues before they became larger problems.

4. BMP Recommendations

4.1 Urban Stormwater Infrastructure Retrofits

Approximately 57 percent of the Thorn Creek Watershed that has already been developed is classified as "Urban" land. In the developed portion of the watershed, stormwater is generally routed directly from impervious surfaces to stormwater collection and conveyance systems with minimal water quality treatment or stormwater volume reductions. In more recently-developed portions of the watershed, stormwater detention has been incorporated into the sites; however, the majority observed did not provide a water quality benefit. Consistent with current stormwater regulations, the primary goal of providing detention is to reduce the discharge rate of stormwater to decrease downstream flooding. However, the outflow volume from most detention basins remains higher than the pre-developed condition. The increased volume, coupled with the elevated flows from such detention basins during an extended drawdown period, is a major cause of increased streambank erosion in urban streams. Additionally, the use of traditional detention basins does not address the environmental impacts (i.e. increased pollutant concentrations and runoff volume) of increased imperviousness. The urban retrofit projects are intended to provide examples of projects that should be implemented in urban areas to allow for improved pollutant removal or stormwater volume reductions.

Many of the project recommendations center on retrofit opportunities within the watershed. It is important to reiterate that incorporating BMPs into new construction is much more cost-effective and efficient than retrofitting existing systems. Site stormwater BMPs should be incorporated at the time of initial design and built during initial construction. This approach offers the most options from the palette of BMPs, providing the engineer more flexibility and more cost-effective solutions. However, current ordinances do not mandate the use of stormwater BMPs to specifically address the pollutants of concern in the Thorn Creek Watershed. For this reason, the plan update focuses on retrofit opportunities within the watershed.

A variety of urban BMPs could be used throughout the watershed, many of which could provide multiple benefits. This plan update proposes the installation of bioretention (and biofiltration), vegetated swales, detention basin retrofits, and building retrofits – such as planter boxes and green roofs – as the primary retrofit practices.[5] Three objectives guided the identification of urban retrofit projects included in this plan update:

- Manage stormwater at the source;
- Use plants and soil to absorb, slow, filter, and cleanse runoff; and
- Recommend stormwater facilities that are simple, cost-effective, and enhance community aesthetics.

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[5] Stormwater BMPs are routinely grouped into categories based upon their unit processes. However, there is no set standard for grouping BMPs, nor should they be isolated into any single category when their use is evaluated. Individuals evaluating the use and applicability of BMPs should tailor the design to blend the benefits of various BMPs. For example, a vegetated swale (which provides settling and filtration of suspended solids by flowing through the surface vegetation) could be modified to include amended soil in the bottom of the swale along with check dams to improve infiltration and filtration through the soil media (which is a process more commonly associated with bioretention).

4.1.1 BIORETENTION

Bioretention areas, or rain gardens, are landscaped shallow depressions that store and filter stormwater runoff. These facilities normally consist of a ponding area, mulch layer, amended soils, and plantings. For areas with low permeability soils or steep slopes, bioretention areas can be designed with amended soils and an optional underdrain system that routes the treated runoff to the storm drain system rather than depending entirely on infiltration.

Bioretention areas function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. Bioretention areas have a wide range of applications and can be easily incorporated into existing residential, commercial, and industrial areas. These facilities can also be used within roadway right-of-ways. Runoff from the site is typically conveyed in shallow engineered open conveyances, shallow pipes, curb cuts, or other innovative drainage structures. Where underlying soils have limited infiltration capacity, an underdrain should be included. Additional volume losses may be realized if the perforated pipe is placed above the bottom of the gravel drainage layer.

An alternative to bioretention retrofits for highly urbanized locations are the Filterra Bioretention Systems (Figure 4.1). These bio*filtration* systems are designed to treat stormwater pollution by incorporating trees and shrubs into curb inlet boxes to trap and treat the stormwater before entering the system. Expected pollutant removal ranges from as much as 70% for phosphorus, 45% for nitrogen, and up to 85% for TSS. A specialized Filterra unit, Bacterra, is expected to remove as much as 98% fecal coliform. While these systems are designed to treat smaller drainage areas they can be an effective urban retrofit to treat water quality.

Figure 4.1 Filterra system. (Source: Filterra.com)

4.1.2 VEGETATED SWALE (CONVEYANCE) RETROFITS

Figure 4.2 Vegetated swale. (Source: werf.org)

Vegetated swales are shallow, open conveyance channels with low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff through the vegetated bottom to downstream discharge points. Swales remove stormwater pollutants by filtering flows through vegetation (usually grasses) and by allowing suspended pollutants to settle due to the shallow flow depths and slow velocities in the swale. Biochemical processes also provide treatment of dissolved constituents. Vegetated swales can also provide effective volume reduction through infiltration and evapotranspiration processes. An effective vegetated swale achieves uniform sheet flow through a densely vegetated area for a period of at least 10 minutes. The vegetation in the swale can vary depending on its location within a development project, is the choice of the designer, and is based upon the relevant functional criteria for the project. When appropriate, swales that are integrated within a project may use turf or other more intensive landscaping, while swales that are located on the project perimeter, within a park, or close to an open space area are encouraged to be planted with a more naturalistic plant palette.

Swales have a wide range of applications and can be used in residential, commercial, and industrial areas as well as treatment for linear projects such as roadways. A vegetated swale can be designed either on-line or off-line. On-line vegetated swales are used for conveying high flows as well as providing treatment of the water quality design flow rate, and can replace curbs, gutters, and storm drain systems. Off-line swales are the preferred practice, but in densely developed areas off-line swales may not always be feasible. In this case, limiting drainage areas and periodically providing outlets along the length of the swale to prevent the accumulation of excessive flows from inputs along the swale can improve the performance of on-line swales. Check dams are also recommended where longitudinal slopes exceed six percent. Check dams enhance sediment removal by causing stormwater to pond, allowing coarse sediment to settle out.

4.1.3 DETENTION BASIN RETROFITS

Myriad detention basins have been constructed throughout the Thorn Creek Watershed, particularly in the central and southern portions of the watershed that were developed more recently. Both dry and wet detention facilities are common. Dry basins were typically vegetated with turf grass and designed to drain completely after storm events. Dry basins also commonly had low flow channels that route flows from basin inlets to the basin outlet with little or no water quality treatment.

Figure 4.3 Traditional wet detention basin.

Figure 4.4 Traditional dry detention basin with low flow channel.

A common dry detention basin retrofit to enhance water quality is to modify the design to incorporate sections of wetland vegetation. Wetland type detention basins typically include components such as an inlet with energy dissipation structures, a sediment forebay to settle out coarse solids and to facilitate maintenance, perimeter areas with shallow sections (0 to 2 feet deep) planted with wetland vegetation, deeper areas or micro pools (3 to 5 feet deep), and a two stage outlet structure to improve water quality treatment. Meandering swales can also be incorporated into the basins to increase the residence time during low flow conditions.

The interactions between the incoming stormwater runoff, aquatic vegetation, wetland soils, and the associated physical, chemical, and biological unit processes are a fundamental part of wetland basin designs. Detention basin wetlands are generally designed as plug flow systems in which the water already present in the permanent pool is displaced by incoming flows with minimal mixing and no short circuiting. Plug flow describes the hypothetical condition of stormwater moving through the wetland in such a way that older slugs of water (meaning discreet volumes of water that have been in the wetland a longer duration) are displaced by incoming slugs of water. This concept assumes there is little or no mixing of slugs in the direction of flow. Short circuiting occurs when quiescent areas or dead zones develop in the wetland where pockets of water remain stagnant, causing other volumes to bypass using shorter flow paths through the basin (e.g., incoming stormwater slugs bypass these dead zones).

Enhancements that maximize residence time, aid in trapping and uptake of pollutants, or assist with volume reduction are the main categories of enhancements available for wetland basins. Water quality benefits can be improved with a larger permanent pool, shallower depths, and denser vegetation. Wetland vegetation with known pollutant uptake potential may also enhance wetland performance. Outlet controls may be used to seasonally change wet pool depths and flow rates through the system to increase residence time. Extended detention flow control may also be integrated into the design to improve peak flow reductions.

4.1.4 BUILDING RETROFITS

Building retrofits are effective BMP techniques that can be viable options in many settings, including in urban areas that are dominated by impervious surfaces and roof tops. Three common techniques include the use of planter boxes, green roofs, and blue roofs.

Figure 4.5 Example raingarden.

Planter boxes are bioretention treatment control measures that are completely contained within an impermeable structure with an underdrain. The boxes can be comprised of a variety of materials, such as brick or concrete, and are filled with gravel on the bottom, planting soil media, and vegetation. Planter boxes require splash blocks for flow energy dissipation and geotextile filter fabric or choking stone to reduce clogging of the underdrain system.

Figure 4.6 Example green roof.

Green roofs (also known as eco-roofs and vegetated roof covers) are roofing systems that layer a soil/vegetative cover over a waterproofing membrane. There are two types of green roofing systems; extensive, which is a light-weight system, and intensive, which is a heavier system that allows for larger plants but requires additional structural support. Green roofs rely on highly porous media and moisture retention layers to store intercepted precipitation and to support vegetation that can reduce peak flows and the volume of stormwater runoff via evapotranspiration. Reduced flows may also limit contaminant mobilization and allow other downstream BMPs to perform more effectively by increasing the percent of runoff volume captured.

Figure 4.7 Example blue roof.

Blue roofs are yet another form of green infrastructure, but unlike green roofs they are non-vegetated systems that focus on collecting stormwater. A blue roof system detains rainwater directly on a rooftop and slowly releases that water to the sewer system, allowing for some depression storage and evaporation losses. The water collected can be used for irrigation, a site infiltration system, a rain garden, or slowly discharge into the sewer system. Blue roofs are less costly than green roofs due to the lack of materials required are most effective and practical when installed on relatively flat surfaces, which are often associated with commercial or industrial buildings. Blue roofs do not provide benefits such as energy use reduction or habitat and aesthetic appeal, but they do slightly outperform green roofs for stormwater reduction. Due to the light colored roofing material they can also provide sustainability benefits through rooftop heat reduction. In some cases, special structural considerations are necessary to ensure that adequate support is provided for the detained water and blue roof materials themselves.

