BLOOMINGTON GREEN INFRASTRUCTURE PLAN

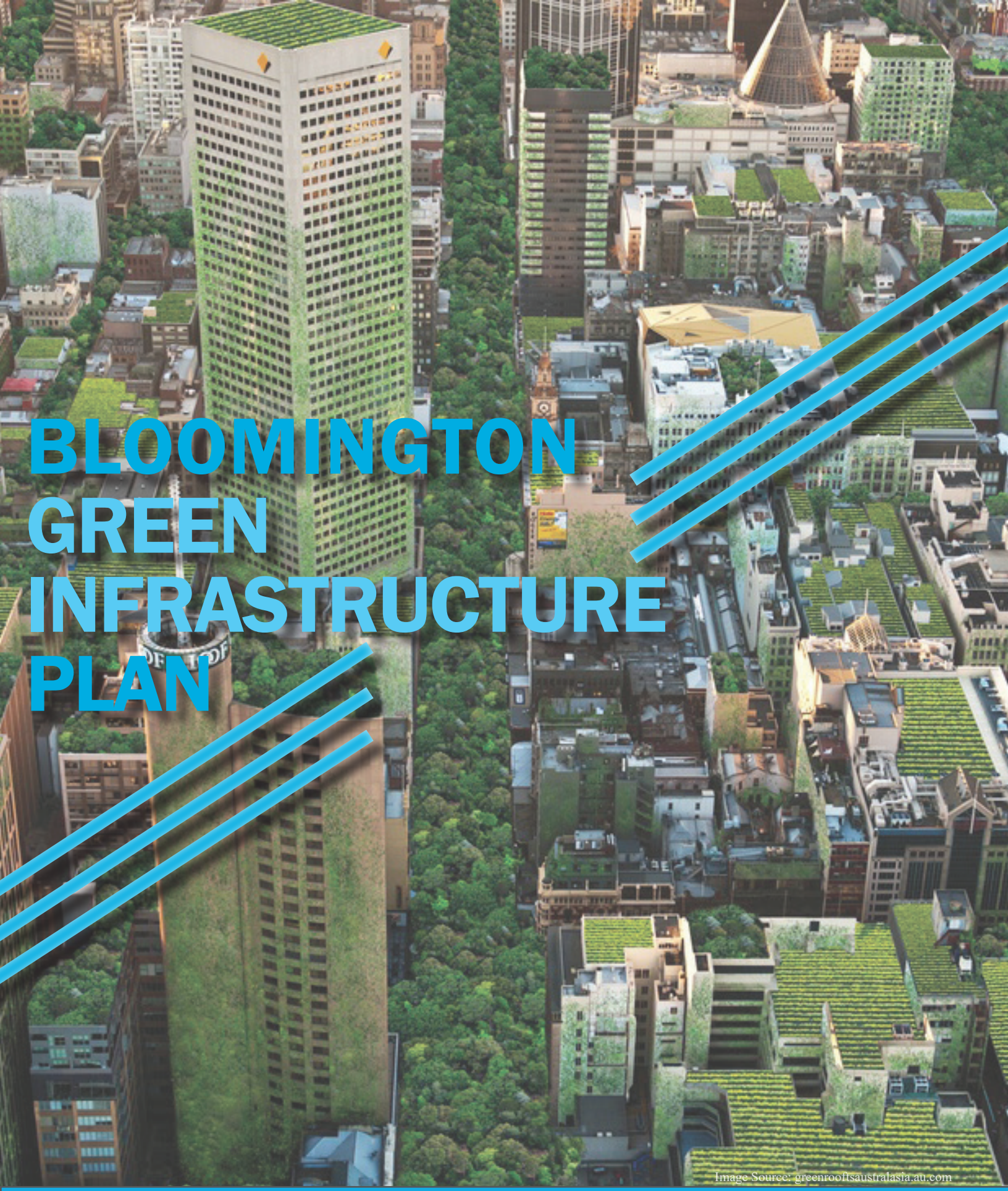


Image Source: greenrooftsaustralasia.au.com

SCHOOL OF PUBLIC AND ENVIRONMENTAL AFFAIRS
INDIANA UNIVERSITY

Produced by Capstone SPEA V-600/E=555 Spring 2016 for the City of Bloomington Planning Department

Kristin Berger, Ryan Clemens, Aileen Driscoll Farid, Allison Eichele, Ari Feldman, Amanda Frazer, Amy Hagerdon, Gregory Lohrke, Lori Lovell, Kerry Neil, Daniel Soebbing, Katlin Walls, Jason Wenning

CONTENTS

Section	Page
Introduction	5
Green Infrastructure	8
Existing Conditions	17
Implementation in Bloomington	27
Benefit-Cost Analysis	43
Policy Overview	51
Stakeholder Engagement	56
Outreach and Education Plan	63
Funding Options	70
Final Conclusions	71
References	74

List of Figures and Tables

No.	Title	Page
Figures 1-10	Green Infrastructure Depictions	6-17
Figure 11	Aerial map of Bloomington, Indiana	20
Figure 12	Land Cover Pie Chart	21
Figure 13	Land Cover Map	22
Figure 14	Karst Features Map	23
Figure 15	Soil Map	24
Figure 16	Lakes & Waterbodies Map	27
Figure 17	Existing Green Infrastructure Map	28
Figure 18	Problem Area Watersheds	30
Figure 19	Individual Problem Area Watersheds	31
Figure 20	Walnut St. and Wiley St. Map	32
Figure 21	Kirkwood Ave. and Indiana Ave.	33
Figure 22	Grant St. and 4th St. Map	34
Figure 23	Henderson St. and 2nd St. Map	35
Figure 24	Percent Imperviousness	37
Figure 25	Green Infrastructure Selection Criteria	39
Figure 26	Harmony School Map	41
Figure 27	People's Park Map	42
Table 1	Climate Data	25
Table 2	Impervious Surface Methods	36
Table 3	List of Benefits and Costs	44
Table 4	BCA Kaldor-Hicks Tableau South High School	46
Table 5	BCA Kaldor-Hicks Tableau Goat Farm	47
Table 6	Original Kaldor-Hicks Tableau Harmony School	48
Table 7	Sensitivity Analysis-Low Discount Rate	49
Table 8	Sensitivity Analysis-Low Infrastructure Costs	50
Table 9	Stakeholder Categories	61
Table 10	Sample Outreach Calendar	65

Image Source: myfreetextures.com

IMPORTANT ACKNOWLEDGMENTS

Linda Pride Thompson
Senior Environmental Planner
City of Bloomington Planning and Transportation Department

Melissa Clark
Senior Lecturer
Director of the Indiana Clean Lakes Program
Certified Lake Professional

Michael Dorsett
Environmental Health and Safety Specialist
Indiana University

Kriste Lindberg
Stormwater Education Specialist
City of Bloomington Utilities

Phil Peden, PE
Utilities Engineer
City of Bloomington Utilities

Jeffrey H. Underwood, CPA
Controller
City of Bloomington, IN

Dana Wilkinson
Stormwater Inspector
Monroe County, IN

Chuck Winkle, GISP
GIS Coordinator
City of Bloomington Utilities

The authors thank the above for their technical and professional assistance in generating the attached plan.

Image Source: upstreammatters.com

EXECUTIVE SUMMARY

URBAN waterways receive a large percentage of stormwater runoff from developed environments and experience hydrological alteration and deterioration of water quality due to the highly variable velocity, quality, and quantity of such flows (Konrad and Booth, 2005). These negative effects can be largely tied to traditional management techniques, specifically the reliance on grey infrastructure to convey stormwater from urban areas to receiving waterways as rapidly as possible. However, due to increasing amounts of impervious surface in urban areas and variable rain patterns, grey infrastructure faces challenges of flooding, erosion of the natural waterways, water pollution from runoff, and high cost for maintenance and upgrades.

Green infrastructure is an increasingly popular alternative to traditional stormwater management techniques. The implementation goal of green infrastructure (GI) is to mimic, protect, or restore lost elements of the natural hydrologic cycle within urban environments using a suite of stormwater control and remediation best management practices (BMPs). GI features such as rain gardens, permeable pavement, and rainwater harvesting cisterns may also provide a number of additional environmental, social, and economic benefits for urban dwellers, such as: reductions of air pollution, reduced urban heat island effect, increased property values, and reduced crime rates. To achieve these and other benefits, the City of Bloomington, Indiana has expressed interest in promoting green infrastructure and has initiated the development of a GI implementation plan.

PLAN DESCRIPTION

The attached plan was produced for the City of Bloomington by a working group of Masters Candidates at the School of Public and Environmental Affairs at Indiana University, Bloomington. The objective of this plan is to provide a comprehensive framework for implementation of green infrastructure features for urban stormwater management within the City of Bloomington. It is the hope of the working group that an effective and efficient implementation framework will contribute to the continued economic, social, and environmental sustainability of the city. The working group provides insight into the evaluation process of available BMPs, selection of implementation sites, benefit-cost analysis of potential projects, policy recommendations, and an understanding of stakeholder engagement and community outreach programs.

PLAN INTRODUCTION

Image Source: Kyle Haskins

HYDROLOGIC SYSTEM

IN an undisturbed system (i.e.. a landscape without buildings, homes or streets), the hydrologic cycle functions naturally. Precipitation falls directly onto vegetated spaces, like forests and grasslands. Vegetation and permeable media slow and reduce runoff, allowing water to either infiltrate into the soil and eventually the groundwater supply, or move to the atmosphere through evapotranspiration- the sum of evaporation from land surface plus transpiration from plants. Even if water does not infiltrate or move to the atmosphere, the attenuating effects of vegetation and natural surfaces greatly reduce the amount of runoff that enters a stream to a level the stream is naturally capable of accommodating. Green spaces also allow for some filtration and pollutant removal before the runoff enters receiving waters. The slower flow and reduced flashiness also means the water carries less sediment to the stream from the watershed and has less erosion potential in-stream.

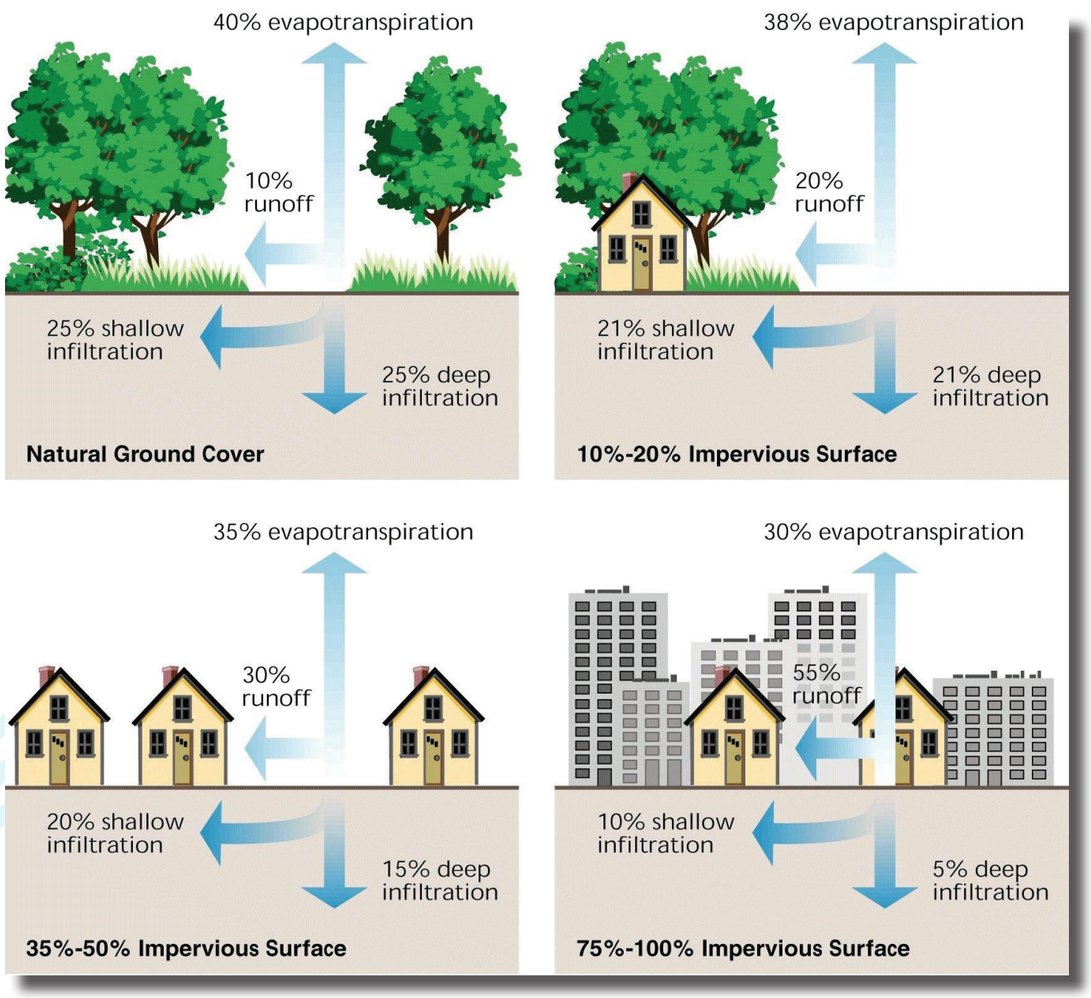


Figure 1. Effect of increased impervious surface on runoff, infiltration and evaporation rates. (From EPA)

URBANIZATION

PROBLEMS arise as alterations are made to the undisturbed system through land development and urbanization. With urbanization comes a higher percentage of impervious surface coverage. Compacted soil, pavement, and buildings begin to replace green spaces like forests and grasslands. For this reason, urbanization has major impacts on the natural hydrologic cycle (Figure 1). Infiltration rates are lower for urban environments in comparison to natural green spaces, due to a larger percent impervious surface cover. Urban spaces also have lower evapotranspiration rates because there are fewer plants. The reduced plant cover decreases the cooling effect of evapotranspiration for the surrounding environment. Similar to the function of sweating in humans to cool us down, evaporation of water from the earth's surface and from plants has a local cooling effect. When infiltration and evapotranspiration are low, there will be increased stormwater runoff and elevated conveyance of pollutants from the landscape to the stream (Bannerman et al., 1993, Griffin et al, 1980).

Finally, because impervious surfaces do not slow the flow of runoff or allow for infiltration or evaporation, overland flow in urbanized areas moves much more quickly than a vegetated surface would allow. This leads to an increased volume of runoff entering stormwater collection features at a much higher velocity. The emphasis of gray infrastructure on rapid conveyance of large volumes of stormwater from these collection points to streams then leads to a number of detrimental effects on urban waterways. Streams often become overloaded with increased flows (Figure 2) and there is a higher incidence of stream bank scouring, leading to exposed tree root systems and destabilization of the stream bank and integrity of land abutting the stream bank. During these high flow events streams may also become so inundated with water they disallow any additional flow from storm sewers. These storm sewer backups lead to flooding of the urban landscape, especially in low lying areas. Many of these symptoms are consistent with what is known as "urban stream syndrome" which is characterized by "a flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology and stability and reduced biotic richness" (Paul and Meyer 2001) and has been linked to increased urban development (Walsh et al. 2005).

Figure 2. High flow conditions following a large storm event along the Jordan River which runs through the Indiana University Campus in Bloomington, Indiana.

OVERVIEW

The City of Bloomington has the opportunity to act on stormwater management practices and community improvement to mitigate future impacts of State water quality regulations and an uncertain climate. This plan seeks to highlight the improvements the community and residents of Bloomington can realize by implementing a comprehensive systems-approach to stormwater management. Green infrastructure (GI), especially when deliberately and purposefully planned for, will improve Bloomington's quality of water runoff, reduce the quantity of runoff, and improve local environmental conditions. Green infrastructure reduces the nutrient and pollutant loads entering our natural waterways from runoff, impedes the initial rush of water during storm events which reduces flooding, and allows groundwater recharge (Coutts and Hahn 2015; EPA 2016). Additionally, the plants installed for green infrastructure produce cleaner air, reduce urban heat island effects, and improve the visual appeal of the area (Coutts and Hahn 2015; EPA 2016). The green infrastructure can provide corridors of green space, increasing the ecosystem value, and promoting environmental values in the community (Coutts and Hahn 2015). Communities living with greater access to green space have also been shown to benefit from improved health. Literature reviews suggest these health benefits are physical, mental, and social in nature (Lee & Maheswaran 2010). With access to green spaces, citizens are encouraged to be more physically active, meet with others socially in public spaces, and may experience a feeling of reduced stress and improved quality of life. An extended list of green infrastructure benefits will be discussed in the benefit-cost analysis section of this plan.

Image Source: inhabitat.com

ALL of these environmental, social, and health benefits of green infrastructure can be economically achieved. Currently, the City of Bloomington experiences flooding events during high-volume storm events, and faces management costs at the wastewater treatment facility due to infiltration of the pipes conveying wastewater. The City must also pay for maintenance and upkeep of areas that are improperly designed for stormwater runoff, for instance, paying to re-sod lawn spaces that don't properly drain. With increasing density from city development, stormwater management using traditional grey infrastructure, like drains and pipes, will only become more costly to install and maintain. Planning for green infrastructure can mitigate these costs while achieving the additional environmental, social and health benefits described above.

This Green Infrastructure Plan will describe potential best management practices for green infrastructure and suggest policies and sites for implementation. A description of the means to implement the practices will also be discussed, including stakeholder involvement, funding, and suggested ordinances for adoption.

GREEN INFRASTRUCTURE

THERE are many different types of green infrastructure (GI), and they can typically be grouped into larger project types. This can be a useful way to think about green infrastructure options because, given the type/goals of a parcel or area, there may be several different green infrastructure options. Grouping them into categories makes it easier to narrow down the possible choices for the specific project site and project goals. Likewise, if development or construction is already scheduled, the groupings can help identify green infrastructure options that can be easily added into the existing construction plans, as adding green infrastructure in during construction or renovation is typically less costly than if the GI were implemented on its own. Finally, the groupings highlight options that are relevant for public lands that the city would have access to and jurisdiction of for green infrastructure implementation. For more information about each of the options mentioned below (including cost estimates, maintenance requirements and more), see Appendix 1, which contains more detailed fact sheets for each group of green infrastructure options. Green infrastructure groups were adapted from Lancaster Green Infrastructure Plan (City of Lancaster, 2011).

DRIVE

Green streets, green alleys, and green parking lots can make your daily commute more enjoyable.

WORK & STUDY

Drop your children off at a green school where they can eat food grown in the school's rooftop garden. Head to work and grab a cup of coffee near the rain garden.

LIVE

Walk along a green sidewalk to your rainwater harvest-fed garden; green living can follow you home.

GREEN INFRASTRUCTURE CAN BE ANYWHERE YOU ARE

GREEN STREETS & ALLEYS

GREEN streets or alleyways are green infrastructure options that add more pervious surfaces to a typical street setting with the goal of managing the runoff of the street, alley and adjacent areas. Implementation options include using permeable pavement instead of traditional concrete or blacktop and landscaping and vegetation additions. Vegetation and landscaping options include street trees, curb extensions and sidewalk planters. Green streets and alleyways can be implemented at lower cost if the road or alleyway will already be undergoing repaving or maintenance. Examples of green street and green alleyway can be found in Figure 3.

Figure 3. Examples of green streets and green alleyway project options including vegetated curb extensions, vegetated medians, permeable pavers and vegetated strips.

GREEN SIDEWALKS

GREEN sidewalks provide similar benefits to green streets or alleyways. They can capture runoff from the sidewalk and adjacent properties. Available implementation options include curb extensions, sidewalk planters, tree trenches and permeable pavement or pavers. They can be implemented during road construction or maintenance, or during reconstruction of utility infrastructure. Green sidewalk installation examples are shown in Figure 4.

GREEN parking lots are designed to capture runoff from the parking lot area and adjacent properties. The main green infrastructure installation would be a more permeable alternative to traditional pavement. Options include gravel, permeable concrete, interlocking pavers with turf or vegetation in between, or brick. Typically, an infiltration bed is installed below the permeable pavement to serve as a catchment for the runoff that infiltrates. Vegetation can also be installed around the edges to catch the runoff that didn't infiltrate through the pervious surface. Interlocking pavers and porous concrete examples are shown in Figure 5.

Figure 4. Green sidewalks can be constructed using various methods, including interlocking pavers with turf or gravel between them (left) and by creating a parkway between the street and the sidewalk by using plants within a soiled or mulched garden bed or planter (right).

Figure 5. Examples of permeable pavement: interlocking pavers (left) and porous concrete (right).

PRIVATE DISCONNECTIONS RAIN GARDENS & RAIN BARRELS

DOWNSPOUT disconnection involves redirecting runoff from the roofs of buildings and homes into rain barrels, cisterns and/or rain gardens. Examples of these features are shown in Figure 6. The primary function of this green infrastructure type is to limit or slow down the runoff entering the storm drains. Private downspout disconnection provides a simple, cost effective way for citizens to become involved in the stormwater runoff issue. It is one of the best ways for private landowners to implement green infrastructure because it does not require a large amount of time, space or money to operate. These can be implemented at essentially any building.

Figure 6. Rain gardens (upper images) collect runoff from an adjacent sidewalk. Rain barrels (lower images) collect and store runoff from connected roof gutter systems. This process is often referred to as rainwater harvesting. Larger systems (lower-right) can collect and store enough water to irrigate gardens along city parkways.

ENHANCED STREET TREE PLANTINGS

INCREASING Increasing Bloomington's tree canopy cover has many benefits including improving air quality, providing cooling and shading effects, improving aesthetics and reduced stormwater volumes (McPherson et al. 2011). Street tree plantings typically occur within a sidewalk and have trees planted with permeable pavers on either side to encourage infiltration.

This type of project can capture water from the sidewalks, streets and other surrounding areas, and would be more easily implemented if road/sidewalk construction or maintenance was already planned and tree plantings were incorporated into the existing plans. Street tree planting example projects can are shown in Figure 7.

Figure 7. Examples of street tree planting projects.

GREEN PARKS

EXISTING parks can be renovated and restored to include green infrastructure options which can not only contribute to aesthetics and recreation, but can also reduce stormwater runoff from surrounding streets, parking lots and neighborhoods. If park renovations are already planned, green infrastructure options could be added onto the plans to make implementation more cost effective.

Green infrastructure options include rain gardens, bioswales, tree plantings, daylighting streams that have been piped underground, and others depending on park and project goals. Public parks are great places for green infrastructure implementation because they provide potentially large areas of land that are available for the city for implementation of green infrastructure that requires larger land area. These parks can take many forms, Figure 8 demonstrates some possibilities.

Figure 8. Examples of green parks.

GREEN SCHOOLS & CITY-OWNED SITES

MANY of the green infrastructure options listed above could be implemented at public schools as part of a green schools program. Because they are publicly owned and typically have a large amount of impervious surfaces (roofs, parking lots, sidewalks), they are good candidates for green infrastructure implementation by the government. These projects help manage stormwater runoff from the property while also opening educational opportunities for the students to learn about green infrastructure and water resources. Green roofs, green parking lots, tree plantings or rain gardens and rain barrels are some of the possible projects that could be implemented at a green school. Likewise, this same principle could be applied to any public building or facility. Examples of features that could be implemented at green schools are shown in Figure 9.

Figure 9. Examples of green schools project options including a green parking lot (top) and a vegetated garden area (bottom).

GREEN ROOFS

GREEN roofs are installations on the roof of a building that consist of an insulation layer, a waterproofing membrane, a layer of growing medium and a vegetation layer. There are two main types of green roofs: extensive (which supports shorter, hardier vegetation and requires very little maintenance after installation) and intensive (which supports a wide variety of vegetation, including shrubs and trees in some cases, but requires more maintenance and, occasionally, irrigation). Green roofs are most cost effective when factored into new construction projects, as opposed to retrofitting an old roof. However, both options may be economically feasible if one considers the many benefits that green roofs offer. They provide functions such as runoff reduction, increased roof longevity, building cooling and insulation, and reduction of urban heat island effect (Oberndorfer et al. 2007). They also contribute to the aesthetics and overall green space of an urban center without taking up valuable real estate. Figure 10 shows different types of green roof designs.

Figure 10. An extensive green roof on top of a school (upper image). A rooftop garden is an example of an intensive green roof (lower image).

EXISTING CONDITIONS

Image Source: www.bloomington.in.gov

This section will detail the existing conditions in Municipal Bloomington. These include physical factors such as geology and hydrology, as well as existing Green Infrastructure.

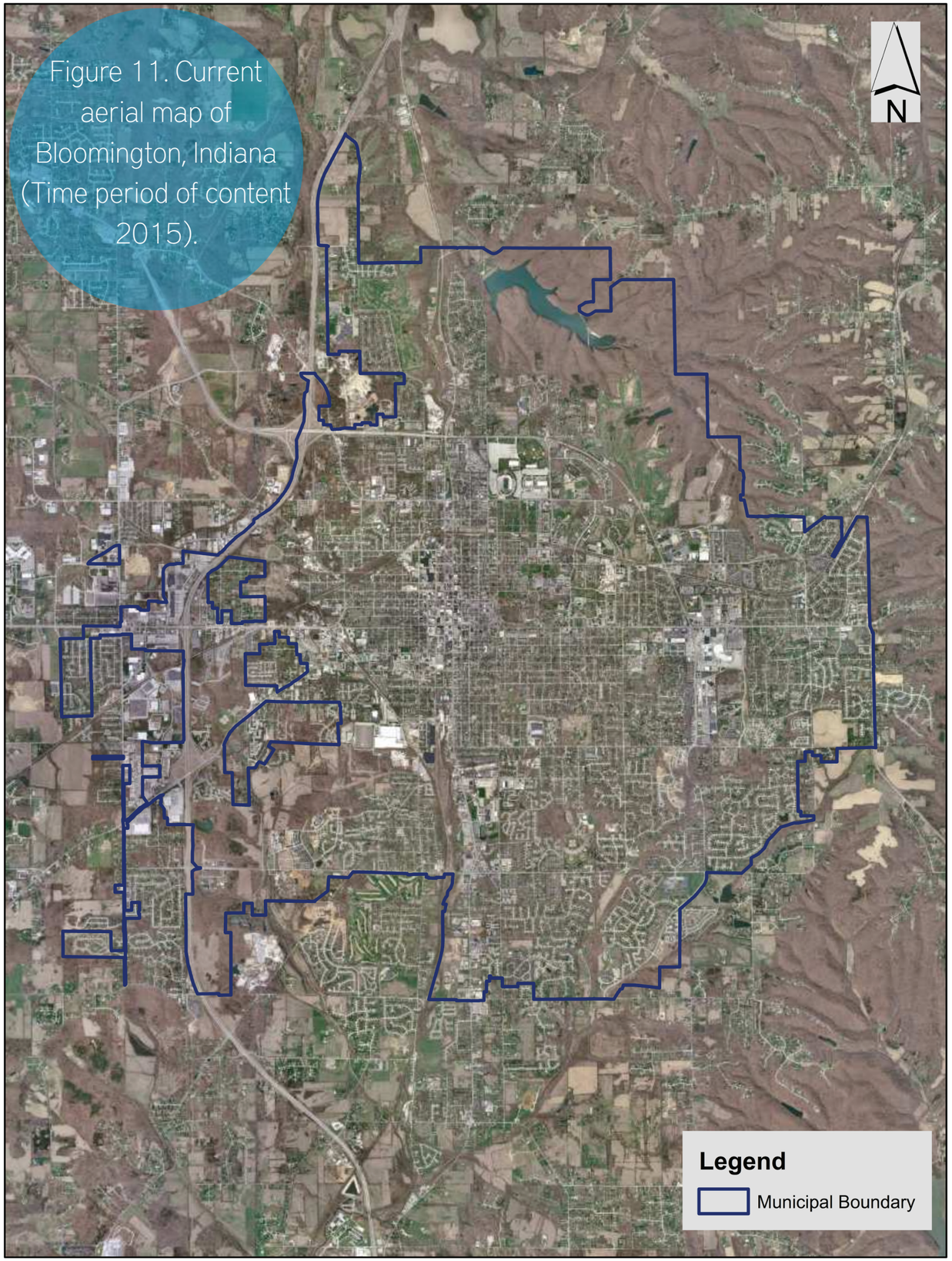


Figure 11. Current aerial map of Bloomington, Indiana (Time period of content 2015).

CITY OF BLOOMINGTON

THE City of Bloomington is located in south-central Indiana, about 50 miles south of Indianapolis in Monroe County (Figure 11). Bloomington had a population of 80,405 as of the 2010 census (US Census Bureau, 2010) and is home to Indiana University-Bloomington, the second largest university in Indiana. The City of Bloomington covers an area of approximately 15,400 acres. Of this area 99.4% (approximately 15,300 acres) is land and 0.6% (approximately 100 acres) are surface waters. The city contains Indiana University (all classes of developed: open, low, medium, high intensity), a distinct urban center, about 7,840 acres of green space and 1,230 acres of rural land use. Green space includes grassland/herbaceous, scrub/shrub, mixed forest, evergreen forest, deciduous forest, and developed/open space is as defined by the USGS National Land Cover Database (NLCD). The database describes developed/open space as including areas with a mixture of some constructed materials, but covered mostly by vegetation in the form of lawn grasses. Areas under this classification have impervious surfaces that account for less than 20% of the area's total land cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Rural land use is characterized by NLCD 2011 as including cultivated cropland and land used for pasture/hay. Figure 12 breaks land cover down by percentage while Figure 13 shows a map of all land cover types present in Bloomington.

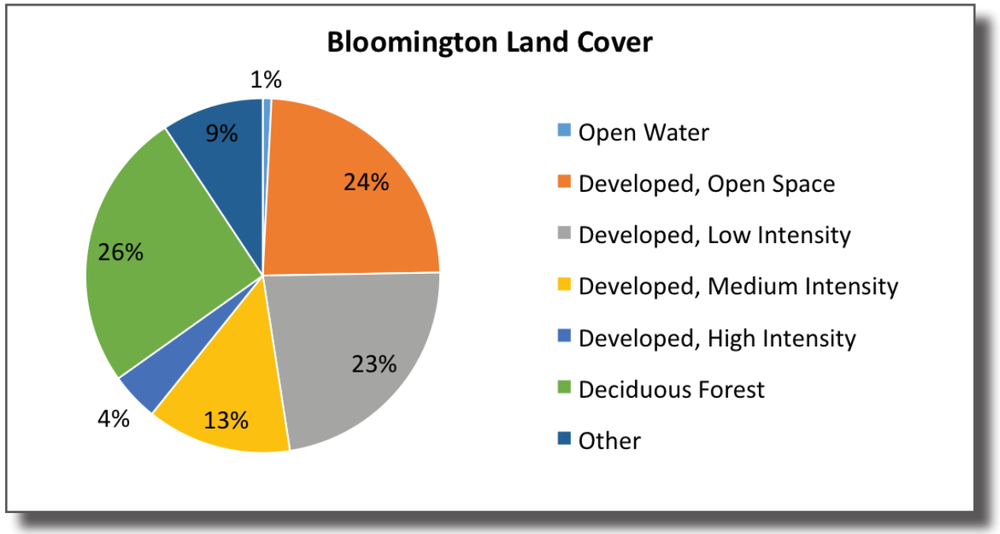
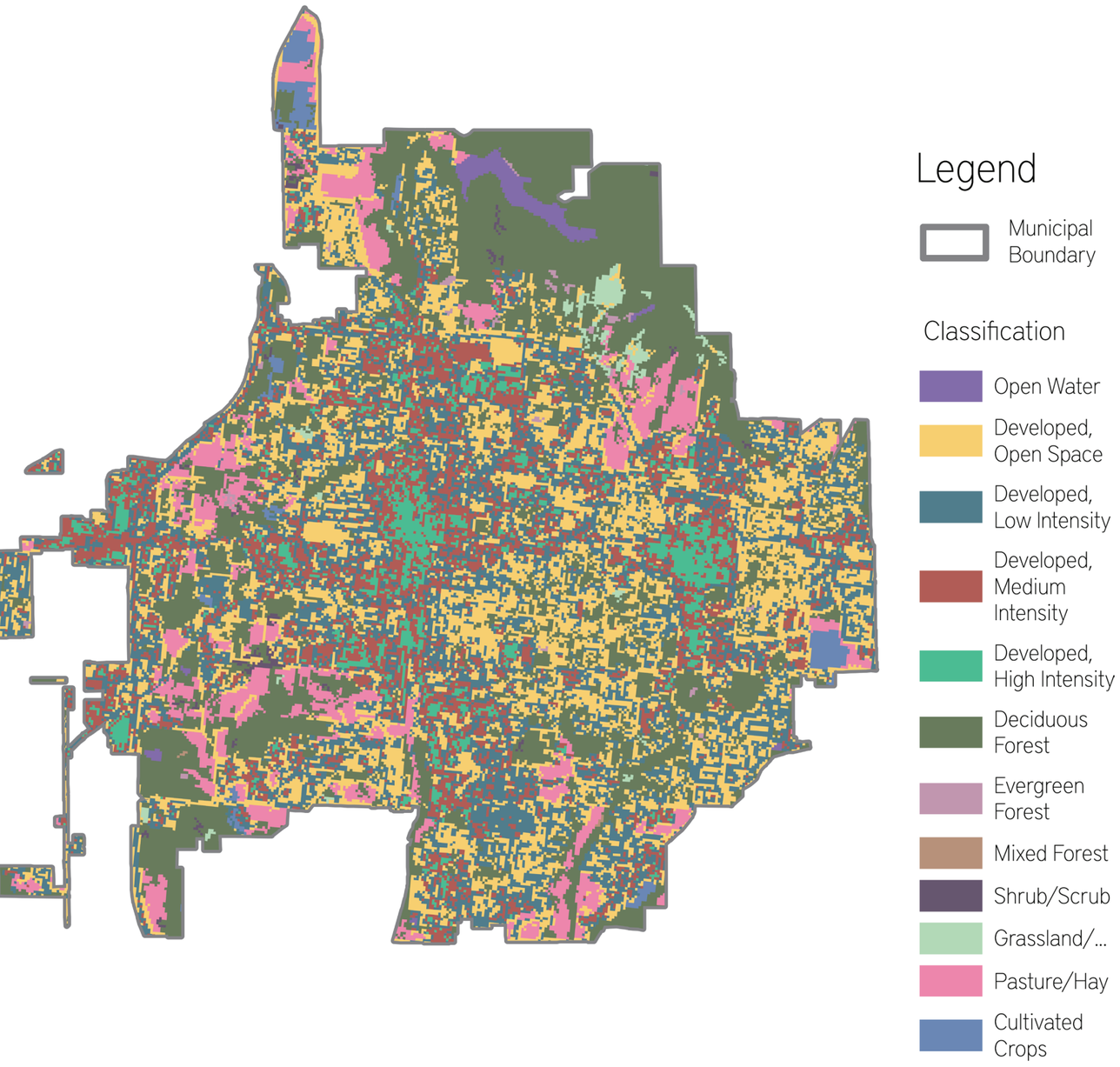


Figure 12. Land cover classifications broken down by percent within Bloomington, Indiana.

NOTE ON METHODS:

The geographic analysis working group used ArcGIS 10.2 in conjunction with shape files from various sources (Appendix II) to establish the conditions of the City of Bloomington with the best available data. We mapped land cover, impervious surface, hydrology, bedrock geology, and topography within the Bloomington municipal boundary. These maps may now be used to analyze potential green infrastructure feature locations. Additionally, we used Google Earth to display current green infrastructure locations within the city.

Land Cover



0 2.5 5 10 Miles

Figure 13. Map of land cover in Bloomington, Indiana. (Time period of content 2011-2014).

GEOLOGY & SOILS

THE underlying geology of Bloomington consists of irregular limestone terrain which influences the characteristics of the surficial karst topography. Karst features are formed from interactions between limestone bedrock and water flows. These water flows dissolve limestone formations, creating a variety of features. These features include sinks, ravines, fissures, underground streams, sinking streams, springs and caves. There are some surficial karst features scattered throughout Bloomington with the highest concentration found in the west and southwest portions of the City. The prevalence of karst features requires consideration when planning a majority of development activities, and should be considered in future green infrastructure plans. All of Bloomington lies on bedrock in the Mississippian system (Figure 14; Karst Features Map). The majority of the city lies on the Sanders group, which is characterized by being mostly skeletal limestone with cherty limestone in the lower portion. Outskirts to the west lie on the Blue River group, which is characterized by mostly micritic, skeletal, and oolitic limestone. Finally, outskirts to the north and southeast of the city lie on the Borden group, which is characterized by mostly siltstone, lenses of crinoidal limestone in the upper portion, as well as ample cherty and silty limestone and dolomite in northwest (Indiana Geological Survey Bedrock Geology layer 1987). Bloomington's soils consist of many different types, as is shown by Figure 15; a description of these soils is found in Appendix III (USDA Soil Survey Geographic Database 2015) .