4.1.5 PERMEABLE PAVEMENT

Figure 4.8 Example permeable pavement.

Permeable pavement in its many variations contains small voids that allow water to pass through to a stone base where runoff is retained and sediments and metals are treated to some degree. Porous asphalt and porous concrete are poured in place while pavers are typically precast and installed in an interlocking array to create a surface. The use of permeable pavement in lieu of conventional pavement surfaces reduces the runoff volume and flow rates while maintaining functionality. Permeable pavement can be applied to residential, commercial, and industrial areas as an alternative to traditional impermeable surfaces like sidewalks and parking lots. Permeable pavements typically are applied to infiltrate stormwater. In soils that prohibit infiltration, an underdrain system will likely be required. These pavements also remove stormwater pollutants through limited sorption and filtration. The paving surface, subgrade, and installation requirements of permeable pavements are more complex than those for conventional asphalt or concrete surfaces.

4.1.6 ESTIMATED LOAD REDUCTIONS AND IMPLEMENTATION COSTS

BMP scenarios were chosen to estimate the potential load reductions throughout the watershed. The scenarios modeled treat 18-20% of the watershed using a combination of urban and suburban BMP distributions. (i.e., the urban sub-basins contain more retrofit and distributed BMPs while the suburban sub-basins contain more retention basins and regional BMPs). The BMP distributions are displayed in Table 4.1.

Table 4-1. BMP Distributions.

BMP Type	Urban	Non-Urban
Bioretention/Raingarden	5%	5%
Vegetated Swale Retrofits	5%	5%
Detention Basin Retrofits	5%	10%
Green Roof	0.5%	0%
Filterra	0.5%	0%
Bacterra	0.5%	0%
Permeable Pavement	2%	0%
Total	**18.5%**	**20%**

Pollutant load reductions estimates for the implementation of a select few from of the suite of BMPs recommended in this section were calculated with a watershed model by using literature estimates of pollutant removal efficiencies.[6] BMPs were selected based on a combination of the pollutant analysis, field assessment, and land use. A summary of the pollutant load reduction estimates are also presented in Appendix C. The reader should recognize the use of pollutant removal efficiencies, or percent removal, to

[6] The model was developed by Geosyntec in large part based on a study performed in 1993 by Tom Price of NIPC for the Lake County Stormwater Management Commission. A similar approach was used in the 2005 Thorn Creek Watershed Based Plan.

estimate pollutant load reductions has several shortcomings.[7] As a result, the estimates derived from the analyses described above do not represent absolute expected results from the implementation of BMPs recommended in this plan, and are only planning-level estimates. BMP costs were developed from cost information derived through various Geosyntec projects and from other sources such as the USDA Forest Service and Milwaukee Metropolitan Sewer District.

4.2 Stream Channel and Riparian Corridor Restoration

As noted in Section 3, several watershed opportunities were identified for stream channel and riparian corridor restoration. These opportunities included stream buffer enhancement, streambank stabilization, and stream restoration (i.e., remeandering channelized segments). The following paragraphs provide brief summaries of the opportunities identified for watershed-wide implementation.

Figure 4.9 Example streambank stabilization project.

Instability of stream channels was observed several locations during the watershed reconnaissance effort. This evidence included portions of the stream channels with variable degrees of stream bank erosion, ranging from moderate to severe. These eroding streams can be a significant source of sediment as well as sediment-bound nutrients. Eroding stream banks and downcutting channels can also detrimentally affect property and infrastructure. Remedial actions to address channel stability concerns require a detailed understanding of the processes causing the channel instability. For example, an exposed stream bank may be the result of bank erosion by stream flows or may be caused by downcutting of the stream channel and subsequent slumping of the stream bank. Remedial actions need to account for the severity of the channel instability. Moderate cases of stream bank instability may be addressed through relatively simple methods, including minor grading and establishment of deep-rooted vegetation as opposed to mowed turf grass. Areas with severe erosion will typically require more involved evaluation and remedies.

Riparian buffers are vegetated areas next to streams that protect the water body from nonpoint source pollution, provide bank stabilization, and provide aquatic and wildlife habitat. Ideally riparian buffers should be composed of native vegetation including grasses or trees, or both. Along many reaches of the stream channels within in the Thorn Creek Watershed, the riparian corridor has been impacted by human activities. Some of these activities include turf grass management up to the stream, agricultural uses, and commercial and industrial facilities immediately adjacent to the stream. The establishment of new riparian buffers in the watershed will likely present challenges given that the buffer areas are generally impacted in order to meet the needs of the property owners. However, opportunities exist within the watershed where buffers can be established.

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[7] As Jones et al. writes, "[p]ercent removal is primarily a function of influent quality. In almost all cases, higher influent pollutant concentrations into functioning BMPs result in reporting of higher pollutant removals than those with cleaner influent. In other words, use of percent removal may be more reflective of how 'dirty' the influent water is than how well the BMP is actually performing." Jones, J.E., J. Clary, E. Strecker, and M. Quigley. 2008, "15 Reasons You Should Think Twice Before Using Percent Removal to Assess BMP Performance," *Stormwater*, January-February 2008.

One of the objectives of the stream assessment effort was to identify opportunities within the watershed for stream restoration. The primary method for identifying these opportunities was through the physical stream characteristic assessment. From this assessment, several stream segments stood out as having relatively degraded physical stream characteristics, such as channelization. Project elements for the identified stream restoration opportunities would include remeandering the stream channel; improving the riparian zone through planting native vegetation, including trees; and installing in-stream structures such as rock riffles with the goals of improving habitat for aquatic organisms and sediment transport.

Table 4.2 identifies the estimated extent and costs of the stream channel and riparian corridor restoration opportunities on a watershed-wide scale. It should be noted here that in addition to grant funding opportunities, wetland mitigation funds from regulated wetland impacts in other portions of the watershed may be a viable funding source for these types of projects.

Table 4.2 Watershed-Wide Stream Channel and Riparian Corridor Restoration Pollutant Load Reduction and Cost Estimates.

BMP	Amount Identified	Nitrogen Reduction (lb/year)	Phosphorus Reduction (lb/year)	Sediment Reduction (lb/year)	BOD Reduction (lb/year)	Estimated Cost[1]
Buffer Installation (urban)	24 miles	355.1	61.1	1,950.0	16.6	$ 2,530,000
Buffer Installation (non-urban)	14 miles	1,990.4	552.9	2,003.3	313.0	$ 1,480,000
Stream Stabilization	1.5 miles	948.7	365.2	1,897.4	515.6	$ 190,080
Stream Restoration	27 miles	ND	ND	ND	ND	$ 9,970,440
Total		**3,294.3**	**979.2**	**5,850.7**	**845.2**	**$14,170,500**

[1] Costs were derived from cost information derived through various Geosyntec projects and from other sources such as the USDA Forest Service.
ND - not determined or insufficient data

4.3 Chloride Reduction Strategies

The removal of chloride from stormwater runoff through implementation of typical stormwater BMPs presents a challenge in that the effectiveness of most BMPs for chloride removal is limited. As a result, the preferred approach for addressing chloride loading within the watershed is through source reduction. The recommendation to address chloride in the Thorn Creek Watershed is separated into two components to target chloride loadings from roadway deicing activities and from commercial and residential sources.

The first component of the recommendation is for watershed communities to evaluate and implement alternative roadway snow and ice management methods. This may include the use of alternative products that have lower, or no, chloride content to supplement road salt usage, such as beet juice. Alternative approaches of snow and ice management should also be included, such as pretreatment of road surfaces with liquid anti-icing products in advance of winter storm events. Admittedly, public safety is of the utmost importance in the evaluation of alternative snow and ice management methods. Therefore, the watershed municipalities should carefully evaluate the effectiveness of alternative products and approaches.

The DuPage River Salt Creek Workgroup formed a Chloride Committee and the Chloride Education and Reduction Program to develop and promote alternatives to conventional roadway deicing practices and guide the implementation of alternatives. An element of their program was gathering information from the 80 municipal deicing programs via survey questionnaires and evaluating alternative anti-icing programs that reduce chloride runoff. As mentioned in Section 2 of this report, the mean salt application rate from the survey was 490 pounds/lane mile.

Assuming similar application rates were applied from the municipalities within the Thorn Creek Watershed, the estimated chloride loading would be approximately 9,000 tons/year. If alternative anti-icing programs were implemented throughout the watershed to reduce mean salt application rates to 300 pounds/lane mile, an estimated 3,500 tons/year, or 40 percent, of chloride loading could be reduced to Thorn Creek and its tributaries.

4.4 Stream Maintenance and Restoration

Reaches of Thorn Creek and its tributaries are in need of debris and trash removal that contributes to overbank flooding and streambank erosion. While debris removal is often necessary, some amount of large woody debris is important, since it provides fish habitat and substrate for the aquatic insects that break down organic debris in the stream.

The recommendation for the Thorn Creek Watershed and its tributary watersheds is that communities should work cooperatively with park districts, forest preserve districts, school districts, and private land owners in the long-term ecological management of stream corridors, wetlands, and upland natural areas. In particular, watershed communities should work cooperatively to implement a regular stream maintenance program that balances improved conveyance with habitat considerations. This effort should entail the enlistment of ecologists, biologists and engineers from organizations operating within the watershed in providing on-going input into the stream maintenance program activities.8 This input should include evaluations of maintenance needs and the methods employed for the maintenance activities. An example of the latter is that the implementation of appropriate soil erosion and sediment control measures should be a critical consideration for stream maintenance activities.

4.5 Farmed Wetland Restoration

Figure 4.10 Farmed wetland site within Thorn Creek Watershed.

Farmed wetlands are wetlands that were partially drained or altered to improve crop production before the Wetland Conservation Compliance provisions (Swampbuster) were enacted in the 1985 Farm Bill. Restoring farmed wetlands improves groundwater quality, helps trap and break down pollutants from runoff, prevents soil erosion, reduces downstream flood damage, and provides habitat for waterfowl and other wildlife. Restoring wetlands is typically accomplished by breaking drainage tiles and building an embankment to pond runoff.