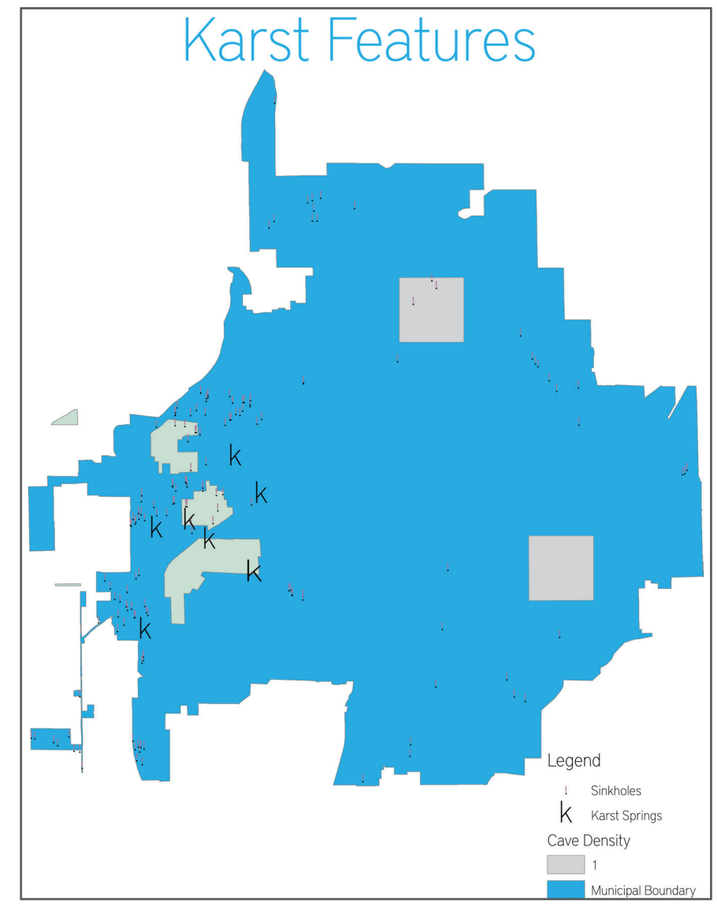


Figure 14. Karst features of Bloomington, Indiana. (Cave density time period of content 1961-1997; sinkhole inventory time period of content 1969-2010; springs time period of content 1970-1997).

Soil Survey Map

Legend

- Municipal Boundary
- Ba
- BdB
- BkF
- Bo
- Bu
- CaD
- Cb
- CoF
- CrB
- CrC
- CrD
- CsC
- CtB
- CtC
- Cu
- EkB
- GpD
- HaD
- HaE
- Hd
- HoA
- HoB
- HoC
- HtB
- IvA
- Omz
- PeB
- St
- TlB
- Ua
- Ud
- W
- Wa
- WeC
- Wr
- ZnC

Figure 15. Soil types by map unit of Bloomington, Indiana. (Time period of content 2015)

TOPOGRAPHY

THE The range of elevations in Bloomington is fairly moderate, with an average elevation of 784 feet above sea level. The highest elevation in the city is 932 feet above mean sea level and is found on the North Side of the Bell Tower near East Lingleback Lane. The lowest elevation is 590 feet above mean sea level, and is located west of Griffy Reservoir. The topography of the city is characterized by flatlands to gently rolling hills, which consists of gentle (<6%) to moderate (6% to 12%) slopes. There are steeper slopes (>12%) within the city, although these are less common and found in lower density residential areas along the periphery of the city (Bloomington Environmental Quality Indicators, City of Bloomington).

HYDROLOGICAL RESOURCES

BLOOMINGTON exhibits a climate typical for southern Indiana (Table 1). Southern Indiana receives an average of nearly 45 inches of rain and an average of nearly 19 inches of snowfall per year (Table 1). The majority of this precipitation drains to Clear Creek, Beanblossom Creek, or Griffy Lake. Bloomington is situated at the divide between the basins of the West and East fork of White River. This geographic location leaves Bloomington with no natural lakes or large rivers and little groundwater available for wells (Maxwell, 1921).

Table 1. Climate Data for Southern Indiana. (NOAA, 2016).

Climate (Average Weather) Data	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Minimum Temperature	°F	19.3	22.8	31.6	41.4	51.5	60.6	64.7	62.5	54.8	43.5	34.9	24.3	42.66
Maximum Temperature	°F	**36.5**	**42**	**52.4**	**64**	**73.9**	**82**	**86**	**84.5**	**78.1**	**66.8**	**53.5**	**41.3**	**63.42**
Heating Degree Days		1151	913	713	375	161	18	0	10	60	325	624	998	445.67
Cooling Degree Days		**0**	**0**	**0**	**5**	**90**	**206**	**321**	**274**	**102**	**19**	**0**	**0**	**84.75**
Monthly Precipitation	inches	2.66	2.71	3.66	4.29	5.12	4.07	4.32	3.99	3.62	3.14	3.95	3.38	3.74

STREAMS

THE l largest stream in the city is Clear Creek, which flows in a south-southwesterly direction before joining Salt Creek, which in turn flows into the East Fork of the White River. Clear Creek bisects Indiana University and is known on campus as Jordan River. Clear Creek's main tributaries are Jackson Creek, Sinking Creek, and West Fork Clear Creek. Most of the upper reaches of Clear Creek flow through Bloomington in culverts or constructed channels until the creek emerges at the southern edge of downtown. Clear Creek drains two thirds of Bloomington, with the remaining third draining to the north to Griffy Lake and Beanblossom Creek.

Beanblossom Creek begins in north central Brown County and flows westward into Lake Lemon. The creek continues from the outlet of Lake Lemon, finally meeting with the West Fork of the White River near the Monroe-Owen County Line. The majority of the Beanblossom Watershed is forested, although there are growing urban/suburban influences from Bloomington and Ellettsville. Tributaries of Beanblossom Creek include Griffy Creek and Jack's Defeat Creek.

LAKES

DUE to the lack of natural lakes or major rivers, the creation of reservoirs was necessary to provide drinking water for the growing population of Bloomington and surrounding area. There are three significant reservoirs near Bloomington: Lake Monroe, Lake Lemon and Griffy Lake. There are smaller impoundments located within the City, but these will not be elaborated upon in this report. Lake Monroe is the largest of the three major reservoirs and provides drinking water to the City. Lake Lemon is the second largest reservoir in Monroe County and is situated to the northeast of Bloomington. The primary flow into Lake Lemon comes from Beanblossom Creek, also draining the north end of Bloomington. Griffy Lake is the largest reservoir within city boundaries, and is located at the northern edge of the city. The lake was created with the impoundment of Griffy Creek, and drainage to the creek still supplies the majority of water to the reservoir. Originally constructed for drinking water, Griffy Lake was soon replaced by Lake Lemon which was later in turn replaced by Lake Monroe as the drinking water source for Bloomington. Other in-city reservoirs include Twin Lakes and Wapehani Lake. Lakes and streams are shown in Figure 16; Hydrological Resources Map.

DRINKING SUPPLY AND WASTEWATER ELIMINATION

TODAY, Lake Monroe serves as the primary drinking water source for the City of Bloomington. The Monroe Water Treatment Plant is located six miles southeast of Bloomington. The City purchases the water for treatment and distribution from the State of Indiana. Sanitary wastewater from Bloomington is received by the Dillman Road and Blucher Poole wastewater treatment plants (WWTPs). The Dillman Road WWTP discharges treated effluent into Clear Creek and the Blucher Poole WWTP discharges into Beanblossom Creek.

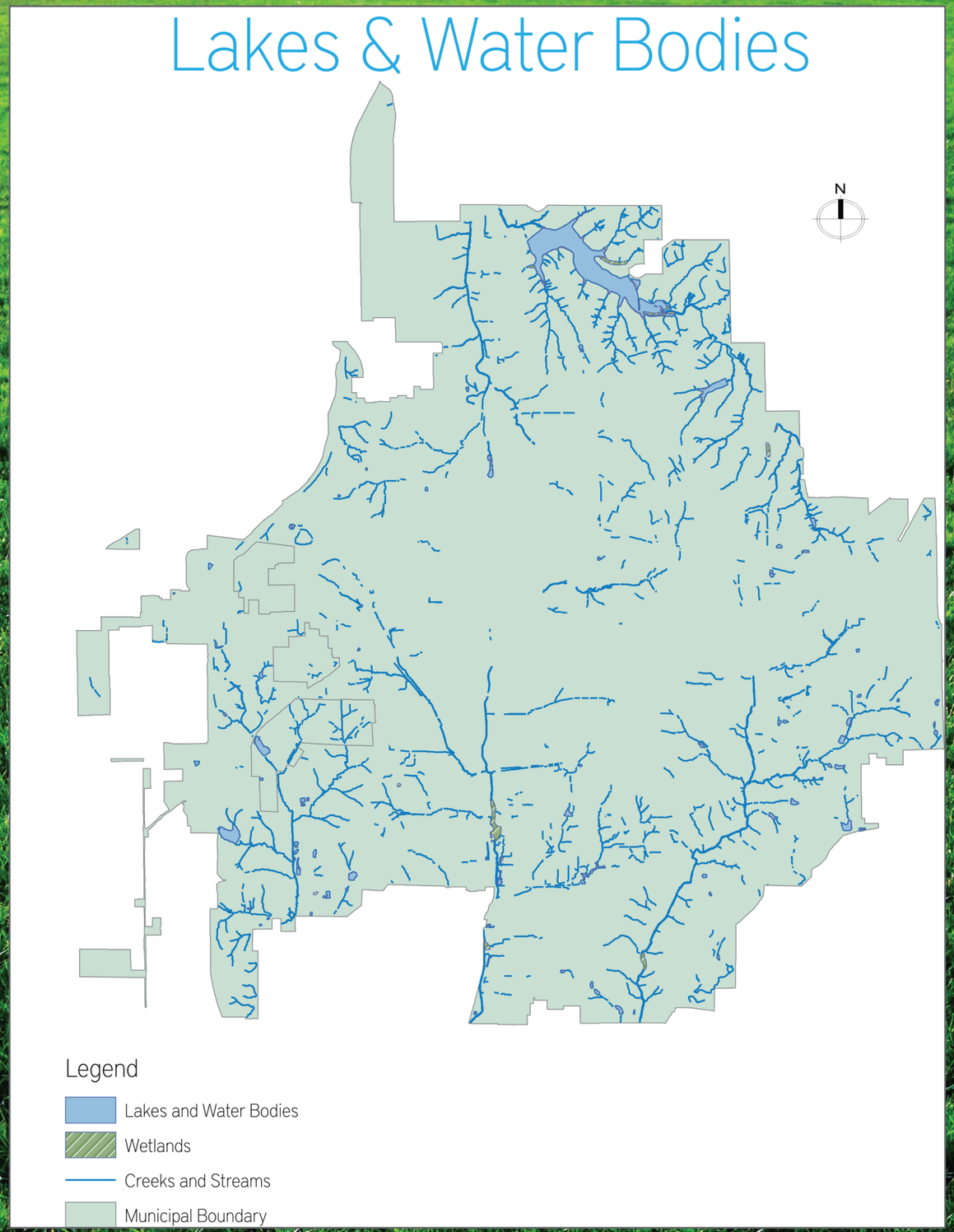


Figure 16. Hydrology and water bodies of Bloomington, Indiana.. (Lakes and water bodies time period of content 2016; wetlands time period of content 1977-2014; creeks and streams time period of content 1991-2016)

EXISTING GREEN INFRASTRUCTURE

THE City of Bloomington has a wealth of green infrastructure that is used every day (Figure 17). The types of green infrastructure currently employed by the city include bioswales, various types of pervious pavement, riparian buffers, vegetated curb extensions, rain barrels, rain gardens, green roofs, garden plots, and detention/retention ponds along with a wide array of conservation easements. Not only does the City employ green infrastructure to mitigate stormwater runoff, so do many of Bloomington's residents. Through Bloomington's rain barrel initiative to its Certified Backyard and Wildlife Habitats program and its urban agriculture programs, Bloomington residents are currently making an impact using green infrastructure. Indiana University, located just east of the downtown district, uses several types of green infrastructure – primarily with new construction to help fulfil its LEED Gold standard – to mitigate potential damages from stormwater runoff from its 1,937-acre campus.

Although Bloomington presently uses an array of green infrastructure strategies, the City must recognize its potential to improve upon current efforts by implementing approaches laid out throughout this document.

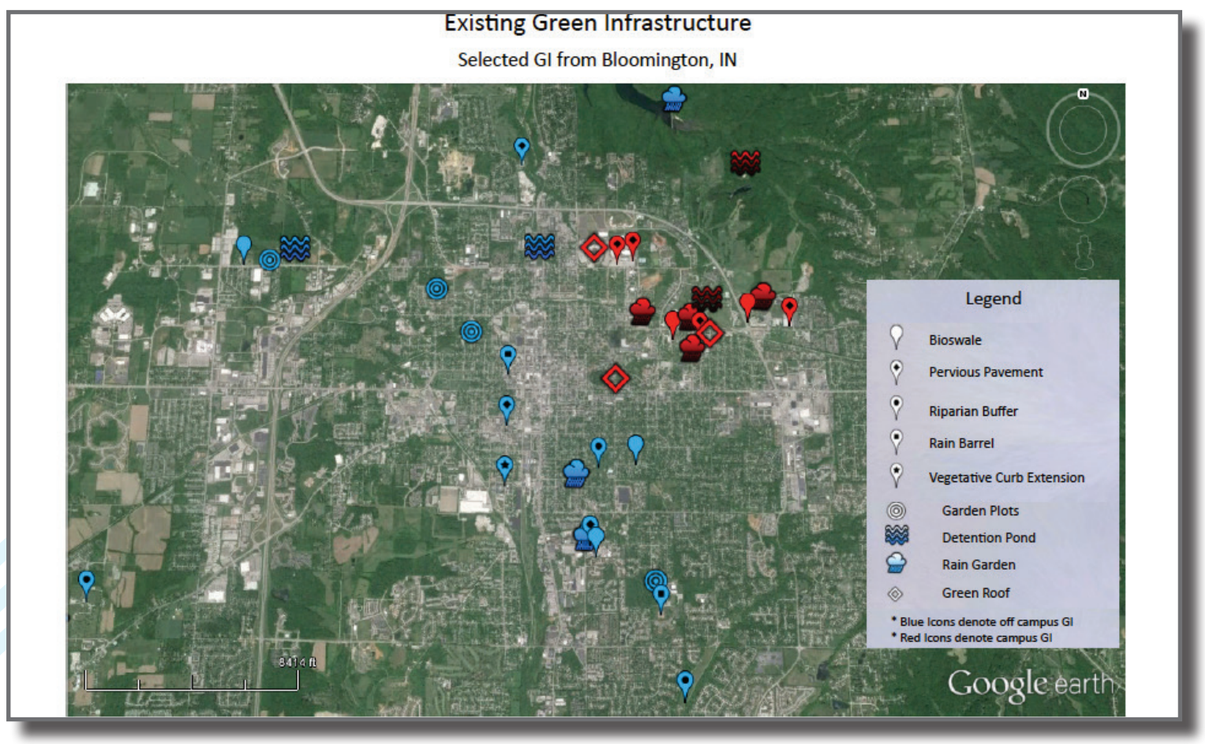


Figure 17. Selected existing green infrastructure installations by type within Bloomington, Indiana city limits. Note this is not a comprehensive display of current green infrastructure (Satellite imagery from 2016).

GI IMPLEMENTATION IN BLOOMINGTON

The next section will discuss implementation strategies for Green Infrastructure in the City of Bloomington. The authors recognize that City-wide implementation is a goal that will require small steps to attain. We recommend a series of highly visible demonstration projects that will gain citizen support to implement City-wide changes. "problem areas" are also factored into selection choice within the decision making framework. Finally, we recommend strategies for transitioning to City-wide GI implementation.

IDENTIFYING PROBLEM AREAS

To improve understanding of the City of Bloomington's needs for green infrastructure, we identified flood-prone problem areas within the city. With the input of the capstone team and city employees, four locations were identified as known problem areas: 2nd Street and Henderson Street, 4th Street and Grant Street, Wiley Street and Walnut Street, and Indiana Avenue and Kirkwood Avenue (Figures 20-23). ArcMap was used to map these areas in their respective watersheds (Figures 18 and 19; Selected and Individual Watersheds Maps), as well as mark the locations of storm drains and pipes, in order to identify candidate green infrastructure projects and ideal locations.

THESE areas are known for flooding problems when there are high rain events. This is one of the reasons why watersheds were delineated specifically for the problem area sites; we wanted to be able to target the sites as directly as possible. It is our goal that by adding green infrastructure to the watersheds of these problem areas that we will be able to mitigate future flood events. As such, two of the demonstration sites (Harmony School and Peoples Park) were placed within these problem area watersheds; these will be explained in further detail later.

The map to the right displays the watersheds that contain the four identified problem areas. The pour points in each watershed serve as visuals for these specific intersections within the Bloomington municipal boundary. More detailed, individual maps of each problem site are shown in the following pages (Figure 24., Methods for calculations can be found in Table 2 page 36).

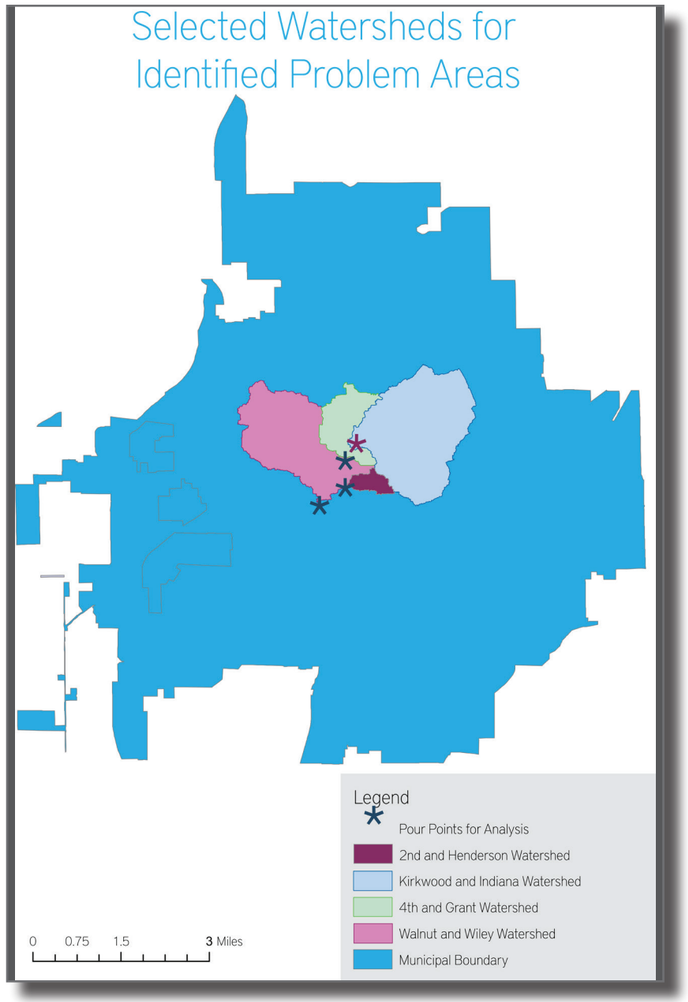


Figure 18. Map of the four delineated problem area watersheds within Bloomington, Indiana. (right)

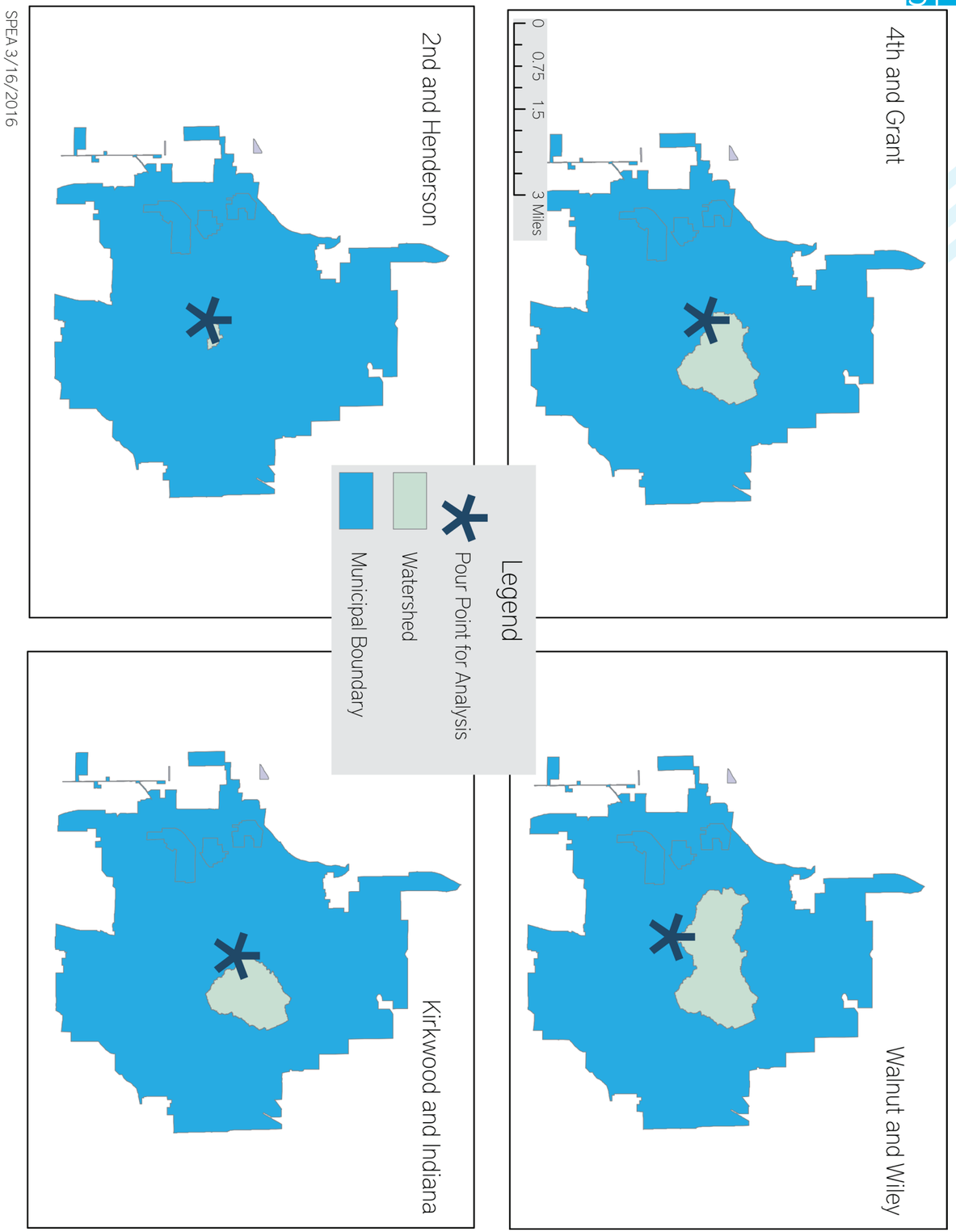
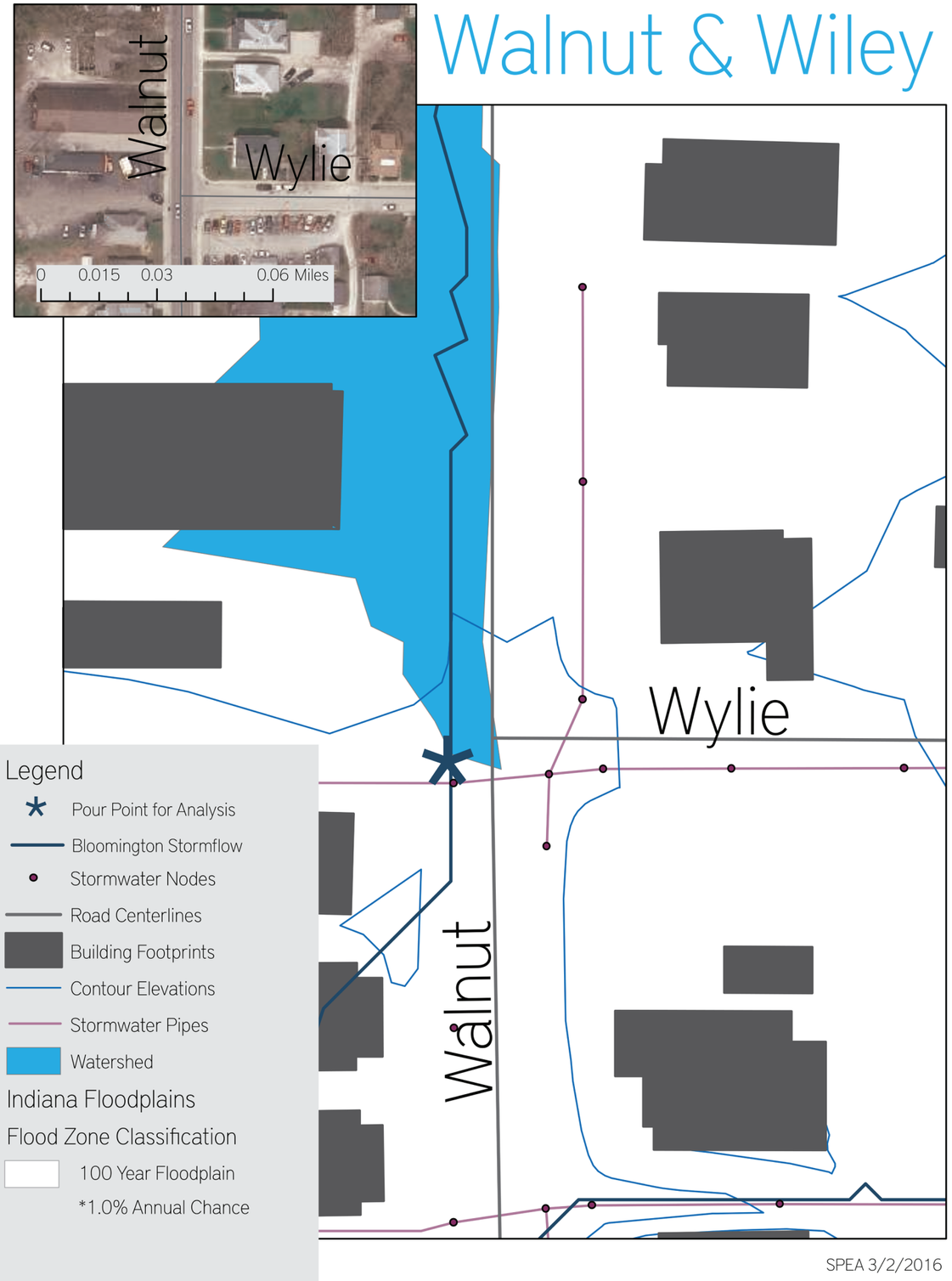


Figure 19. Map of individual problem area watersheds within Bloomington, Indiana.

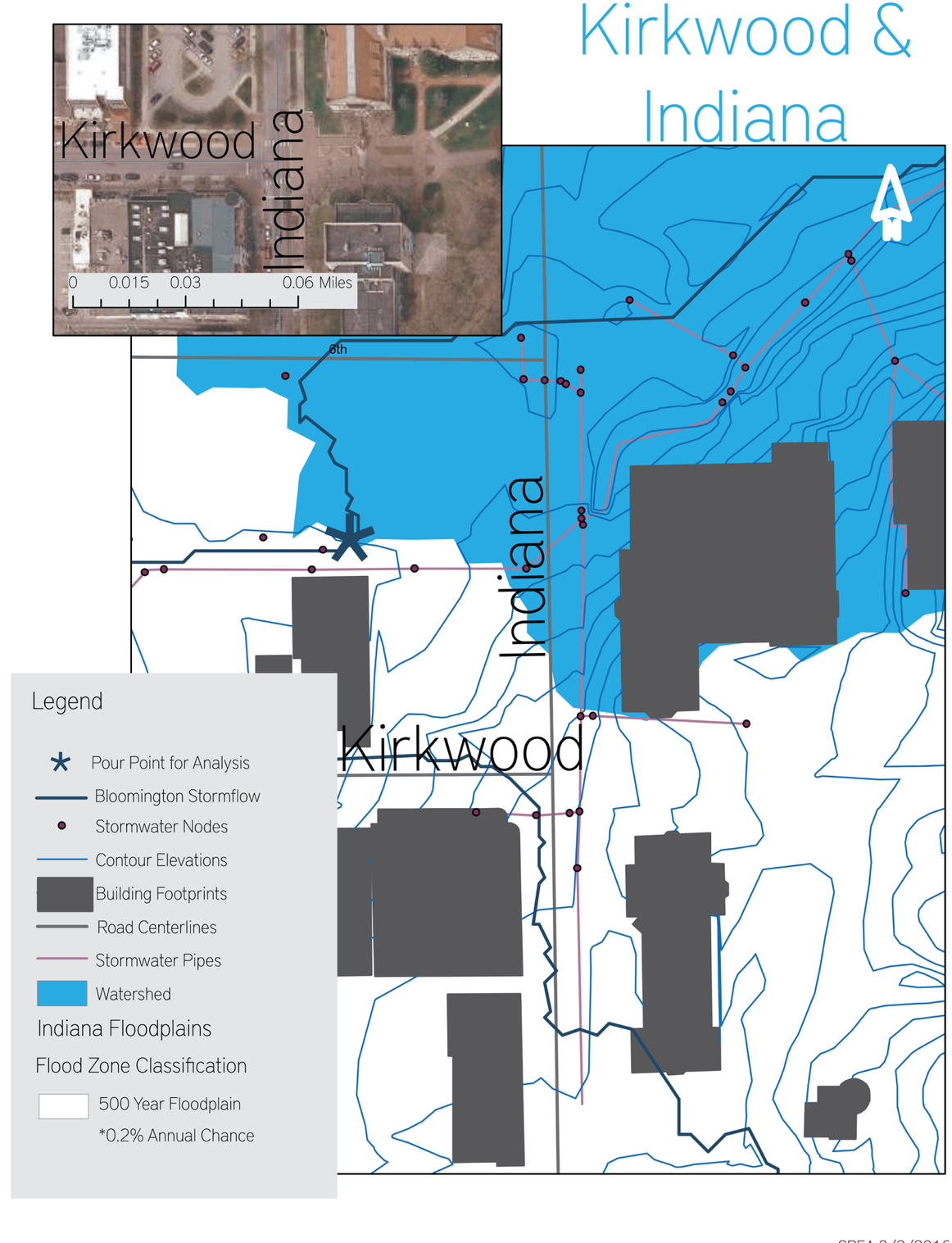
Walnut & Wiley



SPEA 3/2/2016

Figure 20. Detailed site map of Walnut St. and Wiley St. problem area in Bloomington, Indiana.

Kirkwood & Indiana



SPEA 3/2/2016

Figure 21. Detailed site map of Kirkwood Ave. and Indiana Ave. problem area in Bloomington, Indiana.

Grant & 4th

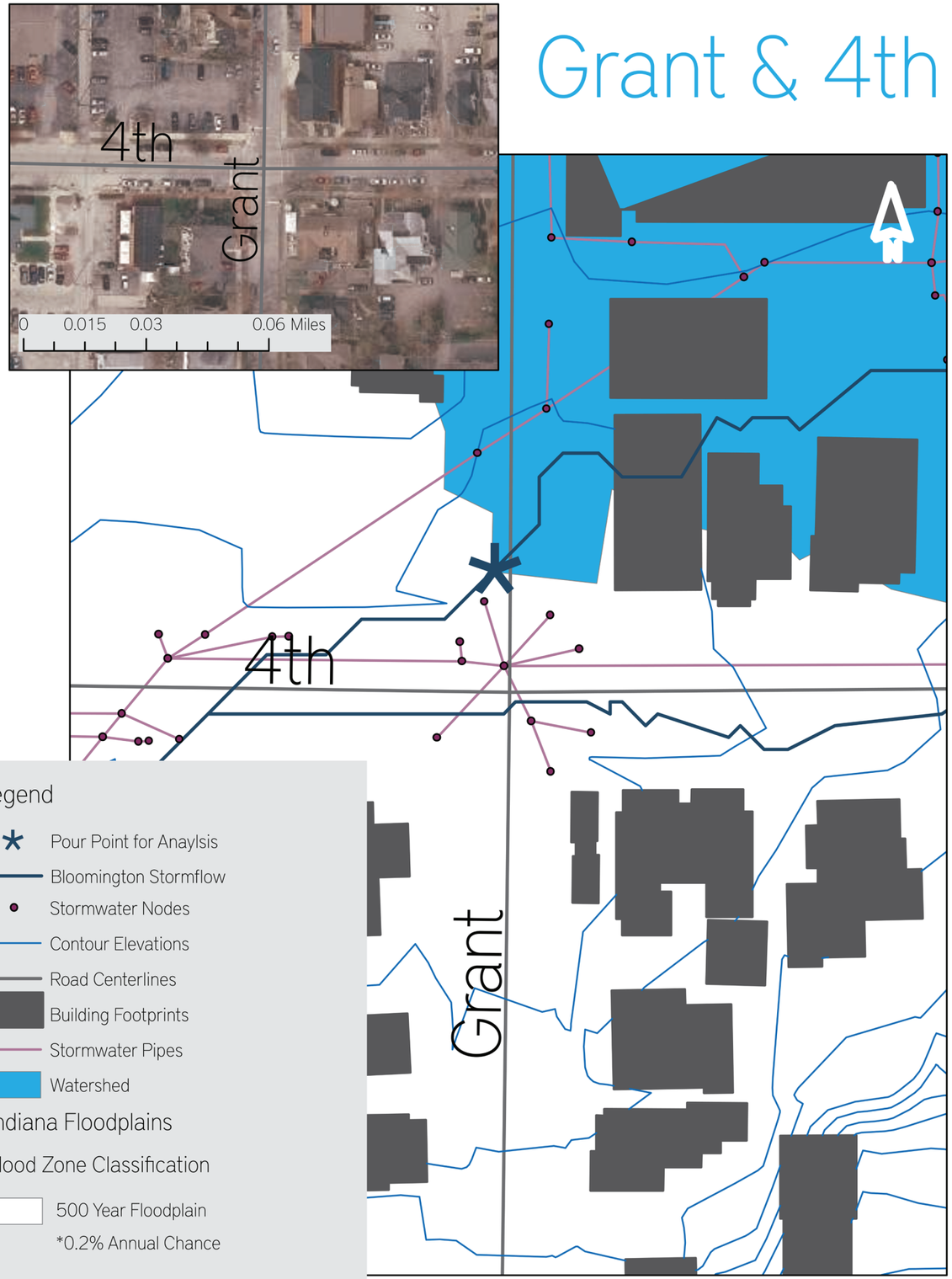


Figure 22. Detailed site map of Grant St. and 4th St. problem area in Bloomington, Indiana.

SPEA 3/2/2016

Henderson & 2nd

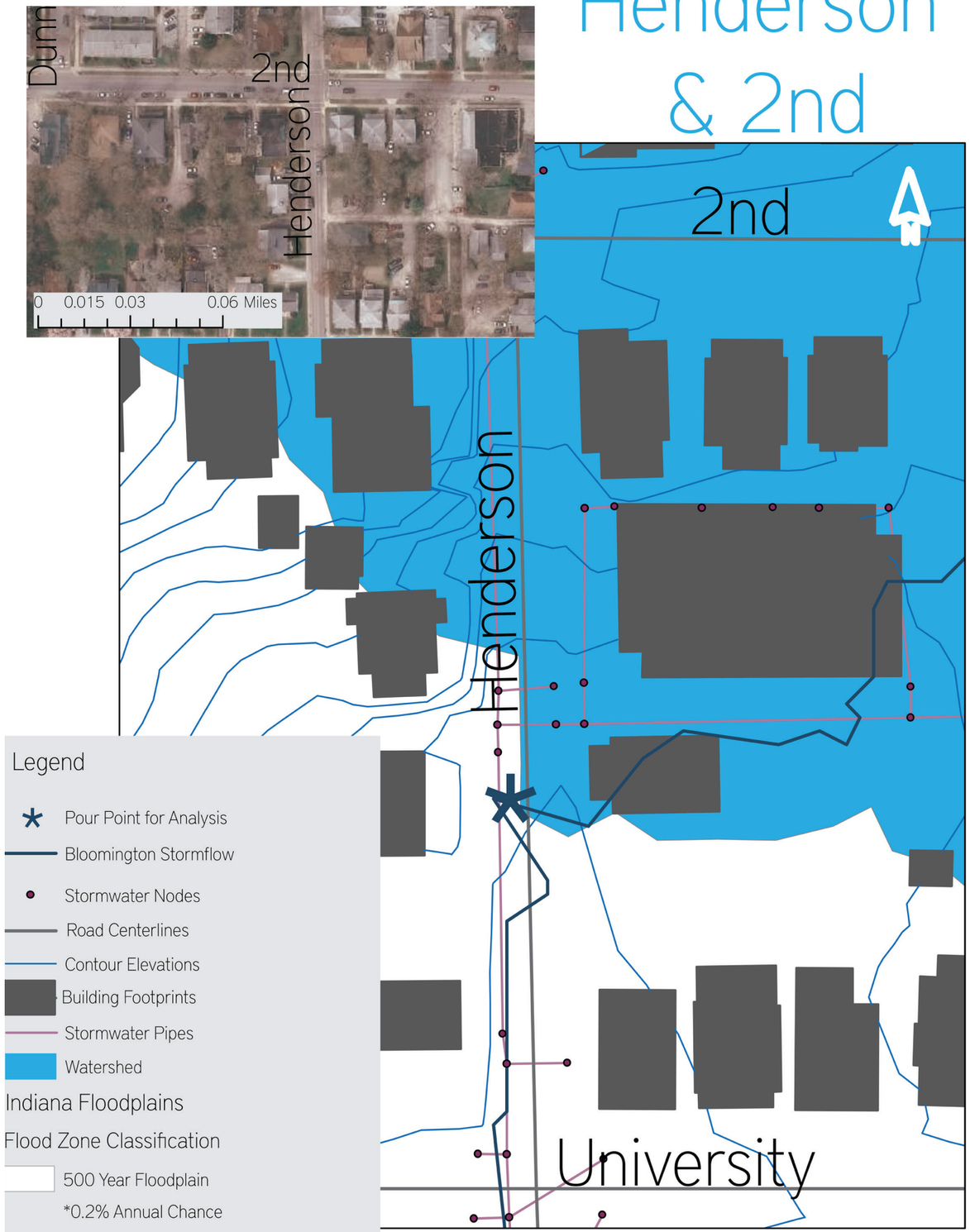


Figure 23. Detailed site map of Henderson St. and 2nd St. problem area in Bloomington, Indiana.