Using a comparison of CMAP's 2005 and 2010 land use data, three farmed wetlands were identified within the Thorn Creek Watershed. One of the farmed wetlands identified is shown in Figure 4.10. An EPA Spreadsheet Tool to Estimate Pollutant Loads (STEPL) was used to estimate the potential pollutant reductions if the wetlands were restored. Table 4.3 displays the estimated pollutant reductions and cost for these projects.

[8] An example of a stream maintenance program that claims to address both conveyance and habitat concerns is provided at: http://www.scwa.ca.gov/stream-maintenance-program/

Table 4.3 Farmed Wetland Restoration Pollutant Load Reduction and Cost Estimates.

BMP Type	Wetland Area (acres)	Nitrogen Reduction (lb/year)	Phosphorus Reduction (lb/year)	Sediment Reduction (lb/year)	BOD Reduction (lb/year)	Estimated Cost[1]
Wetland 1	3.2	218.2	81.9	580.9	58.9	$ 46,096
Wetland 2	5.3	340.5	127.7	918.9	91.0	$ 76,347
Wetland 3	6.5	661.1	245.1	1,977.3	164.3	$ 93,633
Total	**15**	**1,219.8**	**454.8**	**3,477.1**	**314.2**	**$ 216,076**

1) BMP costs were derived through various sources such as the USDA and the Ecosystem Marketplace.