SPEA 3/2/2016

IMPERVIOUS SURFACE

Table 2. Process to calculate impervious surface using ArcGis 10.3.

Step	Description
Clip	We clipped the impervious surface raster to the Bloomington municipal boundary layer.
Raster to Polygon	We converted the impervious surface raster layer to a polygon layer.
Clip	We clipped the new polygon layer to the desired watersheds (i.e., 2nd and Henderson, 4th and Grant, etc.).
Calculate Geometry	Within the attribute table of the clipped polygon layer, we calculed the area (in acres) of all parcels in the watershed(s).
Field Calculator	Since the "gridcode" value represented the percent imperviousness, we multiplied the area (in acres) by the "gridcode" and named it "area X gridcode" in order to account for any errors created due to clipping.
Summary Statistics	We summed both the area (in acres) column and the "area X gridcode" column.
Final Division	We divided the "area X gridcode" sum by the area (in acres) sum to obtain the final percent imperviousness for each of the watersheds as well as within the municipal boundary.

21.8%

Percentage of Impervious Surface within the Bloomington Municipal Boundary

32.5%

Impervious surface within the 4th St. and Grant St. watershed

30.0%

Impervious surface within the Indiana St. and Kirkwood Ave. watershed

38.0%

Impervious surface within the Walnut St. and Wiley St. watershed

35.6%

Impervious surface within the 2nd St. and Henderson St. watershed

Impervious Surface

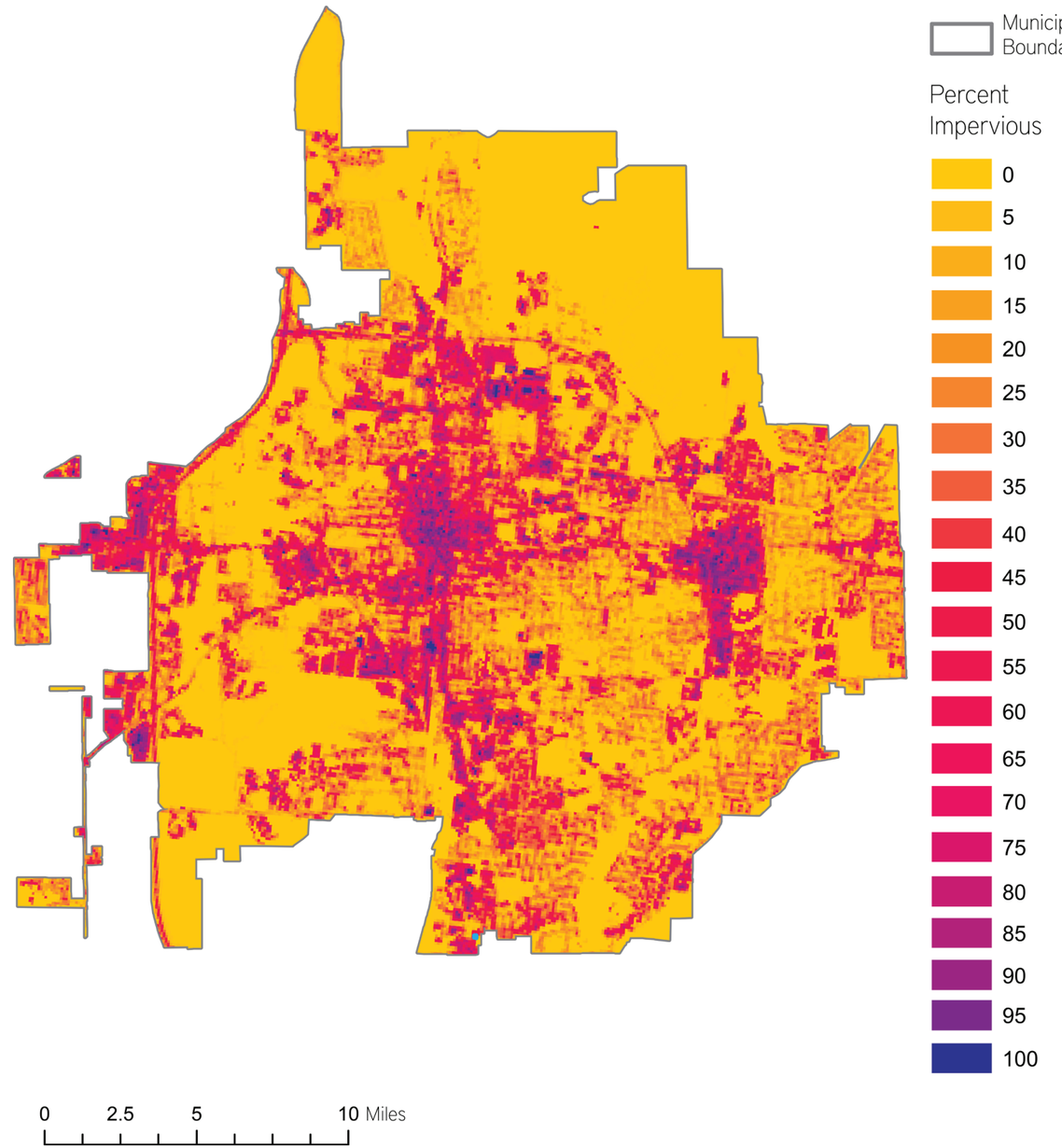


Figure 24. Percent imperviousness of Bloomington, Indiana (Time period of content 2011-2014).

METHODOLOGY: DEMONSTRATION SITES

BEFORE beginning a complete City-wide implementation of green infrastructure, it is recommended to start with a small selection of demonstration sites. These sites function as a testing ground for the effectiveness of each proposed strategy, as well as a learning opportunity to identify unexpected problems, and gauge citizen support. In order to decide where these demonstration sites should be located, several factors must be considered. The capstone team used the following methodology to recommend these sites.

FIRST, the capstone team sought to identify locations that the City had previously considered to be important locations for upgrades or frequently problematic in respect to flooding. Next, the team considered the types of space the City of Bloomington possesses and hopes to change through the green infrastructure plan. These types of space include streets and intersections, parking lots, parks, schools, and residential or commercial buildings. Because demonstration sites would most likely be funded by the City, unless early adopters among the private stakeholders wished to start a project, the team eliminated residential and commercial buildings from the initial list of sites.

Another important consideration was the location of the demonstration sites. After identifying the areas that have experienced flooding in the past, the team identified additional locations throughout Bloomington that would provide a diversity of project types. The factors considered were visibility, population density, and aesthetic appeal. These initial considerations provided a list of areas throughout Bloomington that might be suitable for demonstration projects. The team then narrowed this list by examining the actual locations, through either in-person viewing or Google Streetmaps images. Additional factors to narrow the list included how much available space each location might have to easily integrate a green infrastructure BMP, how recently an upgrade had been performed (locations already needing improvement were preferred), and how costly each installation might be given the location and space.

WITH the above considerations and constraints, the proposed demonstration sites list was created. These locations target problematic areas in Bloomington, serve a representative sampling of Bloomington's demographic and variety of public space, and should be able to incorporate green infrastructure effectively into their current usage. These sites will help the City to practice installation of green infrastructure, gauge citizen response, and begin the process of engaging interested parties for further implementation which will ultimately lead to a greener, healthier, more resilient Bloomington.

METHODOLOGY: GI SELECTION

DESCRIPTIONS of of tools that can be used for site and BMP selection can be found in Appendix IV. Figure 25 highlights the criteria we found most essential to BMP and site selection.

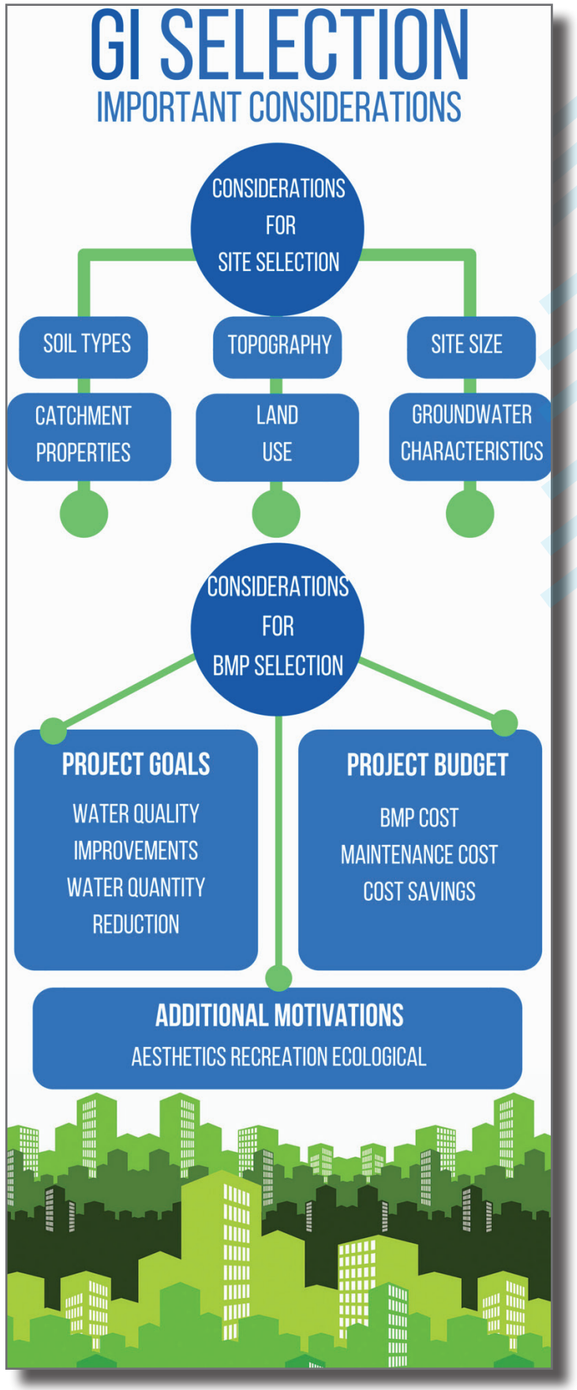


Figure 25. Important selection criteria for choosing proposed Green Infrastructure sites as well as further considerations necessary for choosing specific projects (right).

SUGGESTED DEMONSTRATION SITES

SELECTED using the previously described methodology, this plan suggests six demonstration sites that could serve as pilot projects for full-scale green infrastructure implementation in the City of Bloomington. In Appendix V, a full description with aerial photography is provided to demonstrate locations of the suggested GI. Two of the selected demonstration projects fell within the previously mentioned problem areas: 2nd Street and Henderson Street watershed and Indiana Avenue and Kirkwood Avenue watershed (Figures 26 & 27).

GOAT FARM

Description: Rain gardens at the northern and southern tips of the Goat Farm property can manage stormwater runoff from nearby residential neighborhoods and roadways.

BUTLER PARK

Description: Replacing traditional concrete parking lots with permeable pavement (0.38 acres) will decrease total impervious surface cover for the park. Similarly, the installation of a permeable pavement basketball court (0.11 acres) will reduce impervious surface cover. A vegetated swale placed along a slope can help manage stormwater runoff from nearby residential neighborhoods.

PEOPLES PARK

Description: The installation of stormwater planter boxes and curb extensions improves the management of stormwater from the park and surrounding areas, including flood prone Kirkwood Avenue while providing a highly-visible opportunity for education of the public about stormwater mitigation techniques.

BLOOMINGTON HIGH SCHOOL SOUTH

Description: A downspout disconnect coupled with three strategically placed rain gardens can manage rooftop runoff from the main school buildings which cover about 2 acres of the property. Additional rain gardens can manage some of the runoff from parking areas which make up approximately 1.25 acres of the property.

HARMONY SCHOOL

Description: A 0.3 acre rooftop garden can manage the rainfall collected atop the Harmony School's main building. A bioretention area (rain garden) placed north of the school building can manage runoff from the 0.5 acre parking lot.

CLARIZZ BOULEVARD

Description: The installation of tree pits and planter boxes along the median (0.18 acres) improves stormwater management in this area neighboring College Mall and several other shopping centers. Inclusion of native plant species like milkweed in the design supports local pollinator species. Vegetated curb extensions are also recommended. Sidewalks can be replaced with permeable pavers.

Harmony School

Henderson and 2nd Watershed

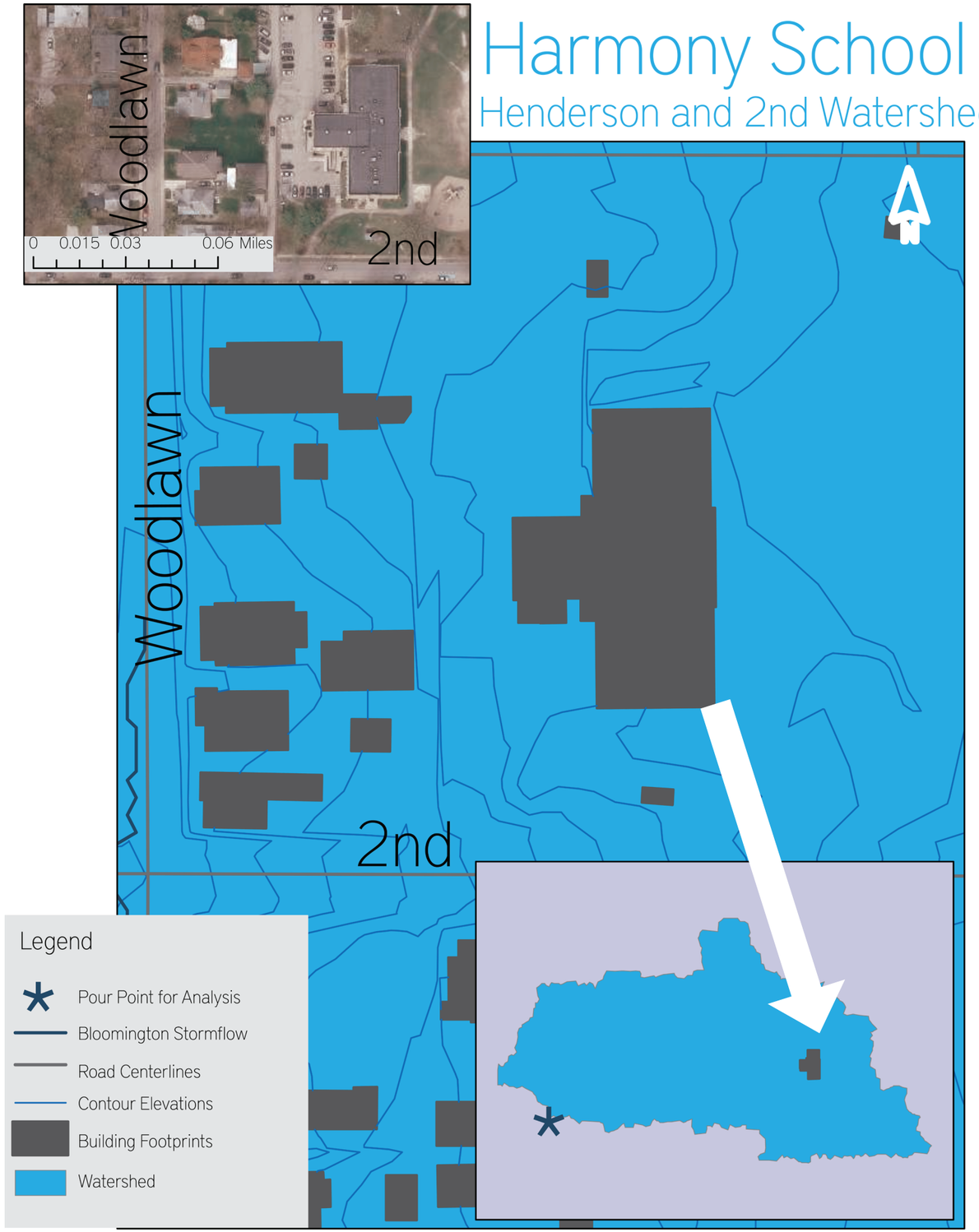


Figure 26. Harmony School demonstration site within the 2nd Street and Henderson Street problem area watershed.

SPEA 3/2/2016

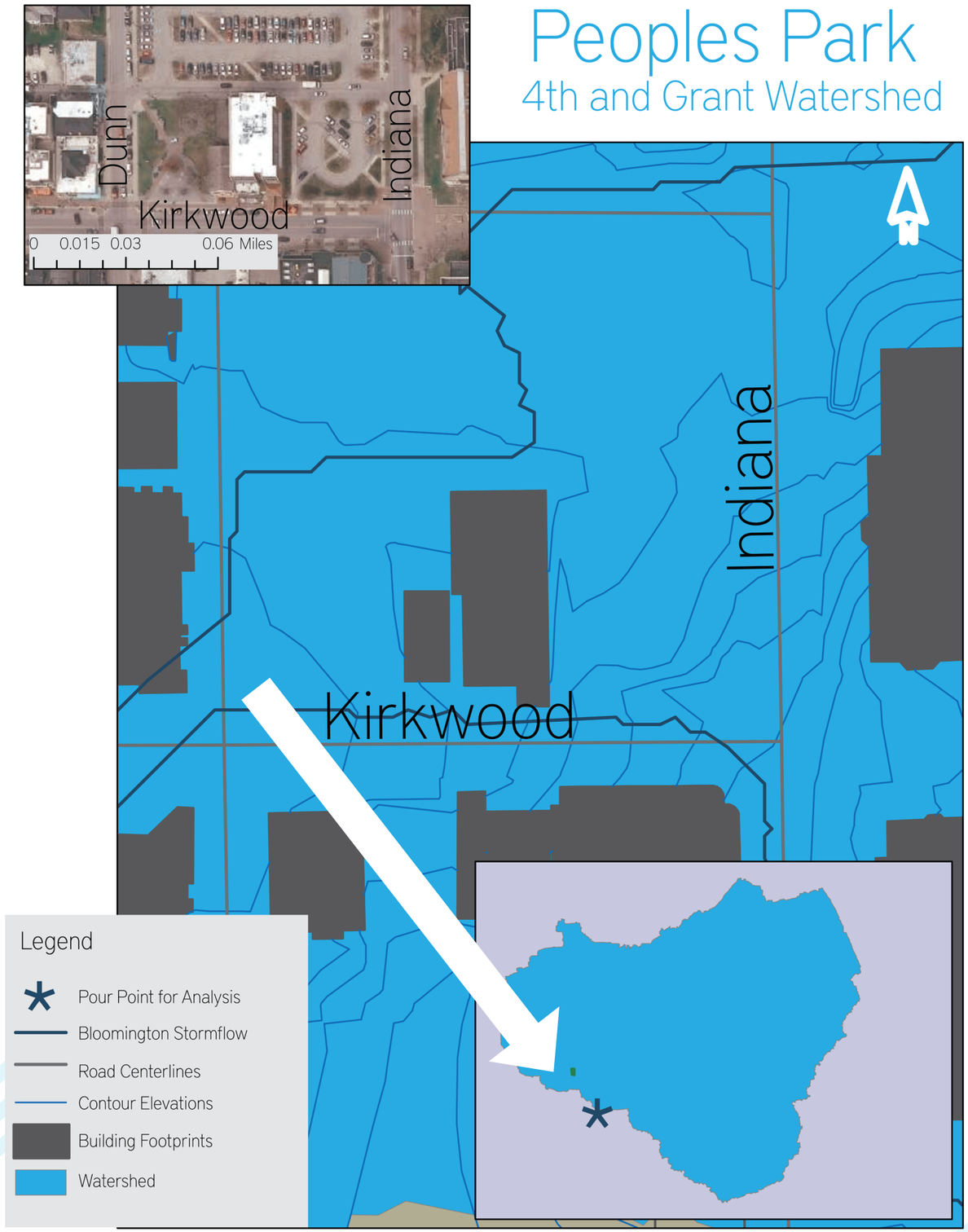


Figure 27. Peoples Park demonstration site within the Indiana Avenue and Kirkwood Avenue problem area watershed.

SPEA 3/2/2016

BENEFIT-COST ANALYSIS

Image Source: www.bloomington.in.gov

While these demonstrations sites provide great opportunities to better manage stormwater runoff, and provide an opportunity to educate the public about the need for that management, ultimately, the cost and benefits of undertaking any public program should be considered. For that reason, a benefit-cost analysis (BCA) of these 6 proposed projects was conducted. The analysis allows a better understanding of the costs, what the necessary assumptions are, and what benefits are unable to be quantified accurately for consideration. This allows for a framework to consider green infrastructure projects for the City in the future.

INITIAL ASSUMPTIONS

TO begin building a benefit-cost analysis for a specific project, it is necessary to consider all of the relevant impacts of the proposed project. For example, the Harmony School project analysis recommends installing a green roof and rain gardens. That means, of course, that there will be an installation cost, and a maintenance cost for those GI features. It also means it is important to understand how long those installations will last. On the benefits side, reductions in stormwater runoff are the primary goal, but understanding how to quantify that for the City of Bloomington requires a variety of assumptions. In fact, valuing the reduction requires knowing how much money the City can avoid spending on installations and services they are already providing. Additionally, reductions in heating and cooling costs for the buildings, reductions in carbon emissions and reductions in other air pollutants can be valued as benefits to the project. There are additional benefits that are much more difficult to quantify, such as the aesthetic appeal of the installations, the sense of pride generated in the community for having such installations, and taking action on water quality issues before state or federal regulations require such actions. These values are difficult to quantify but should not be ignored or forgotten. For example, a study of green infrastructure implementation in Philadelphia demonstrated a statistically significant relationship between green infrastructure installation and crime reduction (Kondo et. al 2015). These impacts can greatly improve the quality of life for Bloomington citizens; they have not been included only due to the difficulty and uncertainty in applying a dollar value to them. For detailed descriptions of how assumptions were used to calculate dollar amounts for the benefits and costs that were quantified, refer to Appendix VI. See Table 3 for a full list of the benefits and costs identified for the proposed projects.

Table 3. List of the potential benefits and costs associated with green infrastructure installation in the
Benefits

Quantitative Benefits	Qualitative Benefits
Avoided costs of grey infrastructure upgrades	Water quality improvements
Avoided stormwater maintenance costs	Reduced urban heat island effect
Improved air quality	Increased aesthetics and property value
Reduced electricity and natural gas usage	Reduced noise pollution
Reduced CO2 (Climate change benefit)	Increased recreational opportunities
	Habitat improvement
	Public education opportunity
	Community cohesion, and pride
	Acting before mandatory regulations
	Reduced crime
Costs	
GI installation cost	
GI maintenance and operation cost	
Time and labor needed to implement	

STAKEHOLDERS INVOLVED

ANOTHER important consideration when constructing the BCA cases for these demonstration sites was the potential stakeholder involvement. The most obvious stakeholder is the City of Bloomington itself, followed by the general public. These are the two stakeholder groups included in the BCA cases, because they are the groups for which it is easiest to calculate clear benefits and costs. However, it is possible to include private businesses in the analysis as well. Private businesses, and homeowners who would like to install GI features could face costs of installation and maintenance similar to the City. However, it is likely that private businesses, even those not installing green infrastructure of their own, benefit from GI installation in the area surrounding their businesses. The qualitative benefits of green infrastructure include reduced crime, more community engagement and time spent out and about. These benefits translate to a better environment for businesses as well as the general population. The Natural Resources Defense Council published a report in 2013 titled "The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value" (Clements et. al 2013) which looks at the benefits commercial and private property owners can realize by utilizing green infrastructure features. This resource can be provided to private and commercial businesses who are interested in more information about the tangible benfits of green infrastructure features.

Image Source: www.cawrse.com

RESULTS OF THE BENEFIT-COST ANALYSIS

After carefully considering the relevant impacts of the proposed projects, and the involved parties, the capstone team combined this information to form a Kaldor-Hicks Tableau (KHT). The KHT is an analysis tool allowing all impacts of a project to be tabulated in net present value dollars for each involved stakeholder (Krutilla, 2005). The net of all costs and benefits for all involved stakeholders is calculated in the KHT, with values larger than $0 indicating that the project's benefits outweigh its costs. When considering multiple projects, each tableau's net value can be compared, and the largest value is the project that is most highly recommended. All KHT for the proposed projects and the subsequent sensitivity analysis are provided in Appendix VII.

Table 4. BCA Kaldor-Hicks Tableau for the highest net value project, the Bloomington South High School project.

	City Residents	City of Bloomington	Net Value
Benefits			
Air Quality Benefit	$24,370.77		$24,370.77
Climate Change	$2,128.97		$2,128.97
Avoided Stormwater Utility Operation and Maintenance Costs		$2,881.49	$2,881.49
Avoided Stormwater Infrastructure Costs		$5,831,834.58	$5,831,834.58
Costs			
Capital Costs		-$2,406,690.00	-$2,406,690.00
Operation and Maintenance Costs		-$1,821,908.89	-$1,821,908.89
Net Value	$26,499.74	$1,606,117.18	$1,632,616.91

MOST COST-EFFECTIVE PROJECT RECOMMENDATION

ALL six demonstration sites chosen resulted in positive net benefits given the recommended green infrastructure features. This indicates that all projects are recommended for implementation. However, given limited resources and time, it is prudent to recommend those projects that are most beneficial for implementation first, and as funding and time permit, to recommend the remaining projects. Of the six projects, the Bloomington High School South demonstration site provides the greatest amount of benefits over the lifetime of the project at an estimated $1.6 million in net benefits. Additionally, because it is a high school, the public education opportunity benefit (which is not quantified) for this project is likely quite large. For these reasons, the Bloomington South High School demonstration project would be the best project to begin implementation. The second highest ranked demonstration site is the Goat Farm with an estimated $1 million in net benefits. This project is also highly recommended given the current City plans for improvements at the site, which makes the inclusion of green infrastructure a timely proposition. See Tables 4-5 for the KHT for these two projects.

Table 5. BCA Kaldor-Hicks Tableau for the second highest net value project, Goat Farm.

	City Residents	City of Bloomington	Net Value
Benefits			
Air Quality Benefit	$22,604.79		$22,604.79
Climate Change	$1,974.62		$1,974.62
Avoided Stormwater Utility Operation and Maintenance Costs		$1,773.22	$1,773.22
Avoided Stormwater Infrastructure Costs		$3,588,821.28	$3,588,821.28
Costs			
Capital Costs		-$1,481,040.00	-$1,481,040.00
Operation and Maintenance Costs		-$1,121,174.70	-$1,121,174.70
Net Value	$24,579.41	$988,379.80	$1,012,959.21

Table 6. Original Kaldor-Hicks Tableau for the Harmony School project.

	City Residents	City of Bloomington	Net Value
Benefits			
Energy Savings	$29,294.42		$29,294.42
Air Quality Benefit	$19,886.56		$19,886.56
Climate Change	$10,612.71		$10,612.71
Avoided Stormwater Utility Operation and Maintenance Costs		$499.11	$499.11
Avoided Stormwater Infrastructure Costs		$1,010,152.04	$1,010,152.04
Costs			
Capital Costs		-$445,401.00	-$445,401.00
Operation and Maintenance Costs		-$560,587.35	-$560,587.35
Net Value	$59,793.69	$4,662.80	$64,456.50

REMAINING DEMONSTRATION PROJECTS

AS mentioned previously, all six demonstration projects had a positive net value, meaning they are all recommended. The 4 remaining demonstrations projects had the following net present values: $424,689 for the Clarizz Boulevard project, $275,000 for the Butler Park project, $71,000 for the Peoples Park project, and $64,000 for the Harmony School project. It is recommended that the projects be approached in order of greatest net value, unless new opportunities or important considerations are discovered, as discussed in the methodology for site selection of the demonstration sites.

SENSITIVITY ANALYSIS

THE final consideration of the BCA is to test the robustness of results to changes in the assumed values of the costs and benefits for the projects. As mentioned, the capstone team attempted to use conservative estimates and assumptions, but these assumptions came largely from a literature review, not practice. Actual costs the City might face could vary widely from the values noted in the literature. The sensitivity analysis is performed by modifying specific assumptions to see how results and recommendations might change if those assumptions are not accurate. Several assumptions were tested, with the KHT results provided in Appendix VIII. Tested assumptions include the lifespan of the project, the applied discount rate

Table 7. Kaldor-Hicks Tableau for the Harmony School project, generated during sensitivity analysis. Discount rate adjusted to 0.03.

	City Residents	City of Bloomington	Net Value
Benefits			
Energy Savings	$38,902.19		$38,902.19
Air Quality Benefit	$26,408.81		$26,408.81
Climate Change	$14,093.40		$14,093.40
Avoided Stormwater Utility Operation and Maintenance Costs		$662.81	$662.81
Avoided Stormwater Infrastructure Costs		$1,010,152.04	$1,010,152.04
Costs			
Capital Costs		-$445,401.00	-$445,401.00
Operation and Maintenance Costs		-$755,159.60	-$755,159.60
Net Value	$79,404.40	-$189,745.75	-$110,341.35

to calculate net present value, the cost of the green infrastructure installations, and the potential avoided costs of stormwater infrastructure upgrades. This analysis was conducted for the Harmony School, given that it had the lowest net present value, and so the accuracy of the assumptions is most critical in its recommendation.

THE analysis reveals that at shorter lifespans of the project, the green infrastructure value actually increases. This is due to the fact that the lifetime cost of operations and maintenances decreases, while the primary benefit of avoided stormwater infrastructure upgrade remains constant as show in Tables 6-8. However, at a lower discount rate of 0.03, the Harmony School project no longer meets the positive net value threshold, indicating that discount rate might pose a significant assumption for the City to examine. Another critical assumption is that of the avoided stormwater infrastructure upgrade costs. This value comes from the assumption that installation of green infrastructure will significantly decrease the gray infrastructure requirements for stormwater runoff, and given projected increases in rainfall in the future, the City can avoid costly gray infrastructure installation projects by implementing green infrastructure features instead. A detailed description of how this avoided cost was calculated can be found in Appendix VIII, and the sensitivity analysis reveals that at lower costs of gray infrastructure assumptions, the avoided cost is not high enough to make the Harmony School project have a net present value. In other words, we do not recommend implementation of the Harmony School project if the cost of installation of gray infrastructure is overestimated in our analysis unless the City perceives the qualitative benefits not calculated to exceed $500,000. Lastly, if the costs of green infrastructure have been overestimated in our analysis, than all projects will be more beneficial than our KHTs indicate. The City can decrease costs by using volunteers for installation, applying for grant funding, and working with private partners. These methods are discussed in later sections of the Plan.

Table 8. Kaldor-Hicks Tableau for the Harmony School project, generated during sensitivity analysis. Low avoided infrastructure costs.

	City Residents	City of Bloomington	Net Value
Benefits			
Energy Savings	$29,294.42		$29,294.42
Air Quality Benefit	$19,886.56		$19,886.56
Climate Change	$10,612.71		$10,612.71
Avoided Stormwater Utility Operation and Maintenance Costs		$499.11	$499.11
Avoided Stormwater Infrastructure Costs		$446,346.25	$446,346.25
Costs			
Capital Costs		-$445,401.00	-$445,401.00
Operation and Maintenance Costs		-$560,587.35	-$560,587.35
Net Value	$59,793.69	-$559,142.99	-$499,349.29

POLICY OVERVIEW

Image Source: www.bloomington.in.gov

POLICY OVERVIEW

In order to establish and maintain a culture that supports green infrastructure comprehensive policy initiatives must be adopted that incentivize best management practices. Stormwater management and green infrastructure policies often have the potential to achieve multiple municipal goals; and can be effective, efficient, as well as sustainable policy options for local decision makers.

STORMWATER management and green infrastructure policies often have the potential to achieve multiple municipal goals; and can be effective, efficient, as well as sustainable policy options for local decision makers.

The Environmental Protection Agency suggests a framework of municipal policies for managing stormwater with green infrastructure. The framework is outlined in an agency toolkit called "Water Quality Scorecard: Incorporating Green Infrastructure Practices at the Municipal, Neighborhood, and Site Scale." The document is utilized to help local governments identify opportunities to protect and improve water quality. The framework suggests a 3-step policy implementation approach to prioritize time and resources when implementing a green infrastructure plan (EPA, 2009).

The Water Quality Scorecard was constructed to assist local governments in improving water quality protection through policies which remove barriers, revise codes, and create incentives for both citizens and developers. Various policy initiatives are described which can be applied on the municipal, neighborhood, or site level which are purposed for the terminal goals of both reducing the amount of stormwater flows and educating stakeholders.

WATERQUALITY SCORECARD

STEP 1:

Adaptations of city codes and the implementation of regulations which support green infrastructure strategies.

STEP 2:

Development incentives, education, and public outreach help to create a community culture that is open to and encourages green infrastructure.

STEP 3:

Large scale green infrastructure and fee incentives further encourage sustainable practices.

Potential Policy Initiatives

While the City of Bloomington has actively encouraged policies to better manage stormwater and water quality, the following policy initiatives are considered high priority policy options, and have shown compelling evidence of success in various other cities across the country:

Open Space Protection

This initiative involves the implementation of development policies, regulations, and incentives to protect natural resource areas and critical habitats; as well as the establishment of no-development buffer zones around wetlands and floodplains in order to protect water quality. Potential incentives to encourage Open Space Protection could include open space credits for green stormwater management facilities designed for public recreation; as well as providing credits against open space impact fees for green roofs. Potential regulatory options to support this initiative could include the adoption of either an open space impact fee or an open space set-aside requirement based on the demand generated by new development.

Infill & Redevelopment

This initiative involves the implementation of policy incentives to direct development to previously developed areas by encouraging development within designated urban growth areas. This policy should ensure that development standards address landscaping, buffering, parking, and open space and are tailored for infill areas. Potential incentives to encourage this initiative could include a reduction in impact fees for infill development based on less demand for new infrastructure, or development incentives for green roofs, and Include provision in stormwater management requirement that reduces on-site management requirements for projects that decrease total imperviousness on previously developed sites.

Green Infrastructure Elements & Street Design

This initiative involves integrating green infrastructure designs and elements into standard roadway construction and retrofits. Potential regulations could be implemented by adopting green infrastructure retrofit standards for major street projects or requiring local road projects to allocate a minimum amount of total project cost to green infrastructure elements.

Minimizing Stormwater from Parking Lots

This initiative involves policies that will either reduce the amount of impervious surface by reducing overall city parking requirements, or require substantial landscaping or green infrastructure to help reduce runoff. Potential regulations could include the adoption of parking lot landscape regulations that require provision of trees, minimum percent of parking lot interior area to be landscaped, minimum sized landscaping areas, or required green infrastructure practices. Also in parking lot landscaping regulations, specify the types and sizes of shrubs and trees most appropriate for controlling or reducing stormwater runoff.

Maintenance & Enforcement

This initiative incorporates monitoring, tracking, and maintenance requirements for stormwater management practices into the municipal stormwater ordinance. The enforcement mechanism could involve the creation of a self-inspection maintenance certification program that allows developers and landowners to train private inspectors to certify compliance with stormwater management plans and long-term maintenance. The regulation would require long-term maintenance agreements which allow for public inspections of the management practices and account for transfer of responsibility in leases and deed transfers.

Image Source: cargocollective.com

STAKEHOLDER INVOLVEMENT

Image Source: www.bloomington.in.gov

This section will detail methods to conduct an effective stakeholder analysis to design a successful Green Infrastructure Plan in the City of Bloomington.

STAKEHOLDER ENGAGEMENT

Phase II of the U.S. Clean Water Act (CWA) requires public input, education, and participation- among other things- as part of the watershed management planning processes for addressing stormwater runoff and nonpoint source pollution in the United States (US Environmental Protection Agency, 2000). Although we may not be creating a complete watershed management plan at this point, the same rigorous approach to stakeholder involvement should be taken to ensure long-term success of this project.

BEYOND statutory requirements, managers and planners should develop a robust practice of securing community support for the goals of the over-all project as well as seeking out, gathering and incorporating the input and values of stakeholders into the policy-making process. Obtaining this support will require maintenance of several key policy attitudes throughout implementation of the green infrastructure plan (Kramer, 2011), including:

- Defining the GI plan: Frame it properly, recruit the right representatives and spokespersons, join cause with other organizations, and become recognized as the authority on the subject.
- Communicating with community members: Use every possible opportunity- whether through circumstance or actively created- to build public engagement.
- Asking people to take part: encourage the feeling that community members are having an effect on the GI plan, and encourage them to take ownership of portions of the plan.
- Advertising support and accomplishments: stage activities and events, present awards, and celebrate successes of the GI plan publically with engaged stakeholders- let stakeholders know that this is a participatory movement with a broad community foundation.
- Giving over control to stakeholders: if possible- to further establish a grassroots dynamic within the GI plan.
- Maintaining support indefinitely: Follow up until the necessary functions for project sustainability are entirely transferred to stakeholders.