Appendix A

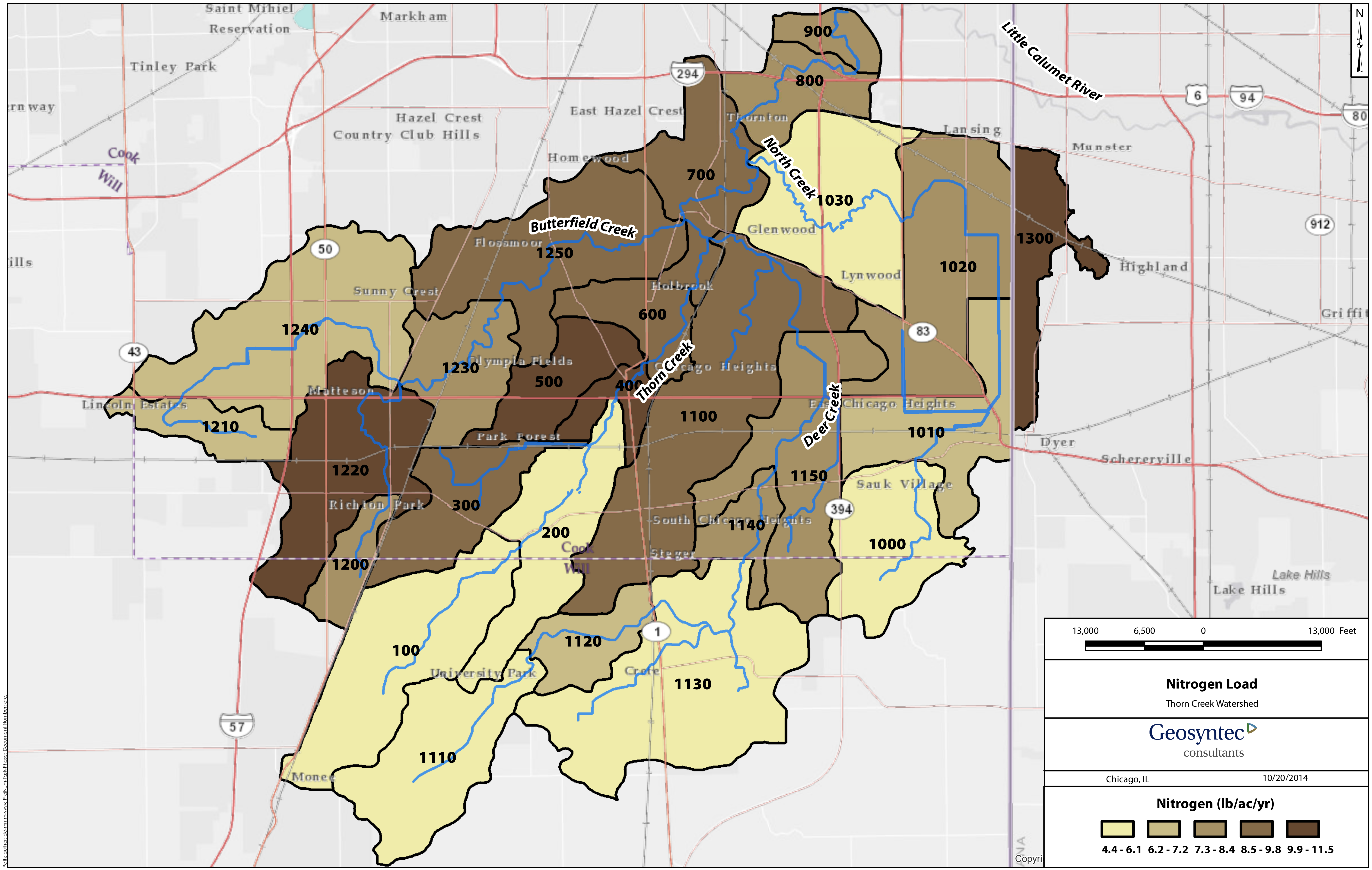
Subwatershed Land Use

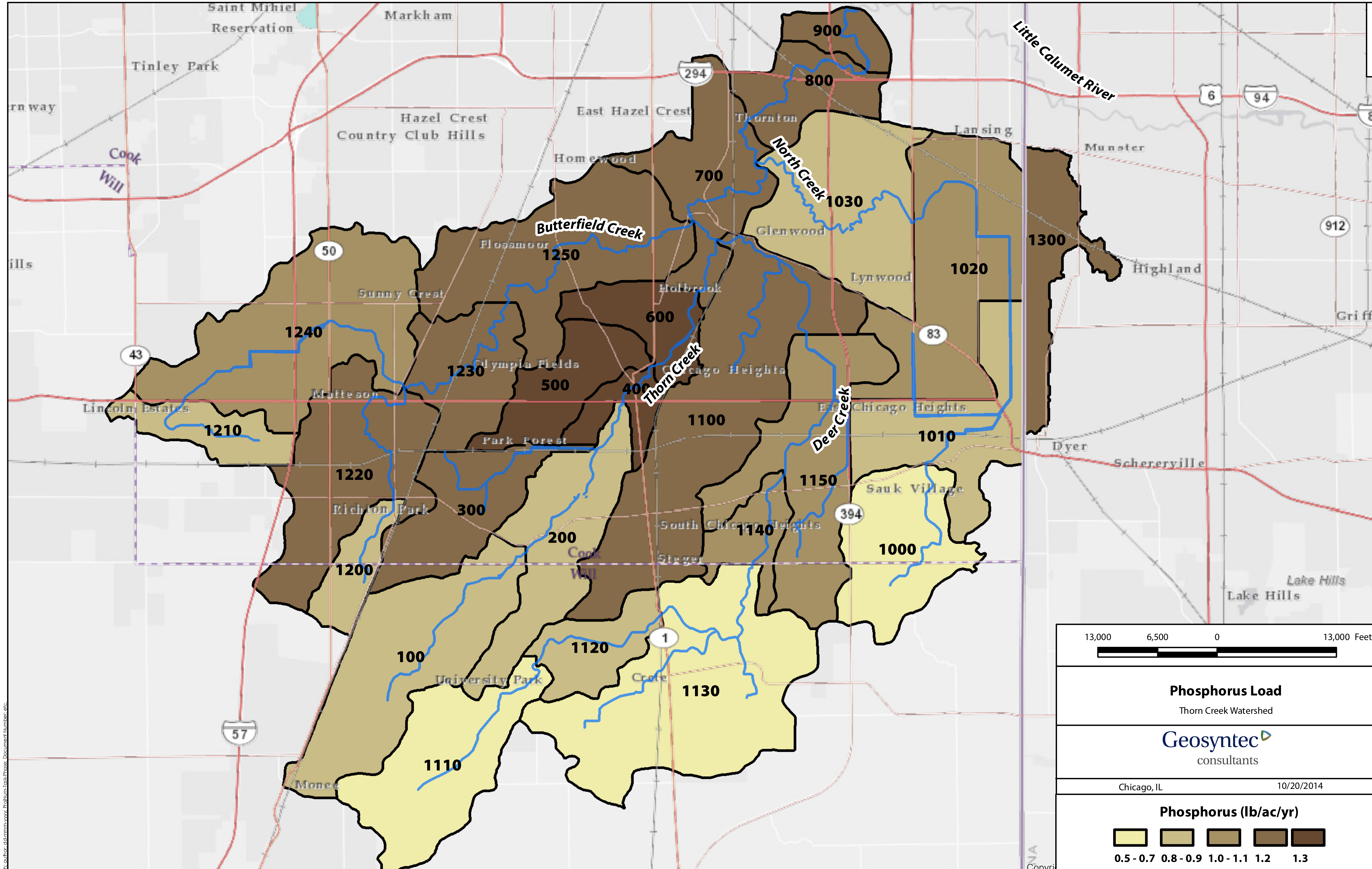
Thorn Creek Landuse Breakdown

Watershed ID	Low and Mid Density Residential	Agriculture (ac/percent)	Transportation/ Communications/ Utility/Waste	Open Space	Vacant or Under Construction	Industrial	Institutional	Commercial	High Density Residential	Not Classifiable	Total
	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac (%)	Ac
Indiana	860 (51%)	7 (0%)	0 (0%0	147 (9%)	0 (0%)	423 (25%)	0 (0%)	219 (13%)	14 (1%)	0 (0%)	1671
100	713 (18%)	596 (15%)	355 (9%)	1470 (37%)	180 (4%)	146 (4%)	532 (13%)	27 (1%)	2 (0%)	0 (0%)	4023
200	571 (21%)	49 (2%)	245 (9%)	1359 (49%)	278 (10%)	103 (4%)	65 (2%)	11 (0%)	81 (3%)	0 (0%)	2762
300	809 (39%)	143 (7%)	487 (23%)	195 (9%)	117 (6%)	14 (1%)	148 (7%)	56 (3%)	126 (6%)	0 (0%)	2097
400	224 (32%)	0 (0%)	190 (27%)	89 (12%)	50 (7%)	2 (0%)	59 (8%)	57 (8%)	41 (6%)	0 (0%)	712
500	562 (36%)	0 (0%)	314 (20%)	109 (7%)	108 (7%)	35 (2%)	171 (11%)	192 (12%)	90 (6%)	2 (0%)	1583
600	340 (27%)	2 (0%)	270 (21%)	299 (23%)	46 (4%)	81 (6%)	173 (14%)	55 (4%)	6 (0%)	0 (0%)	1274
700	282 (11%)	0 (0%)	247 (10%)	915 (37%)	73 (3%)	704 (28%)	159 (6%)	54 (2%)	51 (2%)	1 (0%)	2488
800	286 (19%)	10 (1%)	380 (26%)	603 (41%)	3 (0%)	99 (7%)	28 (2%)	43 (3%)	9 (1%)	7 (0%)	1471
900	279 (42%)	5 (1%)	136 (21%)	15 (23%)	9 (1%)	31 (5%)	31 (5%)	10 (1%)	1 (0%)	4 (1%)	661
1000	571 (23%)	914 (37%)	286 (11%)	317 (13%)	289 (12%)	4 (0%)	70 (3%)	35 (1%)	14 (1%)	0 (0%)	2501
1010	485 (17%)	1015 (36%)	581 (21%)	374 (13%)	115 (4%)	83 (3%)	97 (3%)	42 (1%)	6 (0%)	0 (0%)	2798
1020	1397 (33%)	834 (19%)	945 (22%)	415 (10%)	167 (4%)	82 (2%)	146 (3%)	129 (3%)	101 (2%)	66 (2%)	4284
1030	770 (21%)	284 (8%)	531 (14%)	1675 (45%)	148 (4%)	26 (1%)	110 (3%)	103 (3%)	38 (1%)	9 (0%)	3695
1100	907 (15%)	1069 (18%)	1435 (24%)	367 (6%)	652 (11%)	967 (16%)	201 (3%)	171 (3%)	97 (2%)	6 (0%)	5873
2220	397 (13%)	2192 (71%)	193 (6%)	19 (1%)	229 (7%)	0 (0%)	37 (1%)	17 (1%)	11 (0%)	0 (0%)	3096
1120	459 (37%)	336 (27%)	114 (9%)	63 (5%)	159 (13%)	27 (2%)	85 (7%)	11 (1%)	1 (0%)	0 (0%)	1256
1130	1055 (18%)	2672 (47%)	677 (12%)	398 (7%)	549 (10%)	48 (1%)	191 (3%)	139 (2%)	9 (0%)	0 (0%)	5740
1140	508 (55%)	67 (7%)	152 (17%)	39 (4%)	117 (13%)	1 (0%)	10 (1%)	23 (3%)	0 (0%)	0 (0%)	919
1150	703 (19%)	1063 (29%)	782 (21%)	60 (2%)	506 (14%)	381 (10%)	101 (3%)	45 (1%)	4 (0%)	3 (0%)	3648
1200	119 (14%)	360 (42%)	135 (16%)	2 (0%)	109 (13%)	95 (11%)	1 (0%)	26 (3%)	20 (2%)	0 (0%)	867
1210	362 (32%)	463 (41%)	145 (13%)	22 (2%)	40 (4%)	85 (8%)	0 (0%)	6 (1%)	0 (0%)	0 (0%)	1125
1220	959 (27%)	551 (16%)	739 (21%)	132 (4%)	310 (9%)	113 (3%)	169 (5%)	407 (12%)	87 (2%)	22 (1%)	3490
1230	850 (44%)	2 (0%)	386 (20%)	463 (24%)	77 (4%)	9 (0%)	92 (5%)	30 (2%)	6 (0%)	0 (0%)	1915
1240	1520 (31%)	633 (13%)	852 (17%)	1055 (22%)	384 (8%)	1 (0%)	199 (4%)	175 (4%)	38 (1%)	24 (0%)	4882
1250	2181 (52%)	36 (1%)	808 (19%)	501 (12%)	109 (3%)	29 (1%)	378 (9%)	148 (3%)	40 (1%)	3 (0%)	4234
TOTAL	**18169 (26%)**	**133304 (19%)**	**11385 (16%)**	**11241 (16%)**	**4823 (7%)**	**3590 (5%)**	**3255 (5%)**	**2232 (3%)**	**891 (1%)**	**149 (0%)**	**69041**

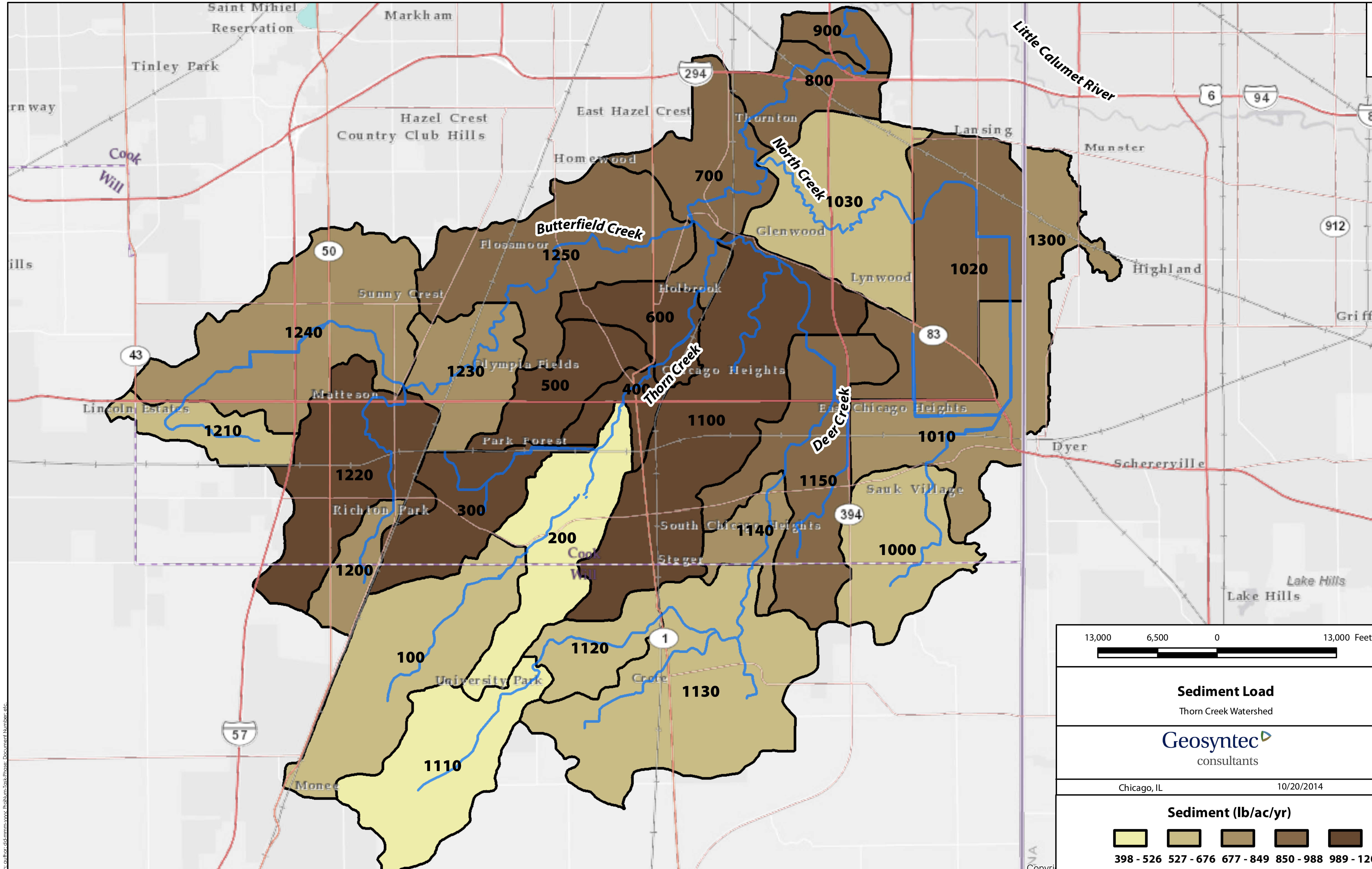
Appendix B

Existing Conditions NPS Pollutant Load Estimates – Maps


Nitrogen Load
Thorn Creek Watershed
Geosyntec consultants
Chicago, IL
10/20/2014
Nitrogen (lb/ac/yr)
4.4 - 6.1
6.2 - 7.2
7.3 - 8.4
8.5 - 9.8
9.9 - 11.5
13,000
6,500
0
13,000 Feet
N
Butterfield Creek
Thorn Creek
North Creek
Deer Creek
Little Calumet River
100
200
300
400
500
600
700
800
900
1000
1010
1020
1030
1100
1110
1120
1130
1140
1150
1200
1210
1220
1230
1240
1250
1300
Saint Mihiel Reservation
Markham
Tinley Park
Hazel Crest
Country Club Hills
East Hazel Crest
Homewood
Thornton
Lansing
Munster
Glenwood
Lynwood
Highland
Flossmoor
Sunny Crest
Holbrook
Olympia Fields
Matteson
Lincoln Estates
Chicago Heights
East Chicago Heights
Park Forest
Richton Park
South Chicago Heights
Steger
Sauk Village
Dyer
Schererville
University Park
Crete
Monee
Lake Hills
Cook
Will
294
6
94
80
912
50
43
83
394
1
57



Phosphorus Load
Thorn Creek Watershed
Geosyntec consultants
Chicago, IL
10/20/2014
Phosphorus (lb/ac/yr)
0.5 - 0.7
0.8 - 0.9
1.0 - 1.1
1.2
1.3
13,000
6,500
0
13,000 Feet
N
Little Calumet River
North Creek
Butterfield Creek
Thorn Creek
Deer Creek
900
800
700
1030
1300
1020
1250
600
1240
1230
500
400
1100
1010
1210
1220
300
1150
1140
1000
200
1200
100
1120
1130
1110
Saint Mihiel Reservation
Markham
Tinley Park
Hazel Crest
Country Club Hills
East Hazel Crest
Thornton
Homewood
Lansing
Munster
Glenwood
Flossmoor
Highland
Lynwood
Sunny Crest
Holbrook
Olympia Fields
Chicago Heights
Matteson
Lincoln Estates
East Chicago Heights
Park Forest
Dyer
Schererville
Sauk Village
Richton Park
South Chicago Heights
Steger
Cook
Will
Lake Hills
University Park
Crete
Monee
294
6
94
80
912
50
43
83
394
1
57


Sediment Load
Thorn Creek Watershed
Geosyntec consultants
Chicago, IL
10/20/2014
Sediment (lb/ac/yr)
398 - 526
527 - 676
677 - 849
850 - 988
989 - 1206
13,000
6,500
0
13,000 Feet
N
Butterfield Creek
Thorn Creek
North Creek
Deer Creek
Little Calumet River
100
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300
400
500
600
700
800
900
1000
1010
1020
1030
1100
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Saint Mihiel Reservation
Markham
Tinley Park
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Country Club Hills
East Hazel Crest
Homewood
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Munster
Glenwood
Lynwood
Flossmoor
Sunny Crest
Holbrook
Olympia Fields
Matteson
Lincoln Estates
Chicago Heights
East Chicago Heights
Park Forest
Richton Park
South Chicago Heights
Steger
Sauk Village
University Park
Crete
Monee
Highland
Dyer
Schererville
Lake Hills
Cook
Will
294
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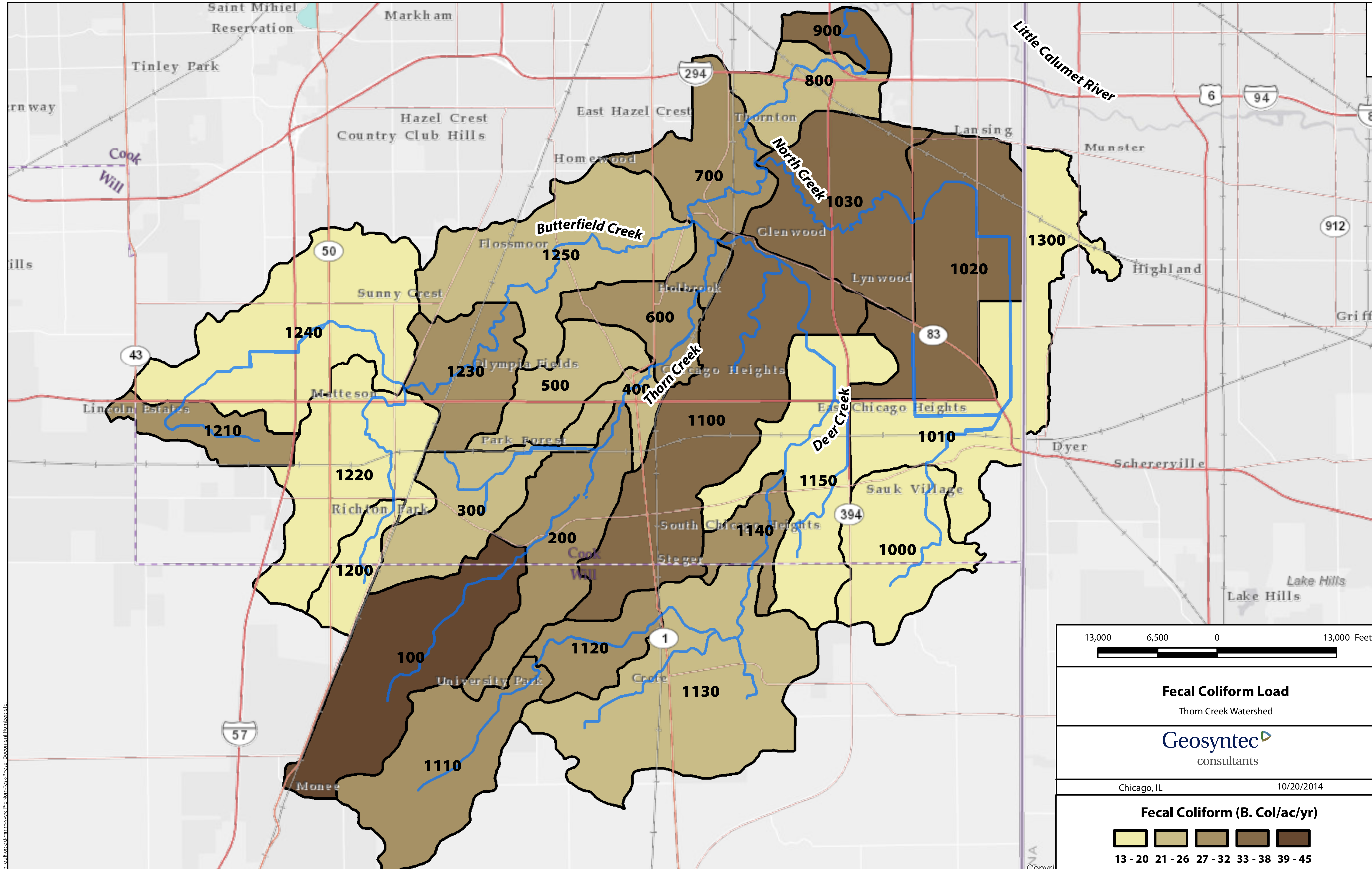
80
912
50
43
83
394
1
57



Saint Mihiel Reservation
Markham
Tinley Park
Hazel Crest
Country Club Hills
East Hazel Crest
Homewood
Thornton
Lansing
Munster
Little Calumet River
North Creek
Butterfield Creek
Flossmoor
Glenwood
Lynwood
Highland
Sunny Crest
Holbrook
Olympia Fields
Chicago Heights
Thorn Creek
Matteson
Lincoln Estates
Park Forest
East Chicago Heights
Deer Creek
Dyer
Schererville
Sauk Village
Richton Park
South Chicago Heights
Steger
Cook
Will
Lake Hills
University Park
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600
1240
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500
400
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1210
1010
1220
1150
300
200
1140
1000
1200
100
1120
1130
1110
294
6
94
80
912
50
43
83
394
1
57
N
13,000
6,500
0
13,000 Feet
Fecal Coliform Load
Thorn Creek Watershed
Geosyntec
consultants
Chicago, IL
10/20/2014
Fecal Coliform (B. Col/ac/yr)
13 - 20
21 - 26
27 - 32
33 - 38
39 - 45

Appendix C

Subwatershed BMP Scenarios – Estimated Pollutant Load Reductions and Costs

Subwatershed BMP Scenarios – Estimated Pollutant Load Reductions and Costs

Subwatershed	Subwatershed Treated	BMP	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (t/yr)	Fecal Reduction (B. Col/yr)	Estimated Cost[1] ($)
Indiana	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	409	80	0.4	570	2,641,643
	5.0%	Retention Pond	523	67	0.4	599	528,329
	0.5%	Filterra	43	7	n/a	n/a	3,302,053
	0.5%	Bacterra	n/a	n/a	n/a	93	3,302,053
	2.0%	Porous Pavement	n/a	16	0.2	n/a	3,962,464
	0.5%	Green Roof	24	2	n/a	n/a	759,472
Total			**998**	**172**	**1.0**	**1,262**	**14,496,014**
100	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	449	108	0.4	626	2,167,975
	10.0%	Retention Pond	1,148	183	0.9	1,315	867,190
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**1,597**	**290**	**1.3**	**1,942**	**3,035,165**
200	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	255	62	0.2	356	1,760,513
	10.0%	Retention Pond	652	105	0.5	747	704,205
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**907**	**167**	**0.7**	**1,103**	**2,464,718**
300	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	402	98	0.4	561	2,601,317
	5.0%	Retention Pond	514	83	0.4	589	520,263
	0.5%	Filterra	42	8	n/a	n/a	3,251,646
	0.5%	Bacterra	n/a	n/a	n/a	92	3,251,646
	2.0%	Porous Pavement	n/a	19	0.1	n/a	3,901,976
	0.5%	Green Roof	23	3	n/a	n/a	747,879
Total			**982**	**211**	**1.0**	**1,242**	**14,274,728**
400	5.0%	Bioswales	1	3	0.5	n/a	70,963
	5.0%	Bioretention	158	36	0.1	221	894,666
	5.0%	Retention Pond	202	30	0.2	232	178,933
	0.5%	Filterra	17	3	n/a	n/a	1,118,332
	0.5%	Bacterra	n/a	n/a	n/a	36	1,118,332
	2.0%	Porous Pavement	n/a	7	0.1	n/a	1,341,998
	0.5%	Green Roof	9	1	n/a	n/a	257,216
Total			**388**	**81**	**0.9**	**489**	**4,980,440**
500	5.0%	Bioswales	1	2	0.2	n/a	30,413
	5.0%	Bioretention	383	82	0.3	534	2,078,306

Subwatershed	Subwatershed Treated	BMP	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (t/yr)	Fecal Reduction (B. Col/yr)	Estimated Cost[1] ($)
	5.0%	Retention Pond	490	69	0.4	561	415,661
	0.5%	Filterra	40	7	n/a	n/a	2,597,882
	0.5%	Bacterra	n/a	n/a	n/a	87	2,597,882
	2.0%	Porous Pavement	n/a	16	0.1	n/a	3,117,459
	0.5%	Green Roof	22	3	n/a	n/a	597,513
Total			**936**	**179**	**1.1**	**1183**	**11,435,116**
	5.0%	Bioswales	1	2	0.3	n/a	35,482
	5.0%	Bioretention	253	59	0.2	353	1,310,692
	5.0%	Retention Pond	324	50	0.3	371	262,138
600	0.5%	Filterra	26	5	n/a	n/a	1,638,365
	0.5%	Bacterra	n/a	n/a	n/a	58	1,638,365
	2.0%	Porous Pavement	n/a	12	0.1	n/a	1,966,038
	0.5%	Green Roof	15	2	n/a	n/a	376,824
Total			**619**	**128**	**0.9**	**782**	**7,227,906**
	5.0%	Bioswales	n/a	1	0.1	n/a	10,138
	5.0%	Bioretention	470	102	0.4	656	2,331,865
	5.0%	Retention Pond	601	86	0.5	688	466,373
700	0.5%	Filterra	49	9	n/a	n/a	2,914,832
	0.5%	Bacterra	n/a	n/a	n/a	107	2,914,832
	2.0%	Porous Pavement	n/a	20	0.2	n/a	3,497,798
	0.5%	Green Roof	27	3	n/a	n/a	670,411
Total			**1,148**	**220**	**1.2**	**1,451**	**12,806,250**
	5.0%	Bioswales	2	4	0.6	n/a	96,307
	5.0%	Bioretention	242	57	0.2	337	1,424,793
	5.0%	Retention Pond	309	48	0.2	354	284,959
800	0.5%	Filterra	25	5	n/a	n/a	1,780,992
	0.5%	Bacterra	n/a	n/a	n/a	55	1,780,992
	2.0%	Porous Pavement	n/a	11	0.1	n/a	2,137,190
	0.5%	Green Roof	14	2	n/a	n/a	409,628
Total			**592**	**128**	**1.2**	**747**	**7,914,861**
	2.0%	Bioswales	n/a	1	0.1	n/a	15,206
	5.0%	Bioretention	114	28	0.1	160	795,872
	5.0%	Retention Pond	146	24	0.1	168	159,174
900	0.5%	Filterra	12	2	n/a	n/a	994,840
	0.5%	Bacterra	n/a	n/a	n/a	26	994,840
	2.0%	Porous Pavement	n/a	6	n/a	n/a	1,193,808
	0.5%	Green Roof	7	1	n/a	n/a	228,813
Total			**280**	**61**	**0.4**	**353**	**4,382,555**
	5.0%	Bioswales	1	2	0.3	n/a	48,154
	5.0%	Bioretention	229	56	0.2	319	1,586,325
1000	10.0%	Retention Pond	585	94	0.5	671	634,530
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-

Subwatershed	Subwatershed Treated	BMP	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (t/yr)	Fecal Reduction (B. Col/yr)	Estimated Cost[1] ($)
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**815**	**152**	**0.9**	**990**	**2,269,009**
1010	5.0%	Bioswales	1	3	0.4	n/a	58,291
	5.0%	Bioretention	352	86	0.3	491	2,084,169
	10.0%	Retention Pond	900	145	0.7	1,031	833,668
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**1,253**	**233**	**1.4**	**1,521**	**2,976,128**
1020	5.0%	Bioswales	1	3	0.4	n/a	65,894
	5.0%	Bioretention	703	169	0.6	981	4,625,027
	5.0%	Retention Pond	899	143	0.7	1,030	925,005
	0.5%	Filterra	74	15	0.1	n/a	5,781,284
	0.5%	Bacterra	n/a	n/a	n/a	160	5,781,284
	2.0%	Porous Pavement	n/a	33	0.3	n/a	6,937,541
	0.5%	Green Roof	41	5	0.1	n/a	1,329,695
Total			**1,718**	**367**	**2.1**	**2,171**	**25,445,731**
1030	5.0%	Bioswales	2	4	0.6	n/a	101,376
	5.0%	Bioretention	405	95	0.4	564	2,558,097
	10.0%	Retention Pond	1,035	161	0.8	1,185	1,023,239
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**1,441**	**261**	**1.8**	**1,750**	**3,682,712**
1100	5.0%	Bioswales	2	5	0.7	n/a	96,307
	5.0%	Bioretention	1,148	263	1.0	1,602	6,232,316
	5.0%	Retention Pond	1,469	222	1.1	1,682	1,246,463
	0.5%	Filterra	120	23	0.1	0	7,790,395
	0.5%	Bacterra	n/a	n/a	n/a	262	7,790,395
	2.0%	Porous Pavement	n/a	52	0.4	n/a	9,348,474
	0.5%	Green Roof	67	8	0.1	n/a	1,791,791
Total			**2,806**	**573**	**3.5**	**3,546**	**34,296,141**
1110	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	149	37	0.1	208	1,077,410
	10.0%	Retention Pond	382	62	0.3	437	430,964
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**531**	**99**	**0.4**	**645**	**1,508,374**

Subwatershed	Subwatershed Treated	BMP	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (t/yr)	Fecal Reduction (B. Col/yr)	Estimated Cost[1] ($)
1120	5.0%	Bioswales	n/a	n/a	0.1	n/a	10,138
	5.0%	Bioretention	149	37	0.1	208	1,065,169
	10.0%	Retention Pond	382	62	0.3	437	426,068
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**531**	**99**	**0.5**	**646**	**1,501,375**
1130	5.0%	Bioswales	1	3	0.4	n/a	70,963
	5.0%	Bioretention	540	127	0.5	753	3,360,122
	10.0%	Retention Pond	1,381	214	1.1	1,581	1,344,049
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**1,922**	**344**	**2.0**	**2,334**	**4,775,135**
1140	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	145	36	0.1	203	1,192,929
	5.0%	Retention Pond	186	30	0.1	213	238,586
	0.5%	Filterra	15	3	n/a	n/a	1,491,161
	0.5%	Bacterra	n/a	n/a	n/a	33	1,491,161
	2.0%	Porous Pavement	n/a	7	0.1	n/a	1,789,393
	0.5%	Green Roof	8	1	n/a	n/a	342,967
Total			**355**	**77**	**0.4**	**449**	**6,546,195**
1150	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	563	134	0.5	785	3,336,064
	5.0%	Retention Pond	720	113	0.6	825	667,213
	0.5%	Filterra	59	12	0.1	n/a	4,170,080
	0.5%	Bacterra	n/a	n/a	n/a	128	4,170,080
	2.0%	Porous Pavement	n/a	26	0.2	n/a	5,004,096
	0.5%	Green Roof	33	4	n/a	n/a	959,118
Total			**1,375**	**289**	**1.4**	**1,738**	**18,306,652**
1200	5.0%	Bioswales	n/a	n/a	n/a	n/a	-
	5.0%	Bioretention	118	26	0.1	164	686,966
	10.0%	Retention Pond	301	45	0.2	345	274,786
	0.0%	Filterra	n/a	n/a	n/a	n/a	-
	0.0%	Bacterra	n/a	n/a	n/a	n/a	-
	0.0%	Porous Pavement	n/a	n/a	n/a	n/a	-
	0.0%	Green Roof	n/a	n/a	n/a	n/a	-
Total			**419**	**71**	**0.3**	**510**	**961,753**
1210	5.0%	Bioswales	n/a	1	0.1	n/a	30,413
	5.0%	Bioretention	139	34	0.1	194	1,043,352
	5.0%	Retention Pond	178	28	0.1	204	208,670

Subwatershed	Subwatershed Treated	BMP	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (t/yr)	Fecal Reduction (B. Col/yr)	Estimated Cost[1] ($)
	0.5%	Filterra	15	3	n/a	n/a	1,304,191
	0.5%	Bacterra	n/a	n/a	n/a	32	1,304,191
	2.0%	Porous Pavement	n/a	7	0.1	n/a	1,565,029
	0.5%	Green Roof	8	1	n/a	n/a	299,964
Total			340	74	**0.5**	429	5,755,809
	5.0%	Bioswales	n/a	1	0.1	n/a	15,206
	5.0%	Bioretention	730	154	0.7	1,019	4,014,631
	5.0%	Retention Pond	934	130	0.7	1,070	802,926
1220	0.5%	Filterra	76	13	0.1	n/a	5,018,288
	0.5%	Bacterra	n/a	n/a	n/a	166	5,018,288
	2.0%	Porous Pavement	n/a	30	0.3	n/a	6,021,946
	0.5%	Green Roof	42	5	0.1	n/a	1,154,206
Total			**1,783**	**333**	**1.9**	**2,255**	**22,045,492**
	5.0%	Bioswales	1	1	0.2	n/a	32,947
	5.0%	Bioretention	308	76	0.3	430	2,231,361
	5.0%	Retention Pond	394	65	0.3	452	446,272
1230	0.5%	Filterra	32	7	n/a	n/a	2,789,201
	0.5%	Bacterra	n/a	n/a	n/a	70	2,789,201
	2.0%	Porous Pavement	n/a	15	0.1	n/a	3,347,042
	0.5%	Green Roof	18	2	n/a	n/a	641,516
Total			**753**	**166**	**0.9**	**952**	**12,277,541**
	5.0%	Bioswales	2	4	0.6	n/a	106,445
	5.0%	Bioretention	684	162	0.6	954	4,507,032
	5.0%	Retention Pond	874	137	0.7	1,002	901,406
1240	0.5%	Filterra	72	14	0.1	n/a	5,633,790
	0.5%	Bacterra	n/a	n/a	n/a	156	5,633,790
	2.0%	Porous Pavement	n/a	32	0.3	n/a	6,760,548
	0.5%	Green Roof	40	5	0.1	n/a	1,295,772
Total			**1,671**	**354**	**2.3**	**2,111**	**24,838,782**
	5.0%	Bioswales	1	2	0.2	n/a	40,550
	5.0%	Bioretention	818	196	0.7	1,141	5,585,190
	5.0%	Retention Pond	1,046	166	0.8	1,198	1,117,038
1250	0.5%	Filterra	86	17	0.1	n/a	6,981,487
	0.5%	Bacterra	n/a	n/a	n/a	186	6,981,487
	2.0%	Porous Pavement	n/a	39	0.3	n/a	8,377,784
	0.5%	Green Roof	48	6	0.1	n/a	1,605,742
Total			**1,997**	**426**	**2.2**	**2,525**	**30,689,278**
Grand Total			**28,156**	**5,554**	**32**	**35,127**	**280,893,861**

2) BMP costs were derived from cost information derived through various Geosyntec projects and from other sources such as the Milwaukee Metropolitan Sewerage District Regional Green Infrastructure Plan.

n/a = not determined or insufficient data

Appendix D

Summary of Watershed-wide BMP Recommendations

Summary of Watershed-wide Best Management Practice Recommendations

BMP Category	BMP Code*	Quantity	Unit	COST ($)	Nitrogen Load Reduction (lbs/year)	Phosphorus Load Reduction (lbs/year)	Sediment Load Reduction (tons/year)	Fecal Coliform Load Reduction (billion colonies/yr)	Comments
AGRICULTURE	Conservation Tillage(329)		acre						Any ag conservation practices that could be adopted in this watershed have likely already been adopted.**
AGRICULTURE	Filter Strip(393)	50.9	acre	$1,480,000	1,990	553	1	313	Geosyntec's "Buffer Installation (non-urban)."
AGRICULTURE	Grassed Waterway(412)		acre						Any ag conservation practices that could be adopted in this watershed have likely already been adopted.**
AGRICULTURE	Terrace(600)		feet						Any ag conservation practices that could be adopted in this watershed have likely already been adopted.**
AGRICULTURE	Nutrient Management(590)		acre						Any ag conservation practices that could be adopted in this watershed have likely already been adopted.** Further, this is a non-structural BMP; thus, pollutant load reduction would not be modeled.
HYDROLOGIC	Clearing and Snagging(326)		feet						Nonstructural BMP; thus, pollutant load reduction not modeled. Practice should be applied selectively with ecological benefits of woody debris considered.
HYDROLOGIC	Stream Channel Restoration(9)	142,560	feet	$9,970,440					Stream channel restoration means remeandering of channelized stream segments; thus, no pollutant load reduction calculated.

BMP Category	BMP Code*	Quantity	Unit	COST ($)	Nitrogen Load Reduction (lbs/year)	Phosphorus Load Reduction (lbs/year)	Sediment Load Reduction (tons/year)	Fecal Coliform Load Reduction (billion colonies/yr)	Comments
HYDROLOGIC	Stream Channel Stabilization(584)		feet						Stream channel stabilizations means grade control. While this BMP type was mentioned in the 2005 plan as a potential BMP, an estimated pollutant load reduction would require a detailed stream investigation.
HYDROLOGIC	Streambank and Shoreline Protection(580)	7,920	feet	$190,080	989	365	2	516	
HYDROLOGIC	Wetland Restoration(657)	15	acre	$216,076	1,220	455	2	314	
URBAN	Filter Strip(835)	87	acre	$2,530,000	355	61	1	17	Geosyntec's "Buffer Installation (urban)."
URBAN	Grass-lined Channel(840) with Permanent Vegetation(880)	38,966	sq. feet	$935,194	18	41	6	n/a	Geosyntec's "Vegetated Swale (Conveyance) Retrofits "is best categorized as Grass-lined Channel (840) with Permanent Vegetation (880). The term "Bioswales" is also used in the addendum; there currently is no practice standard for "bioswale."
URBAN	Infiltration Planter(40)	11,711	number	$117,117,640	803	152	1	1,747	Geosyntec's Filterra and Bacterra systems.
URBAN	Porous Pavement(890)	54	acre	$70,270,584	n/a	348	3	n/a	Also "Permeable Pavement"
URBAN	Rain Garden(13) (new IUM code #897)	30	acre	$63,193,804	10,315	2,397	8	14,392	Geosyntec's "Bioretention" best placed into the Rain Garden category.
URBAN	Street Sweeping(17)		number						Nonstructural BMP; thus, pollutant load reduction not modeled.
URBAN	Bioretention Facility(800)	46	acre	$15,908,110	16,576	2,562	13	18,988	Geosyntec's "Detention Basin Retrofits" are best placed into this category.
URBAN	Infiltration Trench(847)		number						Included in Bioretention Facility (IUM 800) BMPs.

BMP Category	BMP Code*	Quantity	Unit	COST ($)	Nitrogen Load Reduction (lbs/year)	Phosphorus Load Reduction (lbs/year)	Sediment Load Reduction (tons/year)	Fecal Coliform Load Reduction (billion colonies/yr)	Comments
URBAN	Green Roof(11)	26	acre	$13,468,529	445	54	1	n/a	
OTHER2	Septic system upgrade(34)		number						The 2005 plan stated that few septic systems were present. Much effort would be required to calculate for little overall benefit in pollutant load reduction. It is better to address this via ordinances that require a point of sale inspection (thus education and policy recommendations).
OTHER2	Cistern(12)		number	-	-	-	-	-	No reference to cisterns found in 2005 Plan. Non-structural BMP whereby no pollutant load reduction would be modeled.
OTHER2	Education(1)		number						Nonstructural BMP; thus, pollutant load reduction not modeled.
OTHER2	Monitoring(2)		number						Nonstructural BMP; thus, pollutant load reduction not modeled.
OTHER2	Regulations(15)		number						Nonstructural BMP; thus, pollutant load reduction not modeled.
TOTALS				**$295,280,458**	**32,710**	**6,988**	**37**	**36,287**	

* NRCS Conservation Practice Standard or Illinois Urban Manual Practice Standard

** based on Geosyntec's review of transect surveys and personal communication with Robert Jankowski, NRCS District Conservationist.

Appendix E

Summary of Watershed-wide Pollutant Load Reduction Targets

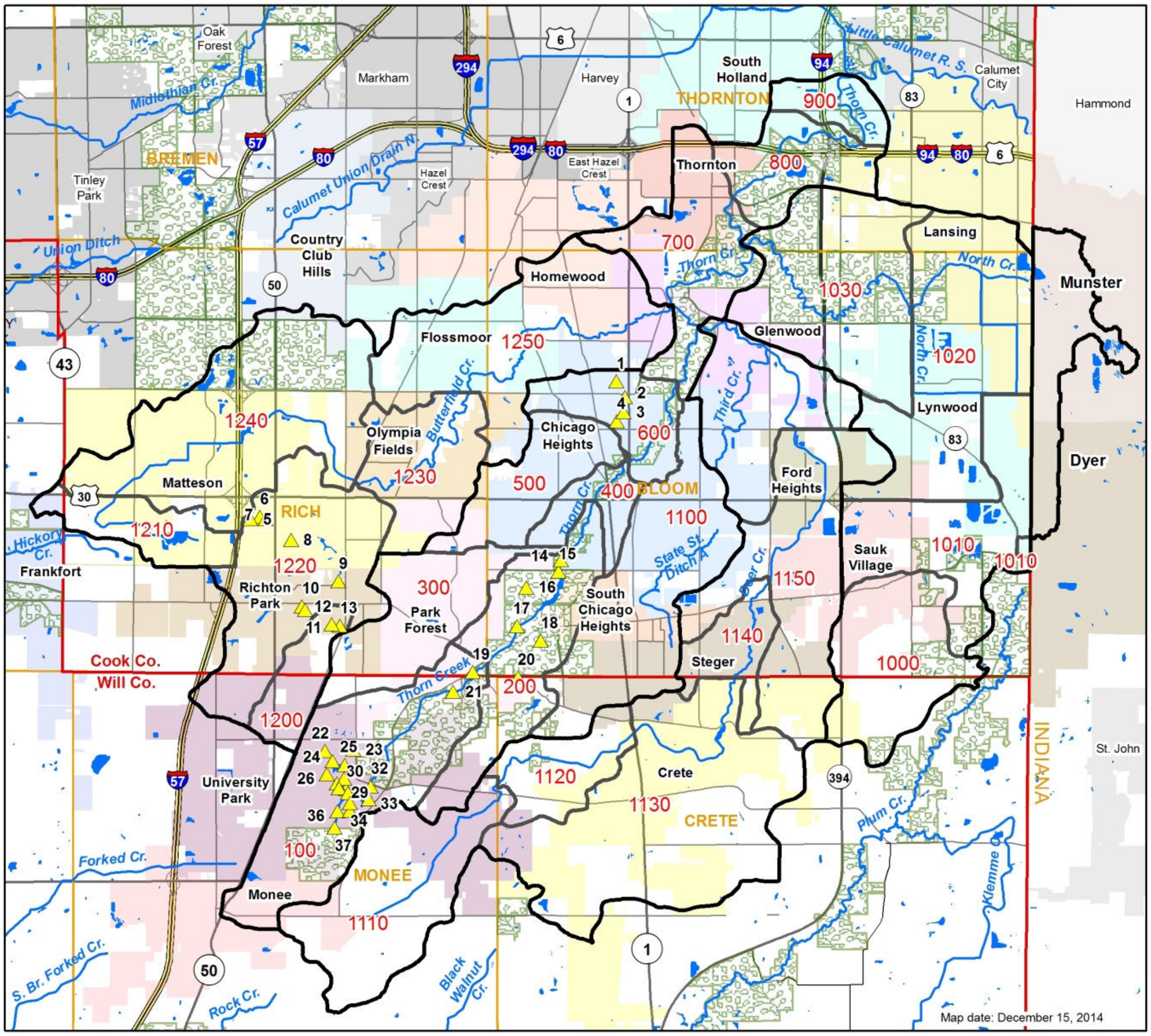
Summary of Watershed-wide Pollutant Load Reduction Targets

Subwatershed	Nitrogen Reduction Target (lb/yr)	Phosphorus Reduction Target (lb/yr)	Sediment Reduction Target (lb/yr)	Fecal Coliform Reduction Target (B. Col/yr)
Scenario-based Stormwater BMPs				
Indiana	998	172	1	1,262
100	1,597	290	1	1,942
200	907	167	1	1,103
300	982	211	1	1,242
400	388	81	1	489
500	936	179	1	1,183
600	619	128	1	782
700	1,148	220	1	1,451
800	592	128	1	747
900	280	61	0	353
1000	815	152	1	990
1010	1,253	233	1	1,521
1020	1,718	367	2	2,171
1030	1,441	261	2	1,750
1100	2,806	573	3	3,546
1110	531	99	0	645
1120	531	99	0	646
1130	1,922	344	2	2,334
1140	355	77	0	449
1150	1,375	289	1	1,738
1200	419	71	0	510
1210	340	74	0	429
1220	1,783	333	2	2,255
1230	753	166	1	952
1240	1,671	354	2	2,111
1250	1,997	426	2	2,525
Subtotal	*28,156*	*5,554*	*32*	*35,127*
Stream Corridor and Farmed Wetland Projects				
Buffer Installation (urban)	355	61	1	17
Buffer Installation (non-urban)	1,990	553	1	313
Stream Stabilization	989	365	1	516
Farmed Wetland Restoration	1,220	455	2	314
Subtotal	*4,554*	*1,434*	*5*	*1,160*
Total	**32,710**	**6,988**	**37**	**36,287**

Appendix F

Stakeholder-identified Site-specific BMPs – Map and Table

Thorn Creek Watershed Based Plan Addendum - Stakeholder-identified Site-specific BMP Locations



Legend

- Thorn Creek Watershed Boundary
- Counties
- Townships
- Lakes/Ponds
- Forest Preserve
- Streams
- BMP project locations

0 2 4 Miles

Chicago Metropolitan Agency for Planning

Data Sources: Watershed Planning Area - CMAP (2004); County & Township Boundaries - CMAP (2014); Municipal Boundaries - Cook Co. (2014) & Will Co. (2014); Major Roads - IDOT (2011); Streams - Illinois EPA (2004); Waterbodies - National Hydrography Dataset (USGS 2007) & CMAP Land Use (2005).

Thorn Creek Watershed Based Plan Addendum: Stakeholder-identified Site-specific BMPs										
Map #	**Subwatshd Code**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Longitude**	**Latitude**	**Comment**
1	600, 1250	Green infrastructure plan	Other	3	#	Prairie State College		-87.639165	41.530469	
2	600, 1250	Green infrastructure plan implementation	various TBD (Hydrologic, Urban, Other)	various TBD	various TBD	Prairie State College	City of Chicago Heights, Cook Co., MWRDGC	-87.636786	41.527231	
3	600	Streambank Protection, Urban Filter Strip	Hydrologic, Urban	580, 835	feet, acres	Prairie State College	Will-So. Cook SWCD	-87.637087	41.52413	
4	600	Brush Management, Restoration & Mngmnt of Declining Habitats	Urban	314, 643	acres	Prairie State College		-87.638944	41.522246	
5	1220	Brush Management, Restoration & Mngmnt of Declining Habitats	Urban	314, 643	acres	Prairie State College		-87.739062	41.501565	
6	1220	Green infrastructure plan	Other	3	#	Prairie State College		-87.736534	41.502064	satellite campus
7	1220	Green infrastructure plan implementation	various TBD (Hydrologic, Urban, Other)	various TBD	various TBD	Prairie State College		-87.734884	41.501621	satellite campus
8	1220	Wetland Restoration, Urban Filter Strip, Vegetated swales (Bioswale or Grass-Lined Channel w/ Permanent Vegetation), Field Border	Hydrologic, Urban, Ag	657/999, 835, n/a (n/a, 840 w/ 880), 386	acres	Vlg of Matteson, multiple private	Land Conservancy Will Co., GSU	-87.727891	41.497393	
9	1220	Stream Channel Stabilization, Streambank Protection, Culvert resizing, Floodplain reconnection/ Wetland Creation, Urban Filter Strip	Hydrologic, Urban	584, 580, n/a, n/a/997, 835	feet, acres	Vlg of Richton Park	MWRDGC	-87.714798	41.488927	E Br Butterfield Crk
10	300, 1200, 1220	Green infrastructure plan	Other	3	#	Vlg of Richton Park, multiple private		-87.724806	41.483742	

Thorn Creek Watershed Based Plan Addendum: Stakeholder-identified Site-specific BMPs (cont.)										
Map #	**Subwatshd Code**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Longitude**	**Latitude**	**Comment**
11	300, 1200, 1220	Green infrastructure plan implementation	various TBD (Hydrologic, Urban, Other)	various TBD	various TBD	Vlg of Richton Park, multiple private		-87.72382	41.483058	
12	1200	Stream Channel Stabilization, Streambank Protection, Culvert resizing, Floodplain reconnection/Wetland Creation, Urban Filter Strip	Hydrologic, Urban	584, 580, n/a, n/a/997, 835	feet, acres	Vlg of Richton Park	MWRDGC	-87.71653	41.480039	E Br Butterfield Crk
13	1200	Brush Management, Restoration & Mngmnt of Declining Habitats	Urban	314, 643	acres	Vlg of Richton Park, others	Land Conservancy Will Co., GSU	-87.714341	41.479785	"Richton Park Prairie"
14	200	Stream Channel Stabilization, Streambank Protection	Hyrdologic	584, 580	feet	FPD Cook Co.	USACE	-87.653971	41.493691	
15	200	Dam Removal	Hydrologic	16	#	FPD Cook Co.	USACE	-87.654578	41.49122	Sauk Lake
16	200	Brush Management, Restoration & Mngmnt of Declining Habitats	Urban	314, 643	acres	FPD Cook Co.	USACE	-87.663447	41.48798	Sauk Trail Woods
17	200	Stream Channel Restoration, Stream Channel Stabilization, Streambank Protection	Hydrologic	9, 584, 580	#, feet	FPD Cook Co.	USACE	-87.665799	41.480006	
18	200	Brush Management, Restoration & Mngmnt of Declining Habitats	Urban	314, 643	acres	FPD Cook Co.	USACE	-87.659349	41.477074	Schubert's Woods, King's Grove
19	100	Stream Channel Stabilization, Streambank Protection, Rain Garden	Hydrologic, Urban	584, 580, 897	feet, #	Land Conservancy of Will Co., private	Vlg of Park Forest, FPD Will Co.	-87.677929	41.470496	
20	200	Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation), Wetland Restoration	Urban, Hydrologic	n/a (n/a, 840 w/ 880), 657	acres	Land Conservancy of Will Co.	Crete Twp., local landowners	-87.665518	41.469441	

Thorn Creek Watershed Based Plan Addendum: Stakeholder-identified Site-specific BMPs (cont.)										
Map #	**Subwatshd Code**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Longitude**	**Latitude**	**Comment**
21	100	Stream Channel Stabilization, Streambank Protection, Urban Filter Strip	Hydrologic, Urban	n/a, 584, 580, 835	feet, acres	Land Conservancy of Will Co.	Vlg of Park Forest	-87.683192	41.466433	
22	100	Bioretention Facility, Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Urban	800, n/a (n/a, 840 w/ 880)	acres	Governors State Univ.		-87.718121	41.453965	
23	100	Bioretention Facility, Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation), Wetland Restoration	Urban, Hydrologic	800, n/a (n/a, 840 w/ 880), 657	acres	Governors State Univ.	Nathan Manilow Sculpture Park	-87.710322	41.454324	
24	100	Wet detention basin retrofit: Constructed Wetland (wetland shelf), Shoreline Protection, Dredging	Hydrologic	656, 580, 7	acres, feet, #	Governors State Univ.	Nathan Manilow Sculpture Park	-87.715965	41.451923	
25	100	Wet detention basin retrofit: Constructed Wetland (wetland shelf), Vegetated swales retrofit (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Hydrologic, Urban	656, n/a (n/a, 840 w/ 880)	acres	Governors State Univ.	Nathan Manilow Sculpture Park	-87.71399	41.450595	
26	100	Green infrastructure plan implementation	various TBD (Hydrologic, Urban, Other)	various TBD	various TBD	Governors State Univ.	Nathan Manilow Sculpture Park	-87.717521	41.44924	GI plan in 2015
27	100	Parking lot retrofits: Porous Pavement, Vegetated swales (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Urban	890, n/a (n/a, 840 w/ 880)	acres, feet	Governors State Univ.		-87.712858	41.448375	East Lot 3

Thorn Creek Watershed Based Plan Addendum: Stakeholder-identified Site-specific BMPs (cont.)										
Map #	**Subwatshd Code**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Longitude**	**Latitude**	**Comment**
28	100	Parking lot retrofits: Porous Pavement, Vegetated swales (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Urban	890, n/a (n/a, 840 w/ 880)	acres, feet	Governors State Univ.		-87.714848	41.447414	East Lot 2
29	100	Wet detention basin retrofit: Constructed Wetland (wetland shelf), Shoreline Protection, Dredging	Hydrologic	656, 580, 7	acres, feet, #	Governors State Univ.		-87.714261	41.446382	
30	100	Wet detention basin retrofit: Constructed Wetland; Vegetated swales retrofit (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Urban	656; n/a (n/a, 840 w/ 880)	acres	Governors State Univ.		-87.712244	41.446214	
31	100	Stream Channel Stabilization, Streambank Protecction	Hydrologic	584, 580	feet	Governors State Univ.		-87.711759	41.445421	
32	100	Stream Channel Restoration, Stream Channel Stabilization, Streambank Protection, storm sewer infrastructure retrofit, lift station retrofit	Hydrologic	9, 584, 580, n/a, n/a	#, feet	Governors State Univ.	Vlg of University Park, Aqua Illinois	-87.7055	41.446765	
33	100	Pond retrofit: Constructed Wetland (wetland shelf), Shoreline Protection, Urban Filter Strip; Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation); Channel Stabilization	Urban	656, 580, 835; n/a (n/a, 840 w/ 880); 584	acres, feet	Governors State Univ.		-87.706112	41.444125	Pine Lake

Thorn Creek Watershed Based Plan Addendum: Stakeholder-identified Site-specific BMPs (cont.)										
Map #	**Subwatshd Code**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Longitude**	**Latitude**	**Comment**
34	100	Stream Channel Stabilization, Streambank Protection	Hydrologic	584, 580	feet	Governors State Univ.		-87.711121	41.443367	GSU Environmental Field Station
35	100	Pond retrofit: Wetland Restoration, Dredging; Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation)	Hydrologic, Urban	657/999, 7; n/a (n/a, 840 w/ 880)	acres, #, feet	Governors State Univ.		-87.711116	41.441789	
36	100	Stream Channel Restoration, Stream Channel Stabilization, Streambank Protection	Hydrologic	9, 584, 580	#, feet	Governors State Univ.	Vlg of University Park, USACE	-87.714566	41.441599	
37	100	Culvert retrofit, Vegetated swale (Bioswale or Grass-Lined Channel w/ Permanent Vegetation), Stream Channel Stabilization, Streambank Protection	Hydrologic, Urban	n/a, n/a (n/a, 840 w/ 880), 584, 580	#, feet, acre	Governors State Univ.	Vlg of University Park	-87.71528	41.438285	

Acronym Key:

FPD	Forest Preserve District
GSU	Governors State University
IEPA	Illinois Environmental Protection Agency
IUM	Natural Resources Conservation Service - Illinois Urban Manual Practice Standard
NRCS	Natural Resources Conservation Service - Conservation Practice Standard
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
SWCD	Soil and Water Conservation District
USACE	United States Army Corps of Engineers
n/a	not available