The preceding points are all special concerns for managers seeking broad and lasting community support through stakeholder engagement. Keeping these attitudes in mind, this section will present a background of stakeholder analysis and a few of the analysis tools available to project managers for creating a strong foundation of community participation and stakeholder involvement.

Who or what are 'stakeholders'?

There is a wide variety of opinion over who or what exactly stakeholders are. Freeman's (1984) seminal work on strategic management and stakeholder theory, "Strategic Management: A stakeholder approach" informs many contemporary definitions of 'the stakeholder', building from the position that a stakeholder is any party affecting or being affected by the actions of an organization. The definition of a stakeholder, however, is slippery and largely influenced by the discipline and motives of strategists and project managers. Instrumental definitions may claim that stakeholders are those without whom an organization would cease to function or exist. A more normative approach yields the view that a stakeholder is any entity, living or non-living, which is affected by organizational operations. Such a broad stance could even be applied to mental attitudes and emotional constructs such as a respect for nature or the preservation of our children's future. There is no explicit ethical content in any of these definitions; however, the reality of setting forward a working definition for the stakeholder of this project is that the coordinating entity will determine who and what counts in the decision-making process. Planners must determine if there is a defensible distinction between legitimate and illegitimate stakeholders in a proposed project, and, if there is a distinction, how to evaluate the legitimacy of an identified stakeholder. As a first step, it is recommended that planners adopt a more inclusive definition, gather all potential stakeholders, and commit to a survey of motives, and interests for potential participants. In an initial outline of stakeholders, it may be valuable to proportionally break down relevant entities in to broad categories and identify motives for participation based on preliminary survey responses (Table 9). Such an approach will help to inform initial planning and remind coordinators of the general trajectory of the project at hand.

Why use stakeholder analysis?

Stakeholder analysis, whether overt or casual, has always been important to successful project management. History tells of numerous policy misadventures that resulted from ignoring the interests and abilities of potential stakeholders. Inattention to these participants may be attributed to not knowing of popular disenfranchisement, self-aggrandizement by project coordinators, or the illusion of invulnerability to project underperformance.

An analysis of 400 strategic decisions by Paul Nutt in Why Decisions Fail (2002) found that half of the decisions failed – were not implemented, only partially implemented, or produced subpar results – due to insufficient attention paid to the interests and knowledge held by key stakeholders. Other studies report similar trends in project failure when managers do not put enough focus on understanding the role of stakeholders in strategic decision making.

Attention to stakeholders, then, is important throughout the implementation of this green infrastructure plan because the integrity, success and survival of the plan relies on satisfying a majority of stakeholders according to their perception of what is valuable in such a plan. Furthermore, involving stakeholder engagement in the initial planning stages of the GI plan will serve the purpose of: eliciting stakeholder preferences and priorities; identifying common ground and differences in what stakeholders want from the planning process; and determining a manageable set of priorities, arrived at through consensus. If these valuable products are not delivered, implementation of the plan may be obstructed by public resistance, challenges to funding, calls for new leadership, or new key initiatives being undermined.

A sincere effort at stakeholder analysis by the project coordinating committee is perhaps the first and best way in which we can avoid these obstructions. But what is the general framework of this stakeholder analysis? A credible stakeholder analysis typology will include methods for: (1) identifying stakeholders; (2) differentiating between and categorizing stakeholders; and (3) investigating relationships between stakeholders (Reed et al., 2009). While the framework presented here will generally follow this typology, additional identification and analysis techniques will be outlined in the appendix for the creation of a more fluid approach to the stakeholder analysis process as the manager needs.

A Streamlined Framework for Stakeholder Involvement

While a traditional stakeholder analysis will follow the three steps outlined in the preceding section, it may be more valuable to give a streamlined framework for stakeholder engagement that synthesizes these elements in a far more manageable work flow. Such a framework is presented in Lawson (2010), where a simple 6 step approach to stakeholder engagement is presented for development of an Ontario, Canada GI program. We have included a list of tools for a more formalized stakeholder analysis following the expressed typology in the appendix, but believe this simpler approach lends itself to a variety of management situations and budgetary or personnel constraints.

Lawson builds upon frameworks for inclusion of stakeholder opinions for environmental planning and decision-making to present a method for specific application to GI planning on the municipal, county, or

Inclusive definitions of the stakeholder

TYPICAL inclusive definitions of the stakeholder from the public and nonprofit sector literature include several normative variations:

- "…any person, group or organization that can place a claim on the organization's attention, resources or output, or is affected by that output" (Bryson, 2003).
- "Those individuals or groups who depend on the organization to fulfill their own goals and on whom, in turn, the organization depends" (Johnson & Scholes, 2008).

watershed level. The author's engagement framework is outlines the six steps as: (1) Establish the goals of the project; (2) Determine the stakeholder sample; (3) Choose consultation technique(s) and methodology; (4) Develop consultation questions (5) Conduct consultation and collect data; (6) Analyze the data and produce analysis reports.

What follows is a more detailed look at each of these steps for the benefit of the implementing agency. This is meant to be a bare framework, readily augmented by inclusion of outside tools and resources, and is to be adapted as the agency sees fit.

1. Establish Goals and Objectives

The first task for the steering committee is to determine the appropriate direction and scale of the stakeholder engagement process. Goals and objectives should lead to answers for the questions planners wish to ask concerning their stakeholder community. When planning for Bloomington's implementation of GI best management practices, the objective should be to assess the social appropriateness and feasibility of placing likely BMPs. It is important, then, for planners to understand who will likely be installing these BMPs as new developments or retrofits and to understand how to gain their support for implementation. Understanding the dynamics of your stakeholder community will allow for an effective initial stage of the program and continued development of the city's GI policy, as well as provide guidance on maintaining oversight on your diverse collection of community interests and activities.

2. Design and Select Sample

Lawson presents the second step of this method as identifying the affected stakeholder groups, the number of groups to include and the distribution of the group sample. Identification methods may be found in tables of the Appendix IX. For Bloomington's GI program, the planning and design process should be exhaustive and include groups beyond the traditional list of stormwater management actors. The steering committee must look beyond the groups and organizations most commonly related to a consulted in a stormwater related project. Traditional actors will play a role in GI implementation, but those who have no traditional role in planning and design but are nonetheless affected by program outcomes should also be identified for sampling and future consultation. Examples of stakeholders identified in a preliminary accounting of Bloomington actors are presented in Table 9.

Beyond identification, the steering committee should imagine the relation of each stakeholder to the coordinating authority and to the other stakeholders. Roles of each stakeholder within the GI plan should be considered, along with their motives and general importance to the plan's successful implementation and future sustainability.

3. Choose Stakeholder Involvement Methodology

There is a diverse array of techniques and instruments available to Bloomington planners for involving stakeholders in the GI implementation plan. Techniques range from the more technical and resource intensive

Choosing Goals and Objectives

Some examples of possible goals and objectives for the Bloomington GI stakeholder engagement plan are:

Goals:

- To provide insight on the challenges ahead for each identified stakeholder group.
- To provide direction for subsequent evolutions of the Bloomington GI plan.
- To ensure the inclusion of appropriate stakeholders and to understand their capacity for facilitating effective BMP installations.

Objectives:

- To identify who the affected stakeholders are in terms of GI/BMP planning and what their main concerns are regarding BMP installation.
- To identify the barriers preventing BMP implementation for each group.
- To identify what infrastructure or facilitating conditions (ordinances, incentives) need to be in place to encourage implementation at a land parcel level.

This is not meant to be an exhaustive list of goals and objectives, but the beginnings of a needs-based assessment of what aspects of the stakeholder community for which the steering committee is lacking insight.

Table 9. Identified stakeholder groups for sample selection..

Traditional Actors	Non-Traditional Actors
City government departments	Local not-for-profits
County government	Local environmental advocates
MS4 coordinators	Business owners
Conservation districts	Neighborhood associations
University partnerships	Individual private landowners
Private consulting firms	
Land developers	
Federal government	

application of Multi-Attribute Utility Theory (MAUT) to rank priorities of participants for comparative assessment, to the less demanding, traditional design of surveys, focus-groups, interviews, and roundtables. The most important consideration for methodology selection is the appropriateness of the methodology to the nature of the issue at hand (the goals and objectives established) and the resources available to the steering committee.

The initial involvement methodology, however, should not be over-involved. As the GI program progresses, consultation with stakeholders may become more involved and progress through multiple iterations, but during this initial stage involvement should be considered of value primarily for a general overview of the stakeholder terrain. If stakeholders are welcoming to a certain type of BMP during this initial consultation, for example, future consultations may be designed to assess feasibility- whether it be economic or technical- within certain stakeholder groups.

4. Develop Consultation Questions

The fourth step in this framework is to develop a set of consultation questions which will evaluate and elaborate upon the established goals and objectives of the Bloomington GI plan by incorporating the point of view of project stakeholders. These questions should generally be open-ended, designed to encourage informative opinions, and properly formatted according to the steering committee's medium of communication with each stakeholder group. The general rule is to actively and passively solicit constructive opinion regarding a few committee objectives: finding the types of stakeholder groups represented within the watershed, current knowledge and enthusiasm for GI features, self-identified drivers for effective GI support, types of incentives desired, etc.

These questions will be a key part of the foundation for community-supported GI implementation. The information received from your stakeholder groups will- among other things- steer technology selection based on which features find most support in the community and the principal areas of education needs for the community. Make sure the steering committee is asking the right questions, and asking them in the right way.

5. Data Collection

During the initial stages of Bloomington's GI implementation plan, the chosen stakeholder consultation methodology should be tested on smaller subsections of the stakeholder population. This will allow an assessment of the consultation's understandability and appropriateness for the general population and a re-working of the methodology as needed. Upon completion of initial testing, the steering committee may begin data collection according to the needs and format of the chosen consultation method.

6. Data Analysis and Report

This final step will involve processing responses and feedback from the various identified stakeholders for application to the GI implementation program. Recommendations for actual data analysis methodology is beyond the scope of this document due to consideration of the implementing agency's discretionary priorities in committing funding and resources to the project.

The variety of methods available include statistical analytical methods that can be used to draw meaningful conclusions from the gathered data. Common methods include multi-objective analysis, multi-criteria analysis, weighting of survey responses, etc. If the steering committee has chosen survey techniques for stakeholder consultation, a variety of software applications exist for simplified data analysis. These software suites are reliable, secure, have strong support services, include robust data analysis, and are relatively inexpensive.

This 6-step procedure will allow easy incorporation of stakeholders into the steering committee's operations. This engagement procedure should be viewed as iterative and an adaptive management strategy for continued improvement in servicing the wide range of stakeholders needed for successful program implementation. With increased engagement from stakeholders, the GI implementation plan should see a strengthening in effect and overall sustainability.

Stakeholder Involvement Case-Study

THE Red Cedar River is located in the south-central portion of Michigan's Lower Peninsula, flowing in a westerly direction, through Lansing, for a total of 51 miles until joining the Grand River, and eventually draining to Lake Michigan. The Red Cedar River Watershed (RCRW) (HUC: 04050004) is comprised of nearly 294,496 acres with varied land use and degree of urbanization. In 2015, Michigan State University submitted a watershed management plan (WMP) for the RCRW which outlined several goals, including the management of stormwater from urbanized areas. One of the first objectives outlined as a step to help develop the WMP and its several goals was to encourage communication and collaboration between partnering organizations and stakeholders.

RCRW managers recognized the critical importance of stakeholder involvement in the planning process. Stakeholders who participate in the initial stages of plan formulation are much more likely to take initial action and sustain ground-level green infrastructure implementation as the plan matures. To maximize inputs from stakeholders, organizers from a central coordinating committee made contact with viable stakeholders from local industry, local government staff, elected officials and commissions, civic groups, adjacent watershed groups, conservation districts and others (a complete participant list which shows the breadth and depth of stakeholder identification may be found at the group's website: http://redcedarriver.weebly.com). Stakeholder analysis incorporated participatory meetings for information gathering and engagement purposes, and the use of the snow-ball method for identifying further viable participants for planning and implementation. As planning actions moved forward, stakeholders were updated according to specific interests and kept engaged with the identification of additional areas for plan enhancements. During plan implementation the coordinating committee of RCRW managers collaborated with interested stakeholders for volunteer activities, data collection, and educational outreach events. For program evaluation, the management team also heavily relied upon input from stakeholder groups, in the form of surveys or meetings, to track the progress of implementation and assess the ongoing social sustainability of the project.

One special aspect of the RCRW management plan's stakeholder engagement philosophy was a special interest in stakeholder preferences as they pertain to selection of best management practice (BMP) for non-point source pollution and stormwater runoff control. A study by Kaplowitz (2011) in one tributary within the RCRW used choice experiment survey approaches to increase public residential stakeholder participation. Through the use of choice experiment surveys, the investigators were able to identify public preferences for alternative BMPs, identify BMP combinations likely to be supported by residential stakeholders, and increase public participation in development decision making.

Key Characteristics of Successful Stakeholder Engagement

- Establish a central stakeholder engagement committee
- Complete a wide and deep identification of viable stakeholders
- Use stakeholder knowledge, skills, and contacts for strengthening the stakeholder group and plan efficacy
- Use choice experiment approaches for increased knowledge of stakeholder preferences and to increase local buy-in
- Continuously evaluate stakeholder engagement as the plan progresses

EDUCATION & OUTREACH PLAN

Image Source: www.bloomington.in.gov

EDUCATION & OUTREACH

Providing Bloomington residents with resources to learn about and implement green infrastructure will help to create positive perceptions toward green infrastructure projects for the future.

FOR those already involved in the field of conservation and water management, the numerous benefits linked with green infrastructure (GI) discussed previously in this document may seem apparent. However, a crucial aspect of implementing the positive changes outlined in this plan is the support of Bloomington's citizens and businesses. An effective outreach and education plan fulfills the important role of breaking through inaccurate perceptions associated with GI initiatives, and opens the door to vital resources which contribute to a project's success and longevity.

IN order to gain that necessary support, this section presents an outreach and public education plan tailored to the City of Bloomington and its unique characteristics. It is broken down into the categories of private land owners in residential areas, business owners, and Indiana University.

REACHING BLOOMINGTON'S RESIDENTS

Table 10 is a sample outreach calendar detailing specific events aimed at reaching out to Bloomington homeowners, landlords, and the residents. Also included is the ideal focus and format for each event, as well as recommended educational materials, which can be found in Appendix X. There are a wide variety of opportunities each month to choose from, and the events below should be considered a framework to be developed and modified to fit the community's evolving needs over the years to come.

Table 10. Example calendar of events

Month	Event	Presentation Format and Focus
January	SWCD Coffee &Conservation	City representative attends this monthly event to discuss green infrastructure initiatives and distribute all educational materials.
February	Bloomington Home Show	Prepare a booth complete with the Stormwater Brochure and Residential Quarter Sheet. Accompany with visuals-based poster board of successfully completed projects in Bloomington directed at homeowners as well as contractors and homebuilders.
March	Endwright Garden Series	Explore a potential partnership with Area 10 Agency on Ageing to promote stormwater management and water quality through the Endwright Garden Series. Open to all, this series features lectures and presentations on a variety of garden topics, ideal for rain gardens. Helpful tools include the Stormwater Brochure, and Residential and Contractor Quarter Sheets.
April	Hilltop Garden Spring into Gardening Speaker Series	Reach a group of active community members already committed to making a change and form a partnership to promote GI projects in Bloomington in ways relevant to gardening. This is a demonstration based event. Possible projects include planting a rain garden.
May	Council of Neighborhood Associations Monthly Meeting	Serving over 60 neighborhood associations CONA is an excellent resource for communicating with large populations of Bloomington and provides a pathway to focus in on specific initiatives with well-established community groups. It is a good opportunity to distribute residential education materials.
June	Bloomington Garden Club Summer Garden Walk and Flower Show	Include a successful rain garden or native planting in this enjoyable and informative walk to demonstrate to Bloomington citizens first hand the aesthetic benefits of stormwater management and open the discussion to the unseen benefits as well. Accompany the walk with residential materials.
July	Monroe County Fair	Partner with the County to prepare an informational booth complete with the Stormwater Brochure, all four quarter sheets. Focus on activities designed to draw in children as well as homeowners and contractors.
August	Farmer's Market Community Volunteer Fair	Prepare a booth complete with Stormwater Brochure, and all quarter sheets to highlight opportunities for community members to volunteer time maintaining or implementing GI projects around Bloomington.
September	Reaching out to MCCSC	Partner with the local school corporation to install a demonstration project at an area school through an educational seminar to kick off the new school year. Prepare the entire educational toolkit for these type of events.
October	Cider Fest- Bloomington Community Orchard	Work with the Bloomington Community Orchard Outreach Team to promote current GI initiatives and future possibilities using the Stormwater Brochure, Residential Quarter Sheet, and GI Planner Quarter Sheet at the sign in table. Explore the possibility of hosting the educational component of the festival.
November	Community Forum	Plan, promote and conduct a community forum to evaluate the success of the Green Infrastructure Plan to date. Invite community input for future plans and suggested changes.
December	Planning Session	City of Bloomington reveals plans and priorities for upcoming year in public setting.

STORMWATER BROCHURE

This informative brochure covers the basics of stormwater management and is directed primarily toward homeowners and residential landowners. It provides background information regarding the role of stormwater in the environment, and various BMPs and resources to manage it.

RESIDENTIAL QUARTER

This is a handbill designed to provide residents with the online resources to explore green infrastructure opportunities on their own. It contains links relevant to Bloomington specifically, as well as EPA resources.

CONTRACTOR QUARTER SHEET

This handbill is targeted to contractor professionals. It provides background information of green infrastructure, and details on installation considerations. The backside of the sheet details opportunities for training and certification programs.

GI PLANNERS QUARTER

An educational resource for people involved in city planning. It contains in-depth resources discussing the benefits of green infrastructure, and guidelines for overcoming implementation barriers.

REACHING AREA BUSINESSES

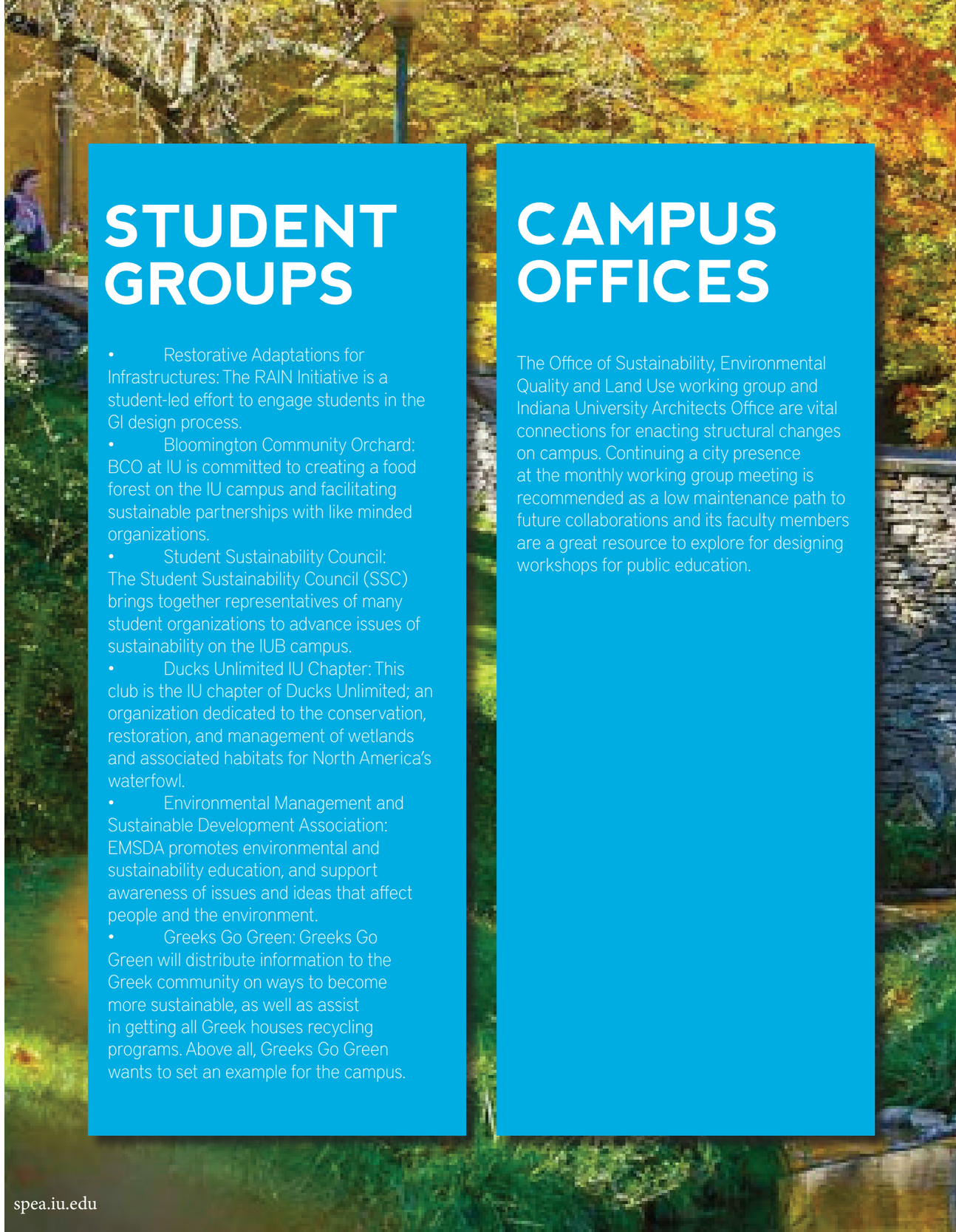
BLOOMINGTON'S local business owners are a central part of the community, just like its residents and neighborhood associations. While there is significant overlap between the two groups, the events described in the calendar above are not the ideal opportunities to target developers, real estate companies, and contractors. By following the same schedule though, the City of Bloomington can double its efforts through attending monthly outreach events specific to the area businesses. A few ways to create an impact are by attending the Monroe County Contractors Workshop, Bloomington Redevelopment Committee monthly meetings, and the Environmental Commission meetings, among many other options. The value of shaping the perspective of those who participate in the evolution of the city should not be underestimated.

IN addition to having a strong presence at community events, it is recommended that the City of Bloomington assist its community members in the search for more in depth information and resources for installing GI on their own property. A simple process for achieving this goal is to create a list of area businesses which provide services such as consulting, installation and maintenance of green infrastructure, BMP materials, and native plants. To compile such a list it is recommend that the City send out a brief survey digitally to relevant local businesses evaluating level of expertise within the field and willingness to be promoted for this purpose. Accompanying this outreach plan is an extensive list of online resources to which citizens and businesses can be referred for more in-depth information as well.

PARTNERING WITH INDIANA UNIVERSITY

THE relationship between the City of Bloomington and Indiana University provides a unique opportunity to collaborate over storm water management. While the adoption of this plan by the City of Bloomington does not constitute any required action on the part of the University, a voluntary partnership through student groups, faculty, staff, and the Indiana University administration is a pathway to numerous education and outreach opportunities.

THERE are many student groups on campus which are focused on sustainability and environmental quality. Student groups present a valuable avenue to inspiring long term change on campus. Here is a small sample of student groups that could participate in mutually beneficial partnerships.



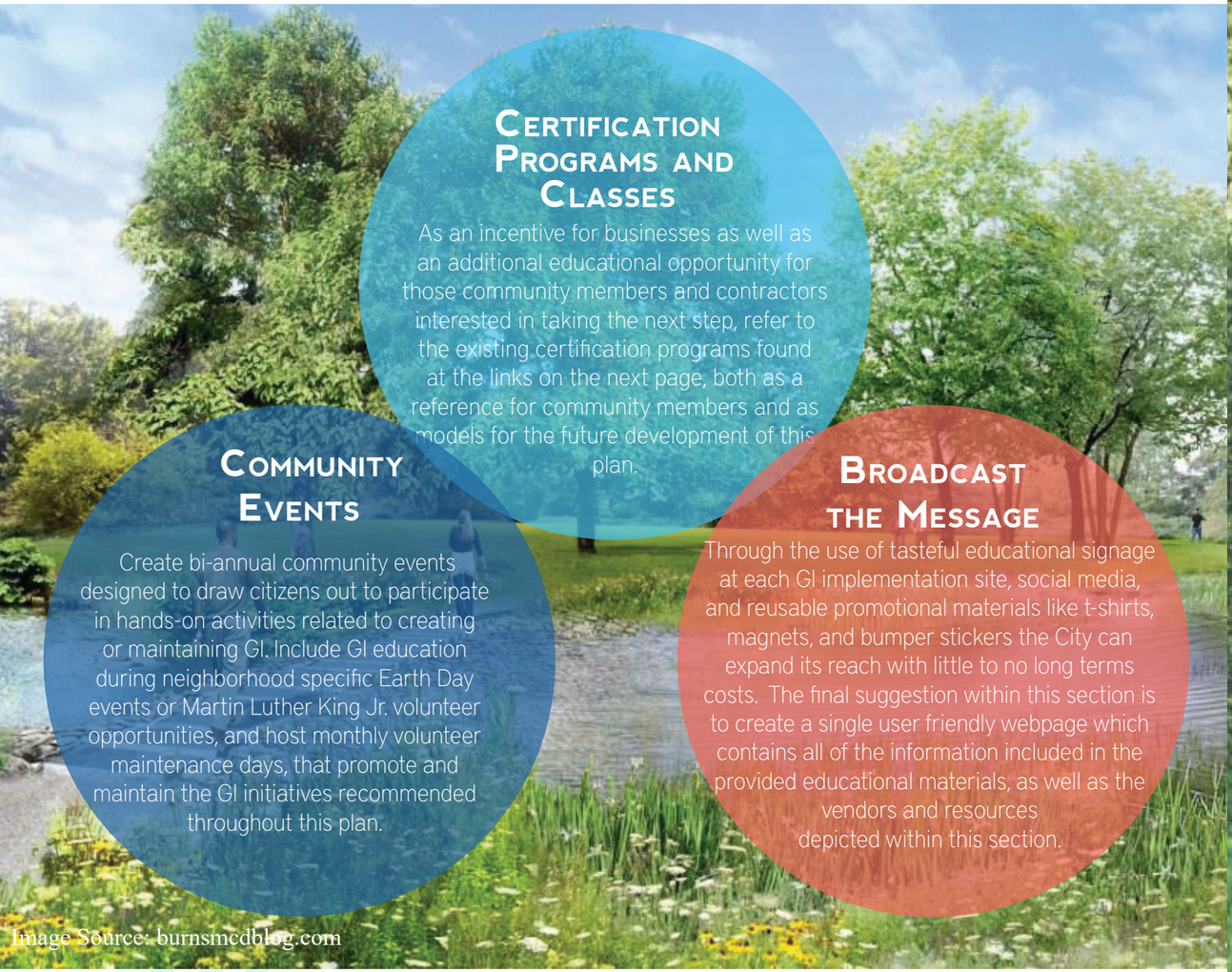
STUDENT GROUPS

- Restorative Adaptations for Infrastructures: The RAIN Initiative is a student-led effort to engage students in the GI design process.
- Bloomington Community Orchard: BCO at IU is committed to creating a food forest on the IU campus and facilitating sustainable partnerships with like minded organizations.
- Student Sustainability Council: The Student Sustainability Council (SSC) brings together representatives of many student organizations to advance issues of sustainability on the IUB campus.
- Ducks Unlimited IU Chapter: This club is the IU chapter of Ducks Unlimited; an organization dedicated to the conservation, restoration, and management of wetlands and associated habitats for North America's waterfowl.
- Environmental Management and Sustainable Development Association: EMSDA promotes environmental and sustainability education, and support awareness of issues and ideas that affect people and the environment.
- Greeks Go Green: Greeks Go Green will distribute information to the Greek community on ways to become more sustainable, as well as assist in getting all Greek houses recycling programs. Above all, Greeks Go Green wants to set an example for the campus.

CAMPUS OFFICES

The Office of Sustainability, Environmental Quality and Land Use working group and Indiana University Architects Office are vital connections for enacting structural changes on campus. Continuing a city presence at the monthly working group meeting is recommended as a low maintenance path to future collaborations and its faculty members are a great resource to explore for designing workshops for public education.

OUTREACH FINAL RECOMMENDATIONS



Certification Programs and Classes

As an incentive for businesses as well as an additional educational opportunity for those community members and contractors interested in taking the next step, refer to the existing certification programs found at the links on the next page, both as a reference for community members and as models for the future development of this plan.

Community Events

Create bi-annual community events designed to draw citizens out to participate in hands-on activities related to creating or maintaining GI. Include GI education during neighborhood specific Earth Day events or Martin Luther King Jr. volunteer opportunities, and host monthly volunteer maintenance days, that promote and maintain the GI initiatives recommended throughout this plan.

Broadcast the Message

Through the use of tasteful educational signage at each GI implementation site, social media, and reusable promotional materials like t-shirts, magnets, and bumper stickers the City can expand its reach with little to no long terms costs. The final suggestion within this section is to create a single user friendly webpage which contains all of the information included in the provided educational materials, as well as the vendors and resources depicted within this section.

Image Source: burnsmcdblog.com

The conclusion to the Outreach and Education Plan addresses three final recommendations designed to increase the longevity and efficiency of this plan in the future. Though outside the scope of this plan, implementing the above suggestions will increase awareness of the need for GI within the City of Bloomington and allow this GI plan to expand sustainably in the future.

CERTIFICATION PROGRAM RESOURCES

Description

The City of Bloomington should consider developing its own training program, for which a free suggested curriculum follows, courtesy of the Green Infrastructure Center Inc. and the Department of Urban and Environmental Planning at the University of Virginia: http://www.gicinc.org/PDFs/Curriculum%20Guide%20for%20Green%20Infrastructure%20Planning.pdf

An excerpt describing the program begins, "The curriculum guide provides an outline for teaching green infrastructure planning. The guide assumes that professors have ordered the appropriate texts and have the technology or data necessary to implement such a course. Suggested course texts are found in the next section of this guide. A bibliography in Appendix X, points to useful case studies and other texts. This course is intended to be implemented as part of a planning department curriculum." Although this comprehensive guide was developed for Virginia at a graduate school level, the creators assure its users of the adaptability of the program, and its implementation should be a long term goal of this plan.

In addition to this curriculum, the next column describes a variety of programs that could prove valueable to the longevity and success of this Green Infrastructure Plan.

Existing Programs

- **EPA Green Jobs Training Catalog: http://www3.epa.gov/npdes/pubs/gi_greenjobs_feb09.pdf**
- **University of Washington Certificate in Green Stormwater Infrastructure Design and Management: http://www.pce.uw.edu/certificates/green-stormwater-infrastructure.html**
- **Green Roof Professional (GRP) Certification for Contractors and Installers: https://www.heatspring.com/courses/green-roof-professional-grp-accreditation-training**
- **Miscellaneous Certifications for Green Infrastructure Professionals: http://environment.law.harvard.edu/wp-content/uploads/2015/08/certifications-green-infrastructure-professionals.pdf**

Consider these programs as resources for community members and government employees, as well as a baseline model for further development of the City of Bloomington Green Infrastructure program.

FUNDING OPTIONS

The EPA identifies seven major funding opportunities for green infrastructure, taxes/general funds, fees, stormwater utility, grants, bonds, loans, and private-public partnership (LaDuca & Kosco, 2014). This section will highlight four possible grants/loans that would be applicable for the city of Bloomington when implementing GI. Additionally, Appendix XI: Funding Sources, has a full list of GI funding options. The purpose of this section is to provide a starting point for researching funding opportunities, due to yearly changes in funding availability.

ADDITIONALLY, funding can be used for GI or LID that improves upon or compliments grey infrastructure, such as rain barrels, green roofs, and vegetated swales. While this project may be used to fund the initial costs of GI, it cannot be used to fund operation and maintenance associated with the project. The Healthy Watersheds Consortium Grant is focused on promoting "actions that conserve, enhance, or improve aquatic ecosystems and support natural landscape and watershed processes" (EPA Healthy Watersheds, 2016). This grant program funding ranges from $50,000 to $150,000. This grant may be used on a larger scale to prevent landscape deterioration and promote and protect healthy watersheds. This program scope ranges from site specific implementations to larger landscape conservation, with an emphasis on a plan to integrating multiple scales of green infrastructure on a watershed scale. Typically, funds support a landscape approach to natural habitat and corridors.

THE fourth and final funding opportunity is the Environmental Solutions for Communities Grant. The 18-month program funds demonstration projects, such as public park enhancements, public facility renovations, and incorporating GI into grey stormwater management practices (EPA Healthy Watersheds, 2016). The program funds may not be used to support NPDES permit requirements. The funding amount ranges from $25,000 to $100,000, with a countrywide average of $40,000.

THE Clean Water Act's Section 319, Nonpoint Source Grant is available to fund projects that address nonpoint pollution sources, that do not directly implement orders to regulate stormwater discharges or that implement a final NPDES permit. This funding may be used to fund technical assistance, monitoring, BMP installation, outreach, education, and the development/implementation of regulations, policies, and local ordinances (EPA NPS, 2013).

THE Clean Water State Revolving Fund (CWSRF) is a second option to fund a wide variety of projects on a citywide scale. The CWSRF is a low interest loan, which averages a below market rate of 30%, with no matching requirements (EPA CWSRF, 2008). The flexible repayment options allow for a repayment period of 20 years or the useful life of the project. The EPA proposes multiple repayment options, such as flush fees, stormwater fees, homeowner fees, recreational/license fees, dedicated district taxes, and donations/membership dues (EPA CWSRF, 2008). The EPA offers a tool for determining repayment options through the Financial Assistance Tool (FACT) (EPA FACT, 2015). CWSRF can fund the capital costs of a project of unconventional infrastructure projects, such and land conservation and tree plants.

FINAL CONCLUSIONS

Image Source: www.bloomington.in.gov

CONCLUSIONS

OVERVIEW

This report has outlined a plan for effective and inclusive implementation of green infrastructure within the City of Bloomington's stormwater management portfolio. This report establishes the costs, benefits, and considerations associated with installing and maintaining green infrastructure features throughout the city as well as potential demonstration projects. Of the demonstration projects explored, the result of benefit-cost analyses supported the implementation of all six projects. The Goat Farm and Bloomington High School South demonstration projects produced the greatest net benefits to the City and Bloomington residents. We recommend the implementation of these, and other, demonstration projects as the City further develops it's green infrastructure program.

Although the City of Bloomington already has progressive policies in place that encourage the implementation of Green Infrastructure, this report recommends additional policy initiatives that address open space protection, infill and redevelopment, green infrastructure elements and street design, minimizing stormwater from parking lots, and maintenance and enforcement procedures. These policies aim to increase the frequency and scope of green infrastructure projects within the city. We recommend collaboration between the City and other stakeholder groups, such as local businesses, city residents, and Indiana University, to maximize the success of all green infrastructure projects and policies implemented.

Image Source: teamurban.com

Image Source: grantassociates.uk.

The inclusion of green infrastructure in a city's stormwater management portfolio provides a variety of benefits including surface water quality improvements and flood risk mitigation by protecting, mimicking, or restoring the natural water cycle. Beyond the realm of stormwater management, green infrastructure is associated with several environmental benefits, increased aesthetic appeal, increased recreation potential, and community cohesion, safety, and health. It is the belief of this working group that green infrastructure is key to the future of stormwater management in the City of Bloomington.

REFERENCES

City of Lancaster, Pennsylvania. 2011. The City of Lancaster's Green Infrastructure Plan.
http://www.cityoflancasterpa.com/sites/default/files/documents/GreenInfrastructurePlan.pdf.
Lancaster, PA.

City of Lancaster, Pennsylvania. 2014. The Economic Benefits of Green Infrastructure.
http://cityoflancasterpa.com/sites/default/files/documents/Lancaster%20Report%20FINAL%2002-11-14.pdf. Lancaster, PA.

Clark, C., P. Adriaens and F. B. Talbot. 2008. "Green Roof Valuation: A Probabilistic Economic Analysis of Environmental Benefits." Environmental Science and Technology. 42: 2155-2161.

CNT (Center for Neighborhood Technology) and American Rivers. 2010. The Value of Green
Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits.
http://www.cnt.org/repository/gi-values-guide.pdf. Chicago, IL.

EPA (U.S. Environmental Protection Agency). 2008. eGRID2007 Version 1.1 Year 2005 Summary Tables.
http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_SummaryTables.pdf.

EPA (U.S. Environmental Protection Agency). 2015. Green Infrastructure Funding Opportunities.
https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities.

Jia, H., H. Yao, Y. Tang, S. L. Yu, J. X. Zhen, and Y. Lu. 2013. Development of a multi-criteria index ranking system for urban runoff best management practices (BMPs) selection. Environmental Monitoring and Assessment 185: 7915-7933. DOI: 10.1007/s10661-013-3144-0

Maxwell, D. 1921.Impounded water in Bloomington, Ind., Municipal and county engineering: design, construction, maintenance, and operation of all public works. 60 (1): 159–161

McPherson, E. et al. 2006. Midwest Community Tree Guide: Benefits, Costs, and Strategic Planting. United States Department of Agriculture, Forest Service, Pacific Southwest Research Station. Davis, CA.

Wang, M. and D. Santini. 1995. "Monetary Values of Air Pollutant Emissions in Various U.S. Regions." Transportation Research Record. 1475: 33-41.

Image Source: myfreetextures.com

NOTES: