Green Stormwater Infrastructure Planning in Midwestern Higher Education Institutions

An Undergraduate Thesis Presented in Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Environment and Natural Resources, Honors Research Distinction

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Spring 2023

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ABSTRACT

Green stormwater infrastructure (GSI) is an innovative approach to stormwater management that has the potential to provide a variety of operational, environmental, and human benefits beyond those offered by more traditional gray stormwater infrastructure systems. This study was an exploratory investigation of the degree to which public four-year universities in the Midwest incorporate GSI in their campus planning and stormwater management programs. I conducted a document content analysis of planning documents, policies, and NPDES MS4 permit program documents from sixteen universities in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. I then conducted semi-structured interviews with faculty and staff from The Ohio State University-Columbus campus and the University of Minnesota-Twin Cities campus to provide case study insight on these two universities. The findings from this study suggest that many universities plan for GSI, but these efforts have significant room for growth. Few universities had a GSI-specific plan or documents with sections dedicated to GSI; however, select universities and documents did offer GSI implementation strategies that can inspire other higher education institutions. Overall, greater adoption of GSI will require higher education institutions to take the initiative by creating GSI-supportive plans and management strategies that can successfully communicate across a variety of stakeholders.

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Research support provided by state and federal funds appropriated to The Ohio State University, College of Food, Agricultural, and Environmental Sciences, Ohio Experiment Station.

INTRODUCTION

Urbanization and corresponding impervious surface development significantly impact the functionality of storm sewer systems and the health of surrounding natural water resources. Higher education institutions often manage large areas of developed land, so as a result, urban stormwater management is a critical area of concern for campus administrators. Additionally, precipitation changes from climate change will require higher education institutions to adapt their current stormwater management systems to be more resilient. Green stormwater infrastructure (GSI) is a site-based approach to stormwater management. It is an innovative approach to traditional stormwater management that provides many other additional human and environmental benefits.

Higher education has seen a growing need to incorporate sustainability into education and operations, with colleges and universities having particularly important roles as leaders in increasing public knowledge of sustainability and adopting innovative sustainability practices (Wright, 2002). GSI offers a holistic, sustainable stormwater management approach by mimicking and enhancing natural water processes, so higher education institutions would benefit from becoming leaders in promoting GSI. However, its newness, coupled with higher education institutions' limited financial resources and administrative capacity, creates uncertainty and challenges with effective adoption.

This study explored campus planning and stormwater management efforts at public four-year universities in the Midwestern United States. It aimed to identify the ways in which higher education institutions incorporate GSI into their campus planning and stormwater management programs. I first conducted a document content analysis to identify and quantify commonly discussed GSI-related technologies and themes. I then conducted semi-structured interviews with pertinent faculty and staff at The Ohio State University-Columbus campus and the University of

Minnesota-Twin Cities campus to learn more about their stormwater management programs. The findings from this study revealed that many universities plan for GSI to some degree, and it identified strategies that would assist with GSI's successful adoption.

LITERATURE REVIEW

The Midwest is a region of the United States that consists of the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin (Angel et al., 2018). Climate change is predicted to significantly change this region by increasing precipitation volumes and intensities. Specifically, the volume of annual precipitation is predicted to increase, as well as the frequency and intensity of heavy precipitation events (Winkler et al., 2014). During warm-weather months, absolute humidity is predicted to increase, which will consequently increase rainfall (Angel et al., 2018). Lake effect snowfall is also predicted to increase (Andresen et al., 2013), with overall winter and spring precipitation increasing by up to 30% by the end of the century (Angel et al., 2018).

Increased precipitation means that existing stormwater management systems will need to accommodate larger volumes of water, often over shorter time periods. In addition to this, there is the need to consider how increased precipitation will increase the volumes of generated urban stormwater runoff. Development often increases an area's impermeability by converting natural, vegetated areas of land to hard, impermeable surfaces. These surfaces prevent water from filtering into the ground, so instead it flows directly into nearby sewer systems or surface waters as urban stormwater runoff (Brears, 2018). Runoff can harm water quality through increased thermal loading (Garret, 2017) and the discharge of nutrients and heavy metals (Rodak et al., 2020). It can also overwhelm sewer systems and cause flooding, which may further lead to infrastructure damages (e.g., damage to buildings, transportation networks, and utility systems)

and public health and safety issues (e.g., drinking water contamination, forced evacuations, and even personal illness or injury) (Angel et al., 2018). Overall, climate change is a threat multiplier that will likely create environmental and infrastructure issues that are costly to address.

Sewer systems have traditionally used "gray" infrastructure to manage stormwater. These are engineered systems that collect and convey stormwater through sewers and then deposit flow into treatment facilities or directly into local surface waters (Brears, 2018). Separate storm sewer systems are mainly used to manage urban stormwater runoff, but combined sewer systems, which connect storm sewers with sanitary sewer lines, are also common, especially in older cities (U.S. EPA, 2022a). Separate and combined sewer systems come with their own set of problems, but both can contribute to water pollution through direct pollutant discharges into local surface waters (U.S. EPA, 2022a; U.S. EPA, 2022c). These discharges worsen during heavy precipitation events, so the predicted impacts from climate change will likely increase their frequency and intensity (Angel et al., 2018).

The Federal Water Pollution Control Act of 1948 was the first national-level effort at addressing direct water pollutant discharges to waters in the United States, and with amendments in 1972, it later became known as the Clean Water Act (CWA) (U.S. EPA, 2022b). In 1987, Congress added Section 402 to the CWA to create the National Pollutant Discharge Elimination System (NPDES) permit program (National Association of Clean Water Agencies [NACWA], 2018), and as part of this program, sewer system operators became required to obtain permit coverage for discharges into local surface waters (Natural Resources Conservation Service [NRCS], 2012). Both separate and combined storm sewer systems are subject to the provisions of the CWA and NPDES program. For separate storm sewer systems, the NPDES Municipal Separate Storm Sewer System (MS4) permit program is used to regulate discharges (NACWA,

2018), and for combined sewer systems, the Combined Sewer Overflow (CSO) Control Policy is used to regulate combined sewer overflow events (U.S. EPA, 2022a).

The concept of stormwater best management practices (BMPs) was instituted to help permittees comply with the provisions of the CWA and NPDES program (U.S. EPA, 2005). BMPs are specific technologies and practices that prevent or reduce water pollution (Fletcher et al., 2015), and they accomplish this by managing the quantity and/or quality of stormwater (Marsalek & Chocat, 2002). They can be used as standalone projects, or they can be used in combination via treatment trains (Wright Water Engineers, Inc. & Geosyntec Consultants, 2019). BMPs are classified as either structural or non-structural. Structural BMPs are physical, site-specific technologies that collect and treat stormwater (Gilliard, 2011), and they can include infrastructure such as detention and retention facilities, media filters, and constructed wetlands (Wright Water Engineers, Inc. & Geosyntec Consultants, 2019). Non-structural BMPs are more process-oriented policies and practices that aim to prevent pollution from being generated to begin with (Gilliard, 2011; Wright Water Engineers, Inc. & Geosyntec Consultants, 2019), and they can include activities such as street sweeping, minimizing fertilizer and pesticide use, and maintaining procedures for proper chemical storage (Fletcher et al., 2015; Wright Water Engineers, Inc. & Geosyntec Consultants, 2019).

As discussed earlier, impervious surfaces are associated with water quality and flooding issues because they prevent water infiltration, which then results in increased stormwater runoff that discharges pollutants into local surface waters and overwhelms sewer systems. Stormwater management solutions are needed to reduce the volume of precipitation conveyed to surface waters and sewer systems, and green stormwater infrastructure presents an attractive opportunity. Green stormwater infrastructure (GSI) is a site-based approach to stormwater management (U.S.

EPA, 2022d). It utilizes both natural and engineered systems to mimic and enhance natural water processes; it achieves this by using collection, interception, conveyance, and storage to reuse stormwater or release it back into the environment through infiltration and evapotranspiration.

Many BMPs fall under the GSI approach. Bioswales, rain gardens, green roofs, and permeable pavement are all examples of structural GSI BMPs, while practices such as stormwater harvesting and reuse, disconnecting downspouts from sewer systems, urban forestry, and natural resource protection are all examples of non-structural GSI BMPs (U.S. EPA, 2022d). These BMPs provide their own individual benefits, but they also work to collectively manage water by creating a network of multiple site-based controls that are dispersed throughout a development (Brears, 2018).

Unlike traditional gray infrastructure systems, which offer a prescriptive solution to managing stormwater, GSI offers a preventative solution by preventing stormwater runoff from being generated and conveyed to sewer systems to begin with (Brears, 2018). GSI is primarily concerned with reducing stormwater volumes and flows and improving water quality (U.S. EPA, 2022d), but it can also offer many other ecological, social, and cultural benefits not offered by gray infrastructure. For example, GSI protects against flooding by increasing an area's absorptive capacity (Angel et al., 2018), and it restores other hydrological processes, such as groundwater recharge (Rodak et al., 2020). GSI also protects natural resources and creates new wildlife habitat, which can further act as carbon sinks and reduce heat island effects (Angel et al., 2018). GSI can even increase property values, improve public health safety, and provide educational and recreational opportunities (Brears, 2018). Overall, GSI provides a more holistic and sustainable approach to stormwater management than gray infrastructure.

Additionally, GSI can be a more adaptable and cost-effective stormwater management solution than gray infrastructure systems. Because sewer systems have a limited water volume capacity, they may need to be expanded in order to accommodate predicted increases in precipitation. However, this can require expensive, upfront construction costs for a single high-budget project (Brears, 2018). GSI is a more flexible alternative that allows stormwater management solutions to be implemented incrementally (Schmotzer, 2020), and its site-specific design tailors it to the unique setting in which it is being used (Brears, 2018). GSI can also be cheaper to maintain than gray infrastructure overall (Brears, 2018; Schmotzer, 2020). Adapting stormwater management systems to climate change will certainly require investments in gray infrastructure (Angel et al., 2018), but particular attention should be directed toward adopting GSI to improve the long-term resiliency of these systems.

GSI is already being adopted to supplement and replace traditional stormwater management systems in municipalities across the United States, and multiple studies have investigated its application within this setting (Dhakal & Chevalier, 2017; Fitzgerald & Laufer, 2017; Keeley et al., 2013; Rieck et al., 2022). However, there is limited research on GSI's applicability to higher education. Higher education institutions are like municipalities in that they are subject to climate change and the provisions of the CWA and NPDES program, but they also often act as "cities within cities" and, consequently, have their own administrative and financial structures that are unique from municipalities (Garret, 2017; Pierce et al., 2021; White, 2014). Because of this, existing research on ideas and best practices for successfully adopting GSI in municipalities may not necessarily apply to higher education institutions. If higher education institutions are to adopt GSI, they must first be provided with the information needed to support

sound decision-making. Therefore, higher education institutions would benefit from research on GSI that caters to their specific setting.

Higher education institutions also undergo additional pressure exerted by students and the public alike to act as role models who can provide leadership in developing and adopting innovative stormwater and resource management strategies (Pierce et al., 2021). Colleges and universities in particular are also uniquely positioned to bring these topics to the forefront of public awareness because of their focus on education and research, so they have an opportunity to instill GSI-centered values and train people on the best ways to adopt various GSI controls (McHugh, 2011).

Although little is known about GSI's application to higher education institutions, there is one study by Gilliard (2011) that was directly focused on researching GSI. Gilliard explored the master plans and stormwater management programs of nine public and private higher education institutions to see how they included GSI, and they used their findings to create a framework that would enable the University of Pennsylvania to establish a campus stormwater management program and planning document that would effectively plan for GSI.

While current literature on GSI's applicability to higher education institutions is limited, there does exist a greater body of research that investigates more general stormwater management considerations in higher education institutions. For example, McHugh (2011) conducted a large-scale overview of how different higher education institutions across the U.S. approach water sustainability and stormwater management, and they found that water is an often overlooked topic when compared to other sustainability priorities. Pierce et at. (2021) studied the challenges of complying with NPDES MS4 permit program requirements within the context of the University of California system, and they identified the need for dedicated financing

mechanisms to fund stormwater infrastructure projects. Garrett (2017) conducted case study research about five public universities in the U.S. that did have dedicated financing mechanisms for their stormwater management programs, and they identified different strategies that could be used to fund the initial construction and/or long-term maintenance of stormwater BMPs.

Even though the literature on this topic is limited, the findings from these aforementioned studies nonetheless offer insight that could be utilized to better inform future GSI work in higher education. They also underscore the essential role of planning in successfully implementing GSI. For example, Gilliard (2011) found that it was easier for higher education institutions to secure funding for GSI when it was included as part of a larger, planned vision. They also argued that organizing GSI efforts into a concentrated planning effort would enable them to "have the largest overall effect possible" (p. 5). Dalton and Davis (2018) also emphasize the role of master planning in the process of steering sustainable development and decision-making at higher education institutions.

This study addressed gaps in the GSI and higher education literature with the following research questions: What green stormwater infrastructure (GSI) planning strategies are being used by higher education institutions to address stormwater management concerns, and what are the expected and observed outcomes of these initiatives? Investigating these questions then led to the third research question: What GSI planning strategies could higher education institutions develop in the future to achieve desired campus outcomes?

METHODOLOGY

This was a qualitative study that used a multi-method approach to explore how public four-year universities in the Midwest incorporate GSI in their campus planning and stormwater management programs. It was organized into two parts. The first part assessed the current state

of GSI planning as it related to campus plans and policies for sixteen universities. The second part involved an in-depth investigation of the stormwater management programs for two select universities: The Ohio State University-Columbus campus and the University of Minnesota-Twin Cities campus. Data used in this study include campus planning documents (i.e., university plans and policies), NPDES MS4 permit program documents, and interview responses.

As noted earlier, this study identified eight states as part of the Midwest: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. These states are in line with the U.S. Fourth National Climate Assessment's definition of the Midwest (Angel et al., 2018).

University plans and policies are defined as formally codified and adopted documents that guide decision-making for physical campus development. Plans used in this study include a variety of long-range planning documents, such as strategic plans and physical master plans. They also include design standards and guidelines, since these documents apply to all physical development across a university campus. When a university plan consisted of a technical report and executive summary as separate documents, only the technical report was used. Policies had to relate to water management in some way to be considered, and they include documents such as sustainability goals and policies from university offices. Studies, reports, recommendations and charges, or drafts of plans were not considered, with the exception of the University of Wisconsin-Green Bay's *Draft Stormwater Management Plan*. This document was considered because it was the only available version of a plan that included information specific to its campus stormwater management program.

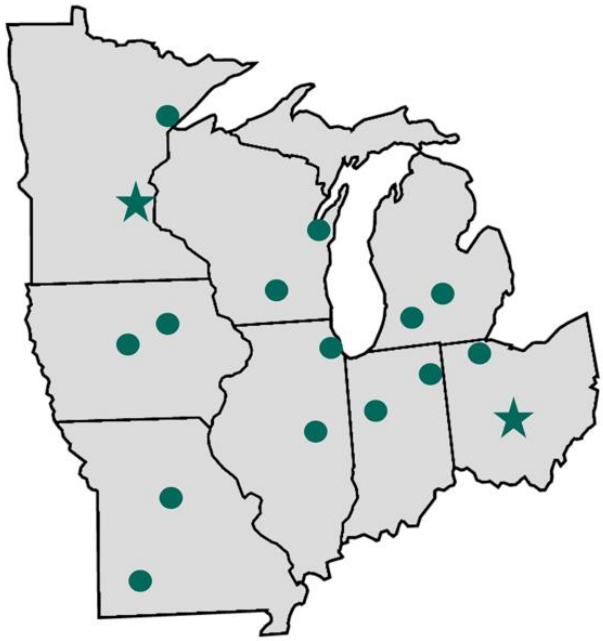
NPDES MS4 permit program documents include permits, stormwater policy statements, stormwater program plans, and other written documents used to comply with the NPDES MS4 permit program's requirements. Documents affiliated with illicit discharge detection and

elimination programs, construction site runoff controls, industrial wastewater pollution prevention programs, wasteload allocations, and watershed-scale management plans were not considered even though they are associated with the NPDES MS4 permit program. This study excluded these documents because they are not directly focused on campus-based stormwater management efforts that would incorporate GSI.

Selecting the Study Sample

This study included two universities from each Midwest state (sixteen universities in total). These universities were based on a selection process that filtered to include those that would likely have the most comprehensive campus planning and stormwater management efforts that incorporated GSI. Table 1 describes the characteristics of the final list of universities used in this study, and Figure 1 indicates the location of these universities.

Figure 1. Universities included in the study sample.



[1] A star symbol indicates a university also used as a case study.

Table 1. Universities included in the study sample.

University Name	Location	Student Enrollment[1]	Campus Size (acre)[2]	STARS Rating[3]
University of Illinois-Chicago	Chicago, IL	32,324	240	Silver, v2.2
University of Illinois-Urbana-Champaign	Champaign, IL	51,605	1,783	Gold, v2.2
Purdue University-Fort Wayne	Fort Wayne, IN	10,208	683	N/A
Purdue University-West Lafayette	West Lafayette, IN	45,500	2,468	Silver, v1.2
Iowa State University[4]	Ames, IA	33,372	1,813	Gold, v2.2
University of Northern Iowa	Cedar Falls, IA	10,477	916	Gold, v1.1
Michigan State University	East Lansing, MI	49,809	5,192	Gold, v2.2
Western Michigan University	Kalamazoo, MI	21,470	1,270	Silver, v2.1
University of Minnesota-Twin Cities	Minneapolis, MN	51,327	1,204	Gold, v2.0
University of Minnesota-Duluth	Duluth, MN	10,858	244	Gold, v2.1
Missouri State University-Springfield	Springfield, MO	23,453	225	Silver, v2.2
University of Missouri-Columbia	Columbia, MO	30,014	1,262	Gold, v2.1
The Ohio State University-Columbus	Columbus, OH	61,391	1,665	Gold, v2.1
University of Toledo	Toledo, OH	19,694	1,037	N/A
University of Wisconsin-Madison	Madison, WI	44,257	936	Silver, v2.2
University of Wisconsin-Green Bay	Green Bay, WI	8,766	700	Silver, v2.2

[1] Student enrollment for the Fall 2019 academic term. Data from the 2021 CCIHE Update.
[2] Data from the U.S. News and World Report College Search tool.
[3] Sustainability Tracking, Assessment & Rating System (STARS) rating from the Association for the Advancement of Sustainability in Higher Education (AASHE) Participant Reports. Ratings reflect an institution's most recent STARS rating. Institutions with "N/A" are members of AASHE but have not earned a STARS rating.
[4] Iowa State University was selected for inclusion in the study sample instead of the University of Iowa due to a transcription error during the keyword scoring process. This error is assumed to be unproblematic for the ultimate purpose of this study.

Filtering Process

I first used data from the 2021 Carnegie Classification of Institutions of Higher Education (CCIHE) Update to obtain initial information on all higher education institutions in the United States. I then used a filtering process so that institutions with a similar setting to The Ohio State University-Columbus campus remained. The selection criteria were as follows: (1) the institution must be located in the Midwest; (2) the institution must be a public, four-year university; and (3) the institution must have an urban campus setting. These criteria assumed some level of resource

availability and stormwater challenge potential. I identified institutions with an urban campus setting as those that were categorized as having a "City" setting in the CCIHE database. This initial data filtering process resulted in a list of 50 public, four-year Midwestern universities with an urban campus setting, which can be found in Appendix C.

I then conducted a document collection process to obtain electronic copies of plans, policies, and NPDES MS4 permit program documents for each university from this list. Once these documents were obtained, I used a final filtering process that added one new selection criteria: (4) the institution must have a GSI-specific plan or stormwater master plan, or it must operate a separate storm sewer system that is subject to the NPDES MS4 permit program and have written documentation outside of its NPDES MS4 permit that describes how physical campus development intends to comply with post-construction stormwater runoff requirements. One exception was made for the state of Missouri because it only had one university that met the fourth selection criteria. For this case, I considered all universities in Missouri so long as they had an NPDES MS4 permit. This second data filtering process resulted in a reduced list of 26 universities, which can also be found in Appendix C.

Campus Planning Document Collection Process

I used standardized website searching and browsing processes to identify and obtain electronic copies of university plans and policies for the list of 50 universities. First, I created a list of 19 search terms organized into 15 categories for use in website search queries. A list of the search terms used to collect university plans and policies, as well as the reasoning for why these terms were included in the study, can be found in Appendix D.

I then conducted these search queries through the search bar feature of each university's main website. The search queries used the exact list of search terms and without quotation marks

in order to maximize the number of returned results. One exception to this search process was with Missouri Western State University, which did not have a search bar feature, but rather a webpage with a predetermined list of linked topics to follow. For this university, the search terms were searched for within this list.

After running a search query, I used website browsing to scan through the returned results. Specifically, I read the titles and previews of each result for potential leads to information about and/or access to university plans and policies, and I used value judgment to decide if a result seemed worth investigating further based on whether or not the result titles or previews included specific text that was similar to the search query being used. I only scanned the first page of results, as it was likely to contain the most relevant results.

If I decided to investigate a result further, I followed the webpage that was linked with the result. I then used additional website browsing to read through the entirety of the webpage's content in search of plans and policies. I would then follow other webpage links in search of additional information, with the process repeating until I determined that sufficient information had been browsed. The entire document collection process, with included the findings from each search query and any website browsing search processes, was recorded.

This search process was not used to identify and obtain a copy of The Ohio State University-Columbus campus's *Stormwater Master Plan* (2020). Instead, this plan was identified during one of the case study interviews, where the interviewee provided a copy of this plan after the interview.

NPDES MS4 Permit Program Document Collection Process

The NPDES program is administered differently throughout the United States, so the process of identifying and obtaining electronic copies of NPDES MS4 permit program

documents varied for each university and across states. It nevertheless followed standardized website searching and browsing processes that were similar to those used in the campus planning document collection process.

The case under which each university received NPDES MS4 permit coverage needed to first be identified. Universities can receive NPDES MS4 permit coverage under an Individual Permit or their respective state's General Permit, and they can be listed as the sole permittee or as a co-permittee with additional self-governing entities (e.g., municipalities or other universities). To find this information, I conducted website browsing through the websites of each state's respective state agency authorized to administer the NPDES MS4 permit program; for each state, I searched for databases or online tools (e.g., interactive maps) with information about the current NPDES MS4 permittees for each state. From there, I recorded information about each university's specific NPDES MS4 permit (e.g., whether the university received coverage under an Individual or General Permit, permit name and ID number, permittee name and contact information, etc.). The entire website browsing search process was recorded, and information about the results from this process can be found in Appendix E.

This search process revealed that the majority of the universities received NPDES MS4 permit coverage under a state General Permit, so I obtained a copy of the NPDES MS4 General Permit for each state, with the exception of Iowa and Michigan because all of the universities from these two states received coverage under an Individual Permit. The process for locating copies of each state's General Permit varied but nevertheless used website browsing conducted through the websites of each state agency authorized to administer the NPDES MS4 permit program for each state. The entire website browsing search process for collecting these documents was recorded.

For universities where it was revealed that they received coverage under an Individual Permit, I used standardized website searching and browsing processes that followed the same procedures as those used in the campus planning document collection process to obtain a copy of their permit. One difference is that I conducted website search queries through the search bar feature of three sources: (1) the website of the state agency responsible for administering the university's NPDES MS4 permit; (2) the university's main website; and (3) the Startpage search engine. Additionally, each university had its own unique NPDES MS4 permit information, so the search terms used in these search queries varied to include this more specific information if it was known.

Once I obtained copies of NPDES MS4 permits, I reviewed the content of each document to identify instances where the permit required the provision of other written plans or policies for NPDES MS4 permit program compliance. I then used the same website searching and browsing processes as before to search for copies of these documents. As with the Individual Permits, the specific name for these additional NPDES MS4 permit program documents varied for each university, so the search terms used in these search queries also varied to include more specific information if it was known. A list of the search terms used to collect all of the different NPDES MS4 permit program documents can be found in Appendix F.

There were scenarios where databases and online tools did not include NPDES MS4 permit information for all of the universities being considered for inclusion in the study sample (See Appendix E), or copies of NPDES MS4 permit program documents could not be found after all search queries had been conducted (See Appendix F). For these scenarios, I emailed university contacts to request information. I used value judgment to identify contacts on the university's website who were assumed to be the most relevant person knowledgeable about the

university's NPDES MS4 permit. If contacts did not respond by October 2022, I eliminated the university from consideration in the study sample. This process, as well as any results from email communications with contacts, was recorded.

This search process revealed that all universities except for the University of Illinois-Chicago received permit coverage under the NPDES MS4 permit program, which instead received coverage under an NPDES combined sewer overflow permit. This study did not consider the University of Illinois-Chicago's NPDES permit and affiliated documents.

Keyword Search Process

I conducted a final keyword search process of the documents for the 26 universities that remained. This was a high-level assessment that searched for the existence of different keywords that I determined to be most relevant to GSI and stormwater management in general. I created two groups of keywords. The first group used 8 keywords organized into 3 categories to evaluate whether a document referenced stormwater management or GSI as a general concept; the keywords used in this group were chosen by using the terms that were featured as keywords in the GSI and stormwater management literature cited in this study. The second group used 35 keywords organized into 8 categories to evaluate whether a document referenced specific GSI controls; the keywords used in this group were chosen based on resources published by the International Stormwater Best Management Practices Database (Clary et al., 2020; Wright Water Engineers, Inc. & Geosyntec Consultants, 2019). A list of all the keywords and the reasoning for why they were included in the study can be found in Appendix H.

I used the "Find" computer command (i.e., "Control+F" or "Command+F") to search for the existence of both groups of keywords within the obtained documents. This search was not concerned with the context of the keywords, but rather whether or not the keywords were simply

included in the text. If a keyword was used, the category that it was affiliated with was assigned a value of 1. If none of the keywords in a category were used, the category was assigned a value of 0. I repeated this process for all keywords in all of the documents where more than two universities were suitable for inclusion in the study sample.

I then calculated a total existence score for a university's entire set of obtained documents by summing the existence scores for all categories across all obtained documents. The top two universities from each state with the highest scores were selected for inclusion in the study sample, with the assumption that these universities were most likely to incorporate GSI into their campus planning and stormwater management programs. All results from the keyword search process were recorded.

Some of the PDF documents were only available as scanned image files as opposed to text files, and because of this, the "Find" command did not work. To address this issue, I opened the affected documents through Google Docs to automatically convert them into a text format. A list of the documents used in this process can be found in Appendix G.

Selecting the Case Studies

Two universities from the initial list of sixteen were selected as case studies for further investigation and analysis. The first case study was predetermined to be The Ohio State University-Columbus campus. The second case study had to be located outside Ohio to explore a university with a different state regulatory climate for the NPDES MS4 permit program. It also had to have a campus setting similar to OSU, which was determined as being located in a large urban setting and having a major river system flowing through its campus, so that observed outcomes would apply to a similar natural environment context.

I identified universities with a large urban campus setting as those that were categorized as having a "City Large" setting in the CCIHE database. To determine whether a major river system flowed through a university's campus, I compared its campus boundaries with surface water data. I used the most recent campus map retrieved from each university's main website to identify campus boundaries, and I used the United States Geological Survey (USGS) National Map Download Viewer to identify surface waters. I defined major river systems as those that had "River," "Creek," or "Stream" in the name of a vector feature included in the USGS Viewer's "Hydro Cached" layer. Even if a named water feature was included in a retrieved campus map, if it was not included in the USGS Viewer, I did not consider it as a major river system.

Of the sixteen universities included in the study sample, two universities (not including OSU) met the criteria for inclusion in the case study analyses. These universities included the Purdue University-Fort Wayne campus and the University of Minnesota-Twin Cities campus. Through email communications, I learned that the Purdue University-Fort Wayne campus does not manage its NPDES MS4 permit and, consequently, stormwater management programs. Because of this, the University of Minnesota-Twin Cities campus was selected as the second case study by default.

Part 1: Document Content Analysis

I used the data analysis software MAXQDA Analytics Pro for the document content analysis. The content analysis coded for the existence of text that described GSI controls, as well as other ideas that related to adopting GSI. It also coded for any benefits or outcomes that universities expected from GSI or stormwater management projects. For documents explicitly focused on the topic of GSI, the content analysis identified GSI implementation strategies. These strategies focused on topics such as the planning and design, financing, and maintenance of GSI

and the types of actors involved in various stages of the GSI adoption process. The content analysis also assessed the layout of these documents and the main topics discussed.

I used a manual coding process based on the work from Saldaña (2021). I organized coded GSI text references into two categories: (1) text referring to GSI that already existed on campus and (2) text that identified GSI to be incorporated into future development. In this way, the content analysis was able to identify the overall inclusion of GSI-related themes, as well as any intentional planning efforts to adopt GSI. The initial code categories used the same GSI and stormwater terms used in the keyword search process (See Appendix H). I then used an iterative coding process when reviewing and manually coding the documents to update the code categories so that they accounted for any new information.

I then used MAXQDA processing tools to analyze the coded data. These tools calculated frequency counts that tracked the existence of coded text segments for different code categories. They also analyzed relationships between documents, code categories, and coded text segments. One particularly important relationship explored in this study was the number of coded text segments and unique documents affiliated with different code categories and document types.

Part 2: Case Study Analyses Interviews

I utilized a semi-structured interview approach for the two case study analyses to gather additional information about each university's stormwater management programs. The entire process for this part of the study received Institutional Review Board (IRB) approval for human subject research, as determined by The Ohio State University Office of Responsible Research Practices. After I made initial contact with university faculty and staff who I identified as having the best knowledge about stormwater management and/or campus planning at the university, I used snowball sampling to identify other potential interviewees. This study conducted interviews

with seven willing participants, with four interviewees from The Ohio State University-Columbus campus and three interviewees from the University of Minnesota-Twin Cities campus.

I contacted university faculty and staff of interest by email. This email included general information about the study, information about the interview set-up and questions to be asked, and expectations for interview privacy and data confidentiality. If the contact was interested in participating, I scheduled an interview through an Outlook Zoom meeting invitation. This interview was a private virtual meeting hosted through my student subscription to Zoom services, OSU CarmenZoom, that utilized the "Waiting Room" and "Lock Meeting" features. At the start of the meeting, all interviewees expressed their verbal consent to participate in the interview and allow the interview to be recorded, stored, and transcribed.

Each interview used eight open-ended interview questions (See Appendix B) and lasted approximately 20-60 minutes in length. The semi-structured interview approach was used to facilitate a more productive conversation that took the findings from the previous document content analysis into account and was flexible to each interviewee's responses. I organized the interview transcriptions in a text document and manually coded the data for any recurring themes related to the motivations, challenges, and outcomes of GSI at the universities.

RESULTS & ANALYSIS

Part 1: Document Content Analysis

A total list of 135 distinct documents was identified and used for the content analysis. This study organized them into the following categories: 33 documents affiliated with the NPDES MS4 permit program, 16 Strategic Plans, 23 campus master plans, 25 university design standards and guidelines, 8 Climate Action Plans, 6 sustainability plans, 7 landscape plans, and

17 documents affiliated with other miscellaneous categories. Appendix A contains a total breakdown of the examined documents by university and document type.

The most frequently identified reason for adopting GSI was the need to respond to climate change and its affiliated impacts on precipitation patterns. Specifically, documents cited increased flooding threats and the need to make infrastructure more resilient. For the University of Illinois-Chicago in particular, flooding threats were exacerbated by the fact that it had an aging stormwater management system that also suffered from deferred maintenance (University of Illinois Chicago, n.d.). A second rationale, while not as frequently cited, was a desire to protect and improve the quality of natural water resources. The two universities from both Illinois and Minnesota noted value in adopting a water stewardship mentality, with the University of Illinois-Urbana-Champaign in particular citing an opportunity to view rainwater as a resource that could be utilized (University of Illinois Chicago, n.d.; Institute for Sustainability, Energy, and Environment, 2020; Capital Planning and Project Management, 2019). The need to comply with stormwater runoff and water quality regulations was also a key motivation in many of the documents affiliated with the NPDES MS4 permit program, but this reason was less frequently mentioned in all the other types of documents. Finally, the University of Wisconsin-Madison's *Campus Master Plan Technical Document* had a particularly unique motivation for pursuing more aggressive GSI investments, crediting its efforts to an overall increased sustainability awareness within the university community (University of Wisconsin Madison, 2015a, p. 186).

Table 2 compares the total number of analyzed documents to the number of documents with at least one text reference that planned for the adoption of new GSI. The Illinois universities had the largest number of total analyzed documents, while the Indiana universities had the

smallest number. With that, the total number of documents did not seem to have any relation to whether or not the universities for a given state had text indicative of GSI planning, as both universities from Illinois and Indiana all had particularly high frequencies of GSI text in their total analyzed documents.

Between 38-94% of documents contained at least one text reference to GSI planning for a given university. All universities except for both universities from Iowa, Missouri State University-Springfield, and the University of Toledo included at least one reference to GSI planning in half or more of their analyzed documents. The University of Illinois-Chicago, Purdue University-West Lafayette, Western Michigan University, and the University of Wisconsin-Madison had particularly high inclusion of GSI planning, where 80% or more of their documents had at least one reference to GSI planning.

Between 44-86% of documents contained at least one text reference to GSI planning for a given state, which was determined by the state's total number of unique documents when looking across all of the combined documents from its two universities. Illinois and Indiana were states with particularly high inclusion of GSI planning for both of the universities studied from each state, where 75% or more of the documents had at least one reference to GSI planning.

Table 3 shows the number of documents from the total list of 135 with at least one text reference to specific GSI controls and GSI-related stormwater management approaches. The listed GSI categories are subsets of the entire list of code categories used in the coding system for this study. These code categories are meant to represent the most well-known and established GSI controls and ideas.

When considering all coded text references (i.e., text was irrespective of whether or not the GSI reference referred to already existing GSI or an intentional planning effort), the term

Table 2. Number of documents with text references indicative of an intentional GSI planning effort vs. total number of analyzed documents, organized by university and state.

State Name	University Name	# of Documents that Plan for GSI	Total # of Documents[1]	% of Documents that Plan for GSI
Illinois	University of Illinois-Chicago	15	16	94%
	University of Illinois-Urbana-Champaign	11	14	79%
	State Total	*25*	*29*	*86%*
Indiana	Purdue University-Fort Wayne	3	4	75%
	Purdue University-West Lafayette	5	6	83%
	State Total	*7*	*9*	*78%*
Iowa	Iowa State University	3	7	43%
	University of Northern Iowa	4	9	44%
	State Total	*7*	*16*	*44%*
Michigan	Michigan State University	5	8	63%
	Western Michigan University	9	11	82%
	State Total	*14*	*19*	*74%*
Minnesota	University of Minnesota-Twin Cities	7	13	54%
	University of Minnesota-Duluth	5	9	56%
	State Total	*9*	*17*	*53%*
Missouri	Missouri State University-Springfield	2	5	40%
	University of Missouri-Columbia	5	8	63%
	State Total	*7*	*13*	*54%*
Ohio	The Ohio State University-Columbus	6	9	67%
	University of Toledo	3	8	38%
	State Total	*8*	*16*	*50%*
Wisconsin	University of Wisconsin-Madison	8	10	80%
	University of Wisconsin-Green Bay	4	6	67%
	State Total	*12*	*16*	*75%*
Total		**89**	**135**	**66%**

[1] This Table includes analysis results based on all of the documents for a given university, as well as all the unique documents for a given state when looking across all of the combined documents from the state's two universities. Some of the universities for a given state were affiliated with the same university system, and they sometimes used the same documents in their individual university analysis. Therefore, the number of documents for the State Totals should be viewed independently from the number of documents affiliated with its two study sample universities.

"green stormwater infrastructure" was only used in two documents, which were both affiliated with the University of Illinois-Urbana-Champaign. Specifically, the University's various *Facilities Standards* documents had an entire "Green Stormwater Infrastructure" section (Facilities & Services, 2018), and its *University of Illinois Facilities & Services Transportation Demand Management Plan 2019-2024* document mentioned GSI as part of a living laboratory strategy (Facilities & Services, 2020, p. 3). The terms "green infrastructure" and "low impact development" were much more commonly used, with references in 35 and 19 documents, respectively. However, when excluding NPDES MS4 permit program documents, the number of documents featuring these terms decreased to 21 for "green infrastructure" and 8 for "low impact development." 43 documents unaffiliated with the NPDES MS4 permit program did include general references to stormwater management planning in some way, but these did not always mention GSI.

Structural controls remained the most frequently mentioned GSI theme over non-structural controls, and trees were the most frequently referenced specific GSI control for all document types, with the exception of NPDES documents. However, trees were more frequently mentioned as a general concept and without any explicit reference to how they could be utilized to manage stormwater. References that did identify trees as a GSI strategy most frequently included using them as part of larger GSI projects, such as green streets and landscape medians, but some also referenced them as standalone GSI solutions. When excluding trees, the most frequently mentioned GSI themes for all of the considered text references were stormwater basins and ponds, swales, and rain gardens. But when considering text that was indicative of university planning, the most frequently mentioned GSI themes changed to preventing landscape disturbance, permeable pavement, and stormwater harvesting and reuse (See Table 3).

Table 3. Number of documents with text references to specific GSI controls and ideas.

Specific GSI Controls & Approaches		# of Documents with Text that Includes a GSI Reference	
		All References	***Planning[1]***
Structural Controls	Trees	48	47
	Permeable pavement	36	33
	Stormwater harvesting & reuse	35	33
	Rain gardens	37	31
	Swales	39	30
	Green & blue roofs	31	28
	Stormwater basins & ponds	40	27
	Landscape buffers, medians & strips	28	25
	"Bioretention"[2]	19	14
	Green streets & boulevards	13	13
	Constructed wetlands	13	10
	"Bioinfiltration"[2]	10	8
	Greenways	7	7
	"Biofiltration"[2]	7	6
Non-Structural Controls	Prevent landscape disturbance	35	33
	Reduce impervious surfaces	30	30
	Restoration activities	32	30
Using a GSI Approach	"Green infrastructure"[2]	35	34
	"Low impact development"[2]	19	18
	"Green stormwater infrastructure"[2]	2	2
Other[3]	Native plantings	47	42
	"Green space"[2]	30	30
	"Open space"[2]	25	25
	Educational signage for GSI	12	11

[1] This list is organized in order of the code categories with the most documents mentioning it. This ranking indicates the prevalence of different GSI controls and ideas across the 135 planning documents, but it does not indicate a relative importance of code categories.
[2] Quotes indicate code categories that used this exact term for the coding process and analysis. All other code categories without quotes may include coded text that did not match these terms exactly but nonetheless indicated references to the code category.
[3] Text references affiliated with these code categories did not refer to a specific GSI control or approach, but they could nonetheless be affiliated with GSI in some way and were, therefore, included in this Table.

The content analysis process identified “Other” categories that did not identify a specific GSI control or approach but could nonetheless be argued to have some degree of relevance to GSI (See Table 3). For example, many documents frequently referenced using native plantings and educational signage. Native plantings were argued to maximize landscaping’s stormwater performance due to their high suitability with the local environment, while educational signage was viewed as a strategy for increasing public knowledge of, and consequently support toward, GSI. The existence of references to both of these categories was equally frequent when considering both all coded text references and text references indicative of university planning.

The terms “open space” and “green space” were also frequently mentioned across all of the documents, and their existence remained the same regardless of whether or not the coded text segment was indicative of GSI planning. But similar to the discussion on trees, references to “open space” and “green space” were not always in the context of stormwater management. The majority of references described efforts to improve campus landscapes and preserve artificially designed open and green spaces, such as quads and lawns, but they infrequently related these efforts explicitly to stormwater management. References that did identify open and green spaces as GSI strategies included using them as spaces that would create an interconnected stormwater management system to improve stormwater drainage and filtration.

Figure 2 identifies a wide variety of benefits and outcomes that universities expected from adopting GSI. The most frequently self-identified outcome was an increased capacity for stormwater management, with slightly greater attention toward the benefits that GSI has on managing water volumes as opposed to improving water quality. Other frequently mentioned outcomes were affiliated with personal, social, cultural, and safety benefits, with the two most

Figure 2. Expected benefits and outcomes of GSI as stated in the analyzed planning documents.

Expected Benefits/Outcomes of GSI

Stormwater Management & Water Resources
- Reduce stormwater runoff
- Prevent/mitigate flooding
- Improve stormwater drainage & infiltration
- Recharge groundwater supplies
- Divert stormwater
- Address combined sewer overflows
- Improve water quality

Other Environmental Benefits
- Preserve natural resource quality
- Prevent/mitigate erosion
- Create new natural habitat
- Increase natural habitat connectivity
- Increase biodiversity & attract pollinators
- Reduce the heat island effect
- Improve air quality
- Sequester greenhouse gas emissions

Education, Research & Professional Development
- Increase awareness & knowledge of GSI
- Provide curriculum opportunities
- Provide research opportunities
- Provide living/learning laboratory opportunities

Personal, Social, Cultural & Safety
- Foster placemaking
- Add aesthetic value
- Provide recreational opportunities
- Foster social interaction & community building
- Create calmer & more comfortable environments
- Improve individual attention & focus
- Connect people to nature
- Foster environmental values & mindfulness
- Improve pedestrian & wintertime safety
- Provide connections to local history

Financial, Operational, Legal & Reputational
- Maintain regulatory compliance
- Reduce gray infrastructure needs
- Improve energy & land use efficiency
- Reduce utility & operations costs
- Increase resiliency of campus infrastructure & landscapes
- Increase physical campus connectivity
- Achieve other university goals
- Become a leader & model of GSI
- Improve public image & reputation

frequently self-identified outcomes being GSI's ability to add aesthetic value and create both active and passive recreational opportunities.

While less frequently mentioned, the documents stated various other financial, operational, legal, and reputational outcomes of GSI. The most frequently cited expected outcome within this category referenced GSI's potential to save money by reducing gray infrastructure maintenance needs and improving operational efficiency and resilience. Universities also stated their confidence in GSI's ability to help them achieve regulatory compliance with local, state, and federal stormwater management programs, such as the NPDES MS4 permit program. Finally, they cited the opportunity to use GSI as a means of improving their public image by addressing other university goals and modeling successful GSI implementation practices for others to follow.

A final category of self-identified outcomes was the potential for GSI to create new academic, research, and even professional development opportunities. Documents most frequently cited GSI's potential to improve public knowledge about sustainable stormwater management practices and the benefits that they can provide. The University of Illinois-Chicago's *Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan* document mentioned a particularly interesting benefit of GSI, which stated that education on these topics would give students an edge in the job market by better preparing them to handle flooding and water management issues in a more innovative way (University of Illinois Chicago, n.d., p. 11).

Table 4 shows the expected benefits and outcomes listed in Figure 2 that were referenced most frequently for each specific structural and non-structural GSI control listed in Table 3. This

Table 4. Most frequently mentioned expected benefits and outcomes of specific GSI controls and ideas as stated in the analyzed planning documents, organized by GSI control type.

Specific GSI Controls		**Expected Benefits/Outcomes (# of Coded Text Segments)**
Structural Controls	Trees	Create calmer & more comfortable environments (15)
	Permeable pavement	Improve water quality (10)
	Stormwater harvesting & reuse	Reduce utility & operations costs (9)
	Rain gardens	Reduce stormwater runoff (7)
	Swales	Reduce stormwater runoff (8) Improve water quality (8)
	Green & blue roofs	Reduce stormwater runoff (10)
	Stormwater basins & ponds	Improve water quality (6)
	Landscape buffers, medians & strips	Improve water quality (8)
	"Bioretention"[1]	Improve water quality (1)
	Green streets & boulevards	Reduce stormwater runoff (4)
	Constructed wetlands	Improve water quality (6) Create new natural habitat (6) Provide recreational opportunities (6)
	"Bioinfiltration"[1]	Improve water quality (1)
	Greenways	Increase physical campus connectivity (4)
	"Biofiltration"[1]	Improve water quality (8)
Non-Structural Controls	Prevent landscape disturbance	Provide recreational opportunities (5)
	Reduce impervious surfaces	Reduce the heat island effect (5)
	Restoration activities	Improve water quality (6) Provide curriculum opportunities (6)

[1] Quotes indicate GSI categories that used this exact term for the coding process and analysis. All other code categories without quotes may include coded text that did not match these terms exactly but nonetheless indicated references to the code category.

Table shows that many specific GSI controls had improvements to water quality as the most frequently mentioned expectation of GSI, even though managing stormwater volumes was mentioned more often than improving water quality when considering all of the coded text.

Strategic Plans & University Policies

None of the analyzed Strategic Plans had text that included GSI. Only Western Michigan University's Strategic Plan, *The Gold Standard 2020*, had "green space" wording that could at best be viewed as an indirect reference to GSI. Specifically, this plan supported "responsible acquisition and use of natural resources, including green space on campus" (Western Michigan University, 2016, p. 10). The University of Illinois System's strategic framework planning document did have a reference to stormwater management in general, stating a desire to manage and reduce stormwater runoff from buildings and parking lots (University of Illinois System, 2016, p. 15), but it did not reference any specific GSI controls.

The Strategic Plans for the University of Illinois-Chicago, University of Northern Iowa, Purdue University-Fort Wayne, and the University of Wisconsin-Madison all identified environmental sustainability, responsibility, and/or stewardship as university priorities, but they did not have any explicit references to GSI or stormwater management in general.

Neither of the two analyzed university policies had GSI-specific text, but they both included references to stormwater management in general. The University of Minnesota System's *Environmental Protection* administrative policy stated a desire to conserve aquatic resources and protect water quality (Office of Institutional Compliance, 2020), and the University of Toledo's *Energy Management and Sustainability* policy stated a desire to "improve storm water quality" to advance water sustainability (University of Toledo, 2019, p. 1).

Campus Master Plans

Campus master plans identified non-structural GSI controls more often than structural controls, with all three of the non-structural controls listed in Tables 3 and 4 having a high number of documents with text that referred to them. This finding remained consistent regardless of whether the analysis considered all of the coded text segments or only references that were indicative of GSI planning. Campus master planning documents revealed an additional non-structural control not identified in Tables 3 and 4; specifically, they mentioned the idea of capitalizing on the value of already existing natural resources to provide recreational opportunities and foster placemaking. Additionally, many of these references were specific to investments in natural rivers and lakes located within or nearby campus.

Trees were the most frequently mentioned specific structural GSI control, but the majority of coded text references were under the context of providing personal, social, cultural, or safety benefits (See Figure 2), as opposed to explicit references that identified their potential benefits to stormwater management. Open and green spaces were also frequently mentioned in many of these documents, but as with trees, references to open and green spaces were infrequently mentioned in the specific context of stormwater management.

Design Guidelines & Standards

University design guidelines and standards frequently included technical guidance for installing and maintaining permeable pavements, green roofs, stormwater basins and ponds, and swales. The text references included recommendations for siting, sizing, and maintaining these GSI controls. They also included information that would help future development projects maintain compliance with various local, state, and federal regulations, such as meeting specific stormwater runoff volume or water quality targets.

As mentioned earlier, the University of Illinois-Urbana-Champaign's various *Facilities Standards* documents had an entire "Green Stormwater Infrastructure" section (Facilities & Services, 2018). This document outlined the University's expectations for incorporating GSI considerations into future campus development, and it included design recommendations for different specific GSI structural controls. Michigan State University's *Storm Water Design Standards* was another notable document, as it provided comprehensive guidance for siting and designing various GSI structural and non-structural controls. It also provided context about the University's specific stormwater management regulations and development objectives, as well as guidance on calculating quantifiable impacts of these various GSI controls (Michigan State University, 2014).

Sustainability & Climate Action Plans

Sustainability plans only included references to two GSI controls that excluded trees; these controls were stormwater harvesting and reuse and preventing landscape disturbance. Climate action plans had a slightly more comprehensive inclusion of GSI themes by mentioning other non-structural and structural controls in addition to those featured in the sustainability plans. Some of the most frequently coded GSI controls for these documents also included stormwater harvesting and reuse, along with permeable pavements and green roofs. As with the campus master planning documents, trees were frequently mentioned, but these references did not always assume an explicit stormwater management purpose.

Landscape Plans

Landscape plans identified trees, landscape restoration, rain gardens, swales, and green roofs as the most frequently mentioned GSI controls. Purdue University-West Lafayette's *Sustainable Landscape Plan West Lafayette Campus* document included strategies to adopt all of

these specific GSI controls, identifying their adoption as part of larger strategies to promote native plantings and "water conservation, retention, and recycling" on campus (Purdue University, 2012, p. ii).

The University of Illinois-Urbana-Champaign's *Resilient Landscape Strategy* document offered different financing strategies to institutionalize more ambitious stormwater management strategies, as well as support long-term landscape maintenance needs, and all of these recommendations were provided through the lens of GSI (Facilities & Services, 2019).

NPDES MS4 Permit Program Documents

All of the universities included GSI-related provisions in their NPDES MS4 permit program documents; however, the majority of GSI references were affiliated with the Public Education and Outreach or Public Involvement and Participation minimum control measures of the NPDES MS4 permit program. Stormwater basins and ponds, rain gardens, and swales were the most frequently mentioned GSI controls for these documents, and this was the same finding as the most frequently mentioned GSI controls for all of the analyzed documents combined. When considering codes in a planning context, swales were replaced by preventing landscape disturbance as the most frequently mentioned GSI control.

GSI was explicitly mentioned as a strategy that could be adopted as part of a permittee's NPDES MS4 permit program in the General Permits for all of the considered states, but only the Illinois, Indiana, Minnesota, Missouri, and Ohio state General Permits had GSI-specific text as it related to providing a specific GSI control for managing post-construction stormwater runoff. With that, the Wisconsin state General Permit did include a section that mentioned GSI as a method for promoting "environmentally sensitive development" (Wisconsin Department of Natural Resources, 2022, p. 21).

Green Stormwater Infrastructure & Stormwater Master Plans

Only four of the sixteen universities studied had either a GSI-specific plan or a stormwater campus master plan unaffiliated with satisfying the NPDES permit program requirements (See Table 5). These documents provided insight into why creating a separate GSI or stormwater master planning document would be beneficial, stating that more intentional planning efforts would improve a university's ability to manage stormwater sustainably and achieve regulatory requirements. They also served as an example of how other universities could potentially structure their own similarly themed plans.

Table 5. Universities with a GSI or stormwater master plan.

	University Name	**Document Name (Year Published)**
Universities with a Green Stormwater Infrastructure (GSI) Plan	University of Illinois-Chicago (UIC)	Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan (n.d.)
	University of Wisconsin-Madison (UWM)	Green Infrastructure & Stormwater Management Master Plan (2015)
Universities with a Stormwater Master Plan	University of Missouri-Columbia (UMC)	University of Missouri 2015 Stormwater Master Plan (2015)
	The Ohio State University-Columbus (OSU)	Stormwater Master Plan (2020)

Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan (UIC)

This was a master planning document intended to coordinate all GSI-specific efforts at the University of Illinois-Chicago campus. Specifically, it was created to help the University "develop and demonstrate an incremental, scalable, and adaptive approach to implementing green infrastructure" (p. 2) by identifying "specific ways to reduce stormwater runoff" (p. 9). It was also developed as a formal response to a previous informal GSI planning effort.

The University's stormwater management strategy is organized into three phases, with each phase gradually increasing the degree of GSI investments. Phase 1 inventoried past GSI projects for use as case study examples. It analyzed their impacts, identified encountered challenges with their adoption, and offered suggestions to improve the success of future GSI projects. It also explained the benefit that pilot projects have on increasing knowledge of and, consequently, stakeholder interest in and support toward GSI. Phase 2 built off the lessons from Phase 1 and identified more opportunities for continued GSI investment and expansion. The University made sure that GSI projects during this phase would align with its campus master plan and also be monitored to inform adaptive management strategies. Phase 3 provided the University's long-term GSI plan by outlining ambitious stormwater management targets. This phase would be marked by GSI's complete integration into all campus planning and development processes. By this point, GSI would have formalized financing mechanisms, and it would be elevated in status as a fundamental consideration in campus development.

The University placed high importance on informed decision-making when adopting GSI, stating that it "should focus on the results of case studies, pilot projects, calculations and stormwater model predictions performed by university and professional experts" (p. 41). All of the phases used stormwater runoff reduction calculations to quantify the expected benefits of different GSI controls, which were derived from both national models and university-made models tailored specifically to the UIC context. Phase 1 provided an overview of the impacts of existing GSI controls, while Phases 2 and 3 provided estimates of expected benefits from suggested GSI projects.

Green Infrastructure & Stormwater Management Master Plan (UWM)

This was a master planning document that was part of a greater campus master planning update at the University of Wisconsin-Madison. It was created for three stated reasons: (1) to "identify green infrastructure opportunities so that they can be appropriately budgeted and accommodated during site planning" (p. 10); (2) to encourage informed land use and operations decisions by incentivizing the University to consider potential impacts on stormwater runoff; and (3) to develop more effective NPDES compliance strategies by helping the University identify tangible stormwater impacts and performance measures.

The document first outlined existing campus conditions as they related to GSI and stormwater management in general. It included a thorough overview of the University's land use and utility systems, environmental context (i.e., information pertaining to watersheds, soils, and natural resource amenities), and regulatory climate. It also used state-level modeling programs to calculate estimates of stormwater runoff and water pollutants for given land use scenarios.

The University's long-term GSI plan organized its strategies into five categories. The first category concerned efforts to institutionalize GSI considerations into campus development and redevelopment projects by creating university policies with stricter stormwater management and water quality standards. These policies covered topics such as stormwater runoff volumes, peak discharge rates, and total suspended solids.

The second and third categories concerned the implementation of specific district-scale and site-scale GSI controls, respectively. The plan identified district-scale controls as strategies to be undertaken simultaneously with other major planned campus development projects, and it offered suggestions to best align GSI implementation with these projects. The plan identified site-scale controls as strategies to be implemented on a project-by-project basis. Site-scale

strategies all had descriptions that provided an overview of each specific GSI control, how it was applicable to campus, any expected benefits and outcomes from its adoption, and siting and design recommendations. They also provided maintenance recommendations and an overview of all the site-scale GSI controls organized by their costs and ability to achieve different stormwater management objectives.

The fourth and fifth categories concerned strategies to integrate GSI into campus land use changes and utility infrastructure improvement projects, respectively. The University stated that these strategies would make it easier to adopt GSI, as they capitalize on the momentum of campus redevelopment efforts to include GSI as a small part of a larger whole instead of presenting it as a standalone project.

University of Missouri 2015 Stormwater Master Plan (UMC)

This document provided a broad overview of sustainable stormwater management efforts undertaken by the University of Missouri-Columbia, as well as a general vision for future stormwater management efforts. Its goal was to identify watershed-scale stormwater management strategies that would help the University improve stormwater quality, promote water resource stewardship, and achieve regulatory compliance. It used a collaborative adaptive management (CAM) GSI planning approach that was organized into an iterative cycle consisting of five distinct stages: (1) Assessing the current status of stormwater runoff intensity and water pollution throughout campus; (2) Identifying opportunity areas for installing GSI controls; (3) Determining GSI siting and sizing; (4) Tracking measurable impacts of installed GSI; and (5) Evaluating impacts to inform future efforts.

Stormwater Master Plan (OSU)

This was a master planning document intended to help The Ohio State University-Columbus make appropriate long-range plans for stormwater investments on its campus. Specifically, it was created to help the University prepare its stormwater management systems to handle changes from future development, meet the sustainability goals of its campus master plan, and ensure compliance with stormwater management and stream corridor protection requirements. It provided baseline information about the University's regulatory climate and anticipated impacts on campus streams and stormwater management systems.

The University campus is organized into three "watershed subcatchment" planning areas that each have their own development agenda and affiliated stormwater recommendations (p. 1). New development in the Main Campus planning area was directed to use a Stormwater BMP Toolbox to determine appropriate stormwater management strategies on a project-by-project basis. This provided calculations to determine the best-suited stormwater BMPs for a project, and it included many GSI controls as options in its picklist. The West Campus planning area was recommended to use "a series of stormwater detention basins to serve multiple future redevelopment sites" (p. 2), with preferences for surface ponds and underground chambers. Development in the Athletic District and Waterman Lab planning area would infill existing stream corridors, so mitigation measures were needed to achieve compliance with federal, state, and city regulations.

All planning areas had a particularly strong focus on stormwater basins and ponds, as opposed to other GSI controls. The document also prioritized district-level stormwater management strategies, with a high preference for installing regional detention facilities, as

opposed to establishing a network of site-based GSI controls that would be designed on a project-by-project basis.

Part 2: Case Study Analyses Interviews

The seven interviewees all worked for their respective university, and their professions included engineers, landscape architects, professors, and researchers. The Ohio State University-Columbus campus (OSU) provided response data from four interviewees, and the University of Minnesota-Twin Cities campus (UMN) provided response data from three interviewees. Table 6 anonymously identifies each interviewee for future reference in this study.

Table 6. Interviewee assignments for each university case study.

The Ohio State University-Columbus	University of Minnesota-Twin Cities
Interviewee A Interviewee B Interviewee C Interviewee D	Interviewee E Interviewee F Interviewee G

The Ohio State University-Columbus

As previously discussed, the OSU *Stormwater Master Plan* was created to help the University appropriately prepare future campus development efforts so that they would comply with stormwater management, water quality, and stream restoration requirements (EMH&T, 2020). OSU also included stormwater management as a part of open space considerations in its *Framework 2.0* campus master plan, specifically identifying the opportunity to create a district-wide stormwater management strategy that would supplement project-scale initiatives (Office of Planning and Real Estate, 2017).

Stormwater management efforts at OSU are led by Facilities Operations and Development, and these considerations are integrated as part of new development and

redevelopment projects on campus. Interviewee C stated that compliance with NPDES requirements remains the fundamental driver for stormwater considerations, but Interviewee A also pointed out that externally contracted project design teams often take the initiative to advocate for the inclusion of more innovative GSI.

Interviewee A credited Division 18 of OSU's Building Design Standards as one of the main motivations for adopting GSI at the University, stating that it gives project design teams a defensible argument to advocate for the inclusion of GSI-related practices. Division 18 has provisions that incentivize new campus development and redevelopment projects to consider strategies that improve ecosystem services, such as natural resources and stormwater management considerations, and many of these strategies directly refer to both structural and non-structural GSI controls (Facilities Operations and Development, 2022).

All of the interviewees stated that OSU does not currently undertake coordinated efforts to research the effects of GSI controls already existing on campus, so observed outcomes were not obtained. Interviewee C noted the Wilma H. Schiermeier Olentangy River Wetland Research Park as an exception, but they also acknowledged that this GSI control was part of a larger university asset, as opposed to being a part of a campuswide intention to consider GSI as a whole. With that, Interviewees A, C, and D mentioned that various University faculty have conducted standalone research efforts that investigated observed outcomes from specific GSI projects. Interviewee A also mentioned that the University collaborates with private corporations for some GSI research projects.

All of the interviewees stated that GSI receives broad interest and support from internal University stakeholders, but they also stated that operational and financial challenges prevent its effective and more widespread adoption. They specifically identified both short- and long-term

maintenance needs, as well as their affiliated costs, as key barriers. Interviewee A expressed how there is uncertainty with being able to identify the specific maintenance requirements and timeline for different GSI controls. Interviewee B also elaborated that because GSI is a relatively new stormwater management approach for OSU, it requires the University to adopt new operations strategies to appropriately maintain it, which would further force it to reevaluate its current financial and facilities management models. As described by Interviewee C, the University struggles to find a balance between its desire for the benefits affiliated with GSI and its willingness to pay and undergo change.

Interviewee C also suggested ways to address these maintenance concerns, with the most important suggestion being the need to incorporate maintenance as a routine task for University landscaping staff. In this way, GSI controls are fully accounted for in a formal maintenance schedule and budgeted accordingly. This interviewee also mentioned the need to ensure that landscaping staff is appropriately trained on how to properly maintain different GSI controls. One particularly interesting idea that they mentioned as a part of this strategy is that it would then help foster an entire network of landscape professionals who are knowledgeable about GSI and can, as a result, offer a wider range of landscaping services.

Interviewee C pointed out another issue with adopting GSI, stating that an absence of strong state-level incentives keeps developers from wanting to pursue these more innovative stormwater management controls. They stated that GSI can perform better than traditional gray infrastructure for removing pollutants such as nutrients and bacteria, so they argued that states should implement stricter water regulations that go beyond sediment controls to include these other pollutant types so that development is directed in favor of GSI. They also discussed the

need for states to clearly articulate a greater preference for GSI over gray infrastructure so that it incentivizes future development efforts to consider these controls more seriously.

University of Minnesota-Twin Cities

The document content analysis revealed that UMN did not have a GSI or stormwater master plan, and this finding was confirmed during the case study interviews. With that, the University's *Design Guidelines* document did feature a section on stormwater management, which identified various GSI-specific technologies as a part of landscaping and open space design considerations (Capital Planning and Project Management, 2019, p. 20). Although the University has not undertaken any major GSI-related planning efforts, such as establishing a master stormwater vision or plan, its engineering staff has been proactive in incorporating GSI considerations into its operational stormwater management programs.

There is no singular unit that oversees the administration of UMN's stormwater management programs and GSI initiatives, but these efforts are primarily led by University engineering, with more limited involvement from University planning. Both of these units are organized under University Services at UMN. Interviewee G stated that University leadership determines the overall direction for how UMN should value and approach stormwater management, but University engineering is responsible for determining the specific strategies that incorporate stormwater management considerations into campus development projects. These strategies are described in UMN's Division 33 Building Standards and BMP Summary Sheets. With respect to GSI, the University views it as an auxiliary aspect of broader stormwater management and water quality considerations.

The majority of GSI investments are incorporated as part of NPDES and University stormwater management requirements for new development and redevelopment projects.

Interviewee F noted that there had been times when GSI was included as part of state-level funding requests that are offered to Minnesota's land grant institutions, and they also noted their participation in developing standalone GSI projects that proposed using funding through Section 319 of the CWA. But overall, GSI is adopted on a project-by-project basis and is ultimately affiliated with efforts to achieve compliance with the University's Building Standards.

Interviewee G stated that there were no efforts on behalf of University operations staff to research the effects of GSI controls already existing on campus, so as with OSU, observed outcomes were not obtained. With that, all of the interviewees stated that there have been various decentralized, standalone efforts led by different University faculty to observe outcomes affiliated with GSI. Interviewees E and F also stated that UMN also offers student curriculum concerning the design, research, and monitoring of GSI-related controls, and Interviewee F mentioned how the findings from these initiatives have been used to inform the development of the University's NPDES MS4 permit program reporting documents.

As with OSU, all of the interviewees identified regulatory drivers as a primary reason for adopting GSI and pursuing more aggressive stormwater management practices in general. The most impactful driver was when the University became an NPDES MS4 permittee, but other state- and city-level programs, such as the state of Minnesota's B3 Guidelines, provided additional regulatory incentives. As stated by Interviewee G, within the context of sustainable stormwater management, UMN is more focused on meeting regulatory requirements as opposed to more visionary University stormwater objectives.

That said, all of the interviewees claimed that UMN has a strong value for natural resource stewardship. Interviewee G stated that UMN's position along the Mississippi River makes the need for environmental stewardship particularly significant. Interviewee F added that

the state of Minnesota as a whole has been forward on promoting water quality and responsible natural resource management, and they suggested that this mentality could be due to the fact that Minnesota has particularly notable quality natural resources. Interviewee E suggested that the greater environmental movement has caused people to shift their perspective from being more self-interested toward collective care and being concerned about their collective stake in the environment's well-being.

Interviewee F mentioned a particularly interesting point about how UMN has been exploring the social and cultural value of water as it relates to different community groups and internal and external University stakeholders, and they discussed how doing so increased the University's capacity to collaborate across different stakeholder groups. By being able to understand and effectively communicate the differences in how people view and value water, UMN was able to facilitate productive conversations that helped opposing viewpoints develop a shared understanding, and this further helped the University gain stakeholder support toward new stormwater management strategies, such as GSI.

Interviewee G mentioned how this stewardship mentality, combined with the autonomy that UMN has over campus development decisions, positions the University to be a leader in promoting stormwater management strategies that go beyond regulatory requirements. They also stated their belief that the University has a responsibility to educate the entire UMN community about sustainable stormwater management practices. Interviewee F also pointed out the need to go a step further by connecting with communities beyond the immediate University campus.

To leverage these opportunities, UMN has positioned collaboration as the focal point for its stormwater management efforts. For example, the University created a Stormwater Linkage Committee, which was intended to be a temporary group that would provide a starting point for

different University stakeholders to establish long-term working relationships. The University also has a Water Council, which acts as its more permanent hub to connect stormwater, GSI, and water resource professionals at the University. Both of these initiatives connect across different academic and operational units to increase internal stakeholder communication and foster a working environment conducive to collaboration, and according to Interviewee F, this has proven vital to the University's success in adopting GSI.

All of the interviewees also emphasized the important roles that communication and collaboration play when working with development project design teams, consultants, and contractors. UMN has had instances where a GSI project was not constructed correctly, so it has taken the initiative to improve communication during the initial planning and design phases of a project. Interviewee F discussed how the University makes sure to clearly articulate the purpose of each GSI project, explain how it fits into broader University goals and values, and set clear expectations of work to be done. They stated that doing this helps keep all project team members on track with the University's expectations and get all the details of a particular project correct, which is particularly important when working on less traditional projects that consultants and contractors might have less experience with, such as GSI.

Interviewee G discussed how all these efforts to improve internal and external communication would consequently improve the quality of the University's stormwater management program and NPDES MS4 permit performance, and Interviewee F expanded on this idea by stating an opportunity to align these efforts with other University and regional goals. They also discussed how they would like to see UMN communicate with other universities that have implemented GSI practices so that they can learn from each other and exchange knowledge and resources.

DISCUSSION & RECOMMENDATIONS

The findings from this study suggest that the universities included in the study sample do consider GSI in their campus planning and stormwater management programs, but there is significant room for growth in fully institutionalizing GSI into these efforts. However, the case study interviews also revealed that universities must work through administrative challenges and cultural barriers in order to be successful. Universities would benefit from developing GSI plans and management strategies that successfully communicate across a variety of stakeholders, and the document content analysis and case study interviews offer insight into how they can effectively approach this.

The majority of universities did not have a GSI-specific plan or documents with sections dedicated to GSI, but they did include GSI as part of their campus stormwater management programs. Additionally, they all considered stormwater management in general as part of campus master planning and capital project planning. It is clear that these universities do promote GSI and stormwater management in larger university planning and operations to some degree; there is, therefore, an opportunity for them to take this one step further by fully institutionalizing GSI considerations into these efforts. As explained by Interviewee G, treating GSI as a fundamental consideration from the onset would allow funding and maintenance to be appropriately reserved.

The findings from both the document content analysis and case study interviews identified capital project planning as being the most effective mechanism for adopting GSI. This is because capital projects are subject to stormwater management and water quality requirements, such as the post-construction runoff control requirements affiliated with the NPDES program (Garret, 2017). Standalone GSI projects are important, but special attention should be given to incorporating GSI as a component of other development projects. In this way, GSI would utilize the resources and professional insight that is already going into a project

without having to necessitate an entirely new project undertaking. Additionally, both of the two GSI-specific planning documents stated that it will be important to hire project design teams, consultants, and contractors who are knowledgeable about GSI and can ensure its successful implementation (University of Illinois Chicago, n.d.; University of Wisconsin Madison, 2015b).

The document content analysis and case study interviews also identified the need for capital project planning to consider GSI maintenance more seriously. The University of Illinois-Urbana-Champaign's *Resilient Landscape Strategy* document (Facilities & Services, 2019) and Interviewees A, B, and C all discussed how current financial systems do not appropriately plan for the long-term maintenance of GSI. Based on this insight, there should be a management plan outlining how maintenance responsibilities shall be delegated and carried out, as well as how staff should be trained so that they complete maintenance tasks correctly. There should also be strategies planned in advance that ensure there is appropriate equipment and long-term financing available to effectively maintain GSI.

Because GSI is site dependent, its performance varies based on the specific controls selected and the context in which they are being used. It will be important to develop a system that determines which GSI controls would be the most appropriate solution for a given development opportunity. All of the interviewees discussed how data collection specific to campus stormwater runoff, water quality, and GSI performance will have a role in helping inform this process; the document content analysis also identified a potential to incorporate this data as part of adaptive stormwater management efforts. As described in the *Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan* document, being able to identify and measure the impacts of GSI will allow university administrators weigh between the costs and benefits of different GSI controls across different development scenarios,

which will then help them decide on the best suited strategy (University of Illinois Chicago, n.d.).

Cross-professional collaboration will remain key to successfully adopting GSI because of the variety of people involved in its planning and design, construction, and maintenance. The case study interviews identified the need for universities to improve their communication with project design teams, consultants, and contractors in order to prevent mistakes with GSI implementation. Interviewee C described how there is a particular misalignment between planners (who operate at a high level of development) and designers and engineers (who operate at a site scale level); therefore, it will be especially important to bridge communication gaps between these stakeholders. Interviewees E and F pointed out that this could require some back-and-forth before all stakeholders are able to clearly understand each other.

This study also identified opportunities for universities to institutionalize GSI into their campus planning, with the document content analysis offering insight into the roles of different planning document types in fostering GSI-supportive environments. For example, stricter stormwater management and water quality standards would push project design teams to pursue more innovative stormwater management strategies like GSI. Campus master planning documents that prioritize GSI would seal its importance as a fundamental part of large-scale land use planning. Design guidelines and standards could be used to provide technical guidance on the specific design and construction of different GSI controls, while landscape plans could be used to develop clear plans for financing and maintaining GSI controls as they relate to campus landscaping operations. Finally, strategic plans–whether intended to provide overall university direction or a part of more specific university initiatives, such as sustainability or climate action

plans–could be used to promote an overarching university value for water and sustainable stormwater management.

Interviewees B, C, E, and F discussed how an inertia currently exists in favor of gray stormwater infrastructure. They explained that urban development has traditionally focused on removing stormwater as quickly as possible to prevent flooding, and over time, industry professionals have developed highly effective strategies to achieve this goal through gray infrastructure systems. GSI asks professionals to collect and hold stormwater at the source, which goes entirely against this former, more traditional school of thought. Based on this interview insight, it can be difficult for people to support GSI, let alone become properly trained on how to effectively plan for and install GSI controls, because it can be an unfamiliar stormwater management solution that does not have as many substantive precedents for success as gray infrastructure.

Additionally, Interviewees C and E identified how university administrators must balance the conflicting interests of dedicating land for GSI and preserving campus real estate for other productive uses. This challenge is particularly real for growing universities that have limited space availability. It is not as relevant for GSI controls that can be integrated into more developed land uses, such as green roofs and permeable pavement, but it may create barriers for GSI controls that require larger land areas, such as rain gardens and swales.

Although the document content analysis revealed that universities mainly consider GSI in relation to improving operational stormwater management and water quality, it also identified many other environmental, social, and educational benefits of GSI. GSI has value beyond stormwater management that is oftentimes overlooked in decision-making; the findings from Figure 2 could help universities identify opportunities where GSI could enhance or complement

other campus priorities so that it achieves multiple benefits at once. By aligning GSI's supplemental benefits with their unique university values, setting, and goals, universities can develop stronger arguments that justify the value of putting in extra effort to adopt GSI.

As described by the UMN interviewees, UMN's campus culture of water stewardship has helped the University adopt a more progressive attitude toward GSI. Adopting a similar mentality would also help university leadership go beyond their comfort zone with gray stormwater infrastructure and try out a more innovative GSI approach by providing a values-based incentive. Interviewee F added that individual champions who advocate for GSI will have important supporting roles, but this mentality needs to be intentionally supported by all university stakeholders to be effectively promoted.

Interviewee C also described the potential that stronger state-level incentives have to encourage more progressive adoption of GSI. With that, the findings from the document content analysis did not seem to suggest a relationship between the degree that universities had documents with references to GSI-related text and the degree that state-level NPDES MS4 permit program requirements had provisions that necessitated consideration of GSI. For example, the Individual Permits for both Iowa universities did not have any references to GSI, but the universities still included clear GSI considerations in their university stormwater management program policies. On the other hand, the Ohio state General Permit clearly referenced GSI as a potential strategy for managing post-construction stormwater runoff, yet neither of the universities from Ohio had a notably high proportion of documents that included at least one reference to GSI planning. State incentives will certainly have an important role in encouraging GSI adoption, but the need for universities to take the initiative for themselves cannot be understated.

Finally, as discussed by Pierce et al. (2021), universities are built upon students, so student engagement will be essential. University administrators should obtain student feedback to inform future sustainable stormwater management practices. Interviewee F also mentioned how this could go one step further to include the perspective of community members from the cities where the universities are located. As described by Interviewee E, there needs to be an established common language around GSI, as well as stormwater management in general, that can be understood by stakeholders beyond industry professionals–such as students, politicians, and local community residents–so that everyone has the ability to get involved in this topic.

Overall, universities must be open to the newness of GSI and willing to restructure their current administration and operations systems so that GSI controls can be implemented successfully. They will need to establish flexible methods for siting and maintaining GSI, and they will need to be adaptable if the implementation of a GSI project does not go exactly as planned. They should have well-established GSI values and goals to improve collaboration, communication, and agreement among internal and external stakeholders. They would also benefit from developing a structured approach that enables them to learn from their past successes and failures and the experiences of others. GSI offers a sustainable, innovative approach to stormwater management; universities have strong potential to adopt it successfully, but they need to be progressive leaders open to change.

Limitations & Future Research

Limited time, resources, and researcher experience created many limitations with this study. To begin, the data and documents used in this study may not be the most accurate or up-to-date representation of planning at a university. Data from both the 2021 CCIHE Update, the USGS National Map Download Viewer, and any of the databases or online tools that were

retrieved and used from the state agency websites as part of the NPDES MS4 permit program document collection process are all subject to change; the website information and search engines are also subject to change.

The document collection processes are subject to human error when scanning for relevant results, and they may have excluded documents that were not publicly available online. As shown in the OSU case study, the interview process identified plans that were not retrieved during the document collection process. Additionally, the document collection processes may have missed the most recent version of a university's documents altogether if they were published after the search time period of June-October. This study did not verify the active status of the collected documents, so this may have resulted in the inclusion of some outdated documents. Future studies could interview a contact from each of the universities included in the study sample to ensure all of a university's active plans are collected.

The document collection processes used private browsing, but it is unknown if the search queries were impacted by search engine algorithms, which would bias the returned results for subsequent search queries. The process of emailing university contacts may also be subject to bias, as the number of university contacts reached and the timeline for reaching out varied across universities. When creating text files of scanned image documents, some of the text from images and figures did not always convert during this process, and as a result, this would have caused the keyword search process to potentially miss relevant text. Additionally, the keyword search process in itself could have overlooked instances where a document did include text relevant to a search term but was not captured because it did not have similar wording as the keyword queries. For example, the term "harvesting" would not capture the existence of other words that would

nonetheless indicate the existence of this theme, such as “reuse” or “collection.” Study constraints prevented a more thorough keyword search process.

This study had one major transcription error with the keyword scoring process. Specifically, I transcribed the incorrect score for the University of Iowa, which then prevented it from being included in the study sample. Had the score been entered correctly, the University of Iowa would have taken the spot of Iowa State University for inclusion in the study sample. This error would affect the document content analysis by potentially changing the total number of coded text segments for each code category, as well as potentially affecting the relationship between code categories and document types. It would also likely impact the overall findings in Table 3 for the state of Iowa averages. However, this error and its predicted impacts are assumed to be unproblematic for the ultimate purpose of this study. This is because the keyword search process was intended to maximize the likelihood that universities in the study sample would actually include GSI-related text in their documents, so even though a lower scored university ended up being used in the study sample, it still provided important insight that helped develop a general baseline of understanding for this topic. Additionally, Iowa State University and the University of Iowa have a similar student enrollment and campus size, as well as a similar number of documents that would be used in the document content analysis.

One objective of this study was to identify observed outcomes of campus GSI projects. The interview responses determined that there were no centralized university efforts that would provide sufficient information to satisfy this objective, but they did identify leads to gather more specific information about observed outcomes for future studies. Learning more about the work of different university faculty could help identify common themes concerning actually observed outcomes, which could then be compared with those described in Figure 2.

In addition to investigating observed outcomes in greater depth, future studies could expand on this project by looking at additional universities in the Midwest. With respect to The Ohio State University in particular, there could be value in assessing the current state of GSI and stormwater management for the entire University system; this study could take inspiration from the work of Pierce et al. (2021). Future work could also be directed toward conducting a case study analysis of the University of Illinois-Chicago and the University of Wisconsin, as they both had GSI-specific plans. Because it was not included in the study sample, the University of Iowa could be investigated, as well. Finally, the case study interviews revealed other universities that interviewees believed were leaders in adopting GSI, so investigating these universities presents another research opportunity.

CONCLUSION

This study was an exploratory investigation of the degree to which public four-year universities in the Midwest incorporate GSI into campus planning and stormwater management programs. Sixteen universities, with two universities from each Midwestern state, were selected for a document content analysis that used data from university plans, policies, and NPDES MS4 permit program documents. Two case study analyses utilizing semi-structured interviews were then conducted to gain further insight into GSI efforts at The Ohio State University-Columbus campus and the University of Minnesota-Twin Cities campus.

The findings from this study will help university administrators identify strategies that could improve their ability to adopt GSI successfully. As campus planning and stormwater management efforts can be decentralized processes that engage a wide variety of internal and external stakeholders, the findings further offer insight into how university administrators can best communicate with project design teams, consultants, contractors, and the university

community as a whole. Institutionalizing GSI into all campus planning and development efforts, as well as making sure that all stages of GSI implementation are accounted for, will remain critical.

It is clear that higher education institutions must adapt their current stormwater infrastructure to accommodate anticipated changes in precipitation from climate change and maintain compliance with local, state, and federal stormwater management and water quality regulations. GSI offers a solution to address these concerns while simultaneously being able to achieve other environmental and institutional goals. It will be up to higher education institutions to take the initiative if they wish to incorporate GSI into their campus planning and stormwater management programs.

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APPENDIX A: Documents Used in the Content Analysis

University of Illinois-Chicago		
Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan	n.d.	GSI plan
The Public's University: Optimizing Impact for the Public Good the Strategic Framework for the University of Illinois System 2016-2026	May 2016	Strategic Plan (university system)
The University of Illinois at Chicago Strategic Priorities	n.d.	Strategic Plan
2010 UIC Campus Master Plan Phase 3 Report	November 2010	Physical master plan
UIC Master Plan Update: 2018 Implementation Plan	November 2018	Physical master plan
University of Illinois Chicago Building Standards	March 2022	Design standards & guidelines
University of Illinois at Chicago New Building Design Guidelines	2021	Design standards & guidelines
University of Illinois at Chicago Exterior Design Standards for Existing Building	November 2016	Design standards & guidelines
University of Illinois Chicago Campus Grounds Design Standards	2021	Design standards & guidelines
UIC Multimodal Transportation Plan	May 2015	Transportation plan
Tree Care Plan The University of Illinois at Chicago	2020	Landscape plan
Campus Pollinator Habitat Plan	n.d.	Landscape plan
UIC Climate Action Plan	September 2009	Climate Action Plan
UIC Climate Commitments Aspirational Goals and Short-Term Action Items	April 2016	Climate Action Plan
Climate Action Implementation Plan	January 2018	Climate Action Plan
Bird Collision Prevention Plan	April 2021	Other
University of Illinois-Urbana-Champaign		
General NPDES Permit for Discharges from Small Municipal Separate Storm Sewer Systems	February 2016	NPDES affiliated document
Stormwater Management Program 2021 Best Management Practices (BMPs)	2021	NPDES affiliated document
The Public's University: Optimizing Impact for the Public Good the Strategic Framework for the University of Illinois System 2016-2026	May 2016	Strategic Plan (university system)
The Next 150 2018-2023 Strategic Plan	n.d.	Strategic Plan
The Impact of Place: University of Illinois at Urbana-Champaign Campus Master Plan	August 2018	Physical master plan
Arboretum Master Plan University of Illinois at Urbana-Champaign	August 2021	Physical master plan
Research Park at the University of Illinois 2018 Master Plan Update	n.d.	Physical master plan
South Campus Master Plan Update	July 2001	Physical master plan
University of Illinois at Urbana-Champaign Facilities Standards	*multiple dates	Design standards & guidelines
Campus Wide Utilities Production and Distribution Master Plan UIUC Project No. – U11045	October 2015	Utilities plan

University of Illinois Facilities & Services Transportation Demand Management Plan 2019-2024	January 2020	Transportation plan
Campus Bicycle Network Master Plan	May 2014	Transportation plan
Resilient Landscape Strategy	November 2019	Landscape plan
Illinois Climate Action Plan 2020	2020	Climate Action Plan
Purdue University-Fort Wayne		
Municipal Separate Storm Sewer System General Permit (INR040000)	December 2021	NPDES affiliated document
Stormwater Quality Management Plan Part C: Program Implementation	June 2015	NPDES affiliated document
Empowering Transformation Strategic Plan 2020-25	n.d.	Strategic Plan
Campus Master Plan 2019 Plan	December 2020	Physical master plan
Purdue University-West Lafayette		
Municipal Separate Storm Sewer System General Permit (INR040000)	December 2021	NPDES affiliated document
Stormwater Quality Management Plan Part C: Program Implementation Update	November 2019	NPDES affiliated document
Purdue Moves (webpage information) • Freezing Tuition and Cutting Costs • Purdue Polytechnic High School • Income Share Agreements • Purdue Online • Purdue University Global • Engineering Preeminence at Scale • Transforming technology: Creating the Purdue Polytechnic Institute • Strengthening computer science • Drug Discovery • Plant Sciences • Life Sciences • Data Science Research • Changing the way Learning Occurs • International experiences • Living and learning • Year-round university • Degree in 3 • Data Science Education	*webpage info acquired on 09/23/2022	Strategic Plan
Giant Leaps Master Plan	2018	Physical master plan
Sustainable Landscape Plan West Lafayette Campus	April 2012	Landscape plan
2020 Physical Facilities Sustainability Master Plan (webpage information) • 2020 Physical Facilities Sustainability Master Plan • Energy • Water • Materials and Waste • Buildings • Grounds	*webpage info acquired on 09/23/2022	Sustainability strategic plan
Iowa State University		

Iowa Department of Natural Resources National Pollutant Discharge Elimination System (NPDES) Permit Iowa NPDES Permit Number: 85-03-0-04	February 2019	NPDES affiliated document
Iowa State University Storm Water Management Policy Statements	September 2004	NPDES affiliated document
Iowa State University 2022–2031 Strategic Plan	n.d.	Strategic Plan
Iowa State University Campus Master Plan	February 1992	Physical master plan
Facilities Design Manual	*multiple dates	Design standards & guidelines
Iowa State University Strategic Plan for Sustainability in Operations 2021-2025	October 2020	Sustainability strategic plan
Envisioning Excellence in Sustainability at Iowa State University	n.d.	Sustainability strategic plan
University of Northern Iowa		
Iowa Department of Natural Resources National Pollutant Discharge Elimination System (NPDES) Permit Iowa NPDES Permit Number: 07-09-0-04	September 2021	NPDES affiliated document
Post-Construction Site Runoff Control Policy Statement (webpage information)	*webpage info acquired on 08/14/2022	NPDES affiliated document
Post Construction & Re-pavement Site Plan Review Program Statement (webpage information)	*webpage info acquired on 08/14/2022	NPDES affiliated document
Repavement, Stormwater Repair Retrofit Evaluation Policy Statement (webpage information)	*webpage info acquired on 08/14/2022	NPDES affiliated document
Pollution Prevention Plan Statement (webpage information)	*webpage info acquired on 08/14/2022	NPDES affiliated document
University of Northern Iowa Vision, Mission, and Strategic Plan 2017-2022	n.d.	Strategic Plan
University of Northern Iowa Campus Master Plan 2017	December 2017	Physical master plan
University of Northern Iowa South Campus Design Guidelines	August 2001	Design standards & guidelines
Design Standards	*multiple dates	Design standards & guidelines
Michigan State University		
Authorization to Discharge Under the National Pollutant Discharge Elimination System Permit No. MI0059342	April 2015	NPDES affiliated document
Michigan State University Storm Water Management Program	April 2017	NPDES affiliated document
MSU 2030	September 2021	Strategic Plan
Michigan State University Campus Land Use Master Plan: Update 2017	February 2017	Physical master plan
Planning and Construction Standards	*multiple dates	Design standards & guidelines
Michigan State University Energy Transition Plan	January 2012	Utilities plan
MSU Mobility Plan	n.d.	Transportation plan
Western Michigan University		
Authorization to Discharge Under the National Pollutant Discharge Elimination System Permit No. MI0060092	August 2018	NPDES affiliated document

Western Michigan University Stormwater Management Program (SWMP) and Table 2. WMU Public Education Plan (PEP)	May 2018	NPDES affiliated document
The Gold Standard 2020	2016	Strategic Plan
Western Michigan University Campus Master Plan Technical Report	September 2002	Physical master plan
Western Michigan University Campus Master Plan Update 2008-09 Sustainability and Environmental Issues	n.d.	Physical master plan
Western Michigan University College of Engineering and Applied Sciences Campus Master Plan	February 2000	Physical master plan
Western Michigan University South Neighborhood Master Plan	2018	Physical master plan
WMU Design Guidelines	*multiple dates	Design standards & guidelines
Western Michigan University Business, Technology and Research Park Site Design Standards	April 2010	Design standards & guidelines
Western Michigan University Transportation Master Plan	December 2019	Transportation plan
Western Michigan University Parkview Campus Management Plan Kalamazoo, Michigan	December 2014	Landscape plan
Western Michigan University Woodlot Management Plan Kalamazoo, Michigan	July 2012	Landscape plan
University of Minnesota-Twin Cities		
Authorization to Discharge Stormwater Associated with Small Municipal Separate Storm Sewer Systems Under the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Program MNR040000	November 2020	NPDES affiliated document
MS4 Part 2 Permit Application Authorization to Discharge Stormwater Associated with Small Municipal Separate Storm Sewer System (MS4) Stormwater Pollution Prevention Program (SWPPP) Document for the University of Minnesota, Twin Cities	September 2020	NPDES affiliated document
BMP Summary Sheets	*multiple dates	NPDES affiliated document
Environmental Protection	July 2020	University policy
MPact 2025 Systemwide Strategic Plan	July 2020	Strategic Plan (university system)
University of Minnesota Twin Cities Campus Plan Update	December 2021	Physical master plan
Minneapolis Campus Development Framework	February 2016	Physical master plan
University of Minnesota St. Paul Campus Strategic Facilities Plan	2019	Physical master plan
University of Minnesota AHC Strategic Facilities Master Plan Phase One Report	February 2015	Physical master plan
Building Standards	*multiple dates	Design standards & guidelines
University of Minnesota Design Guidelines	December 2019	Design standards & guidelines
University of Minnesota 2019 Bicycle Plan	n.d.	Transportation plan
Climate Action Plan for the University of Minnesota, Twin Cities Version 1.1	December 2011	Climate Action Plan
University of Minnesota-Duluth		
Authorization to Discharge Stormwater Associated with Small Municipal Separate Storm Sewer Systems Under the	November 2020	NPDES affiliated document

National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Program MNR040000		
MS4 Part 2 Permit Application Authorization to Discharge Stormwater Associated with Small Municipal Separate Storm Sewer System (MS4) Stormwater Pollution Prevention Program (SWPPP) Document for the U of M Duluth MS4	September 2020	NPDES affiliated document
BMP Summary Sheets	*multiple dates	NPDES affiliated document
Environmental Protection	July 2020	University policy
MPact 2025: Systemwide Strategic Plan	July 2020	Strategic Plan (university system)
University of Minnesota Duluth Campus Master Plan Update	2013	Physical master plan
Building Standards	*multiple dates	Design standards & guidelines
University of Minnesota Design Guidelines	December 2019	Design standards & guidelines
University of Minnesota Duluth Energy Action Plan - Version 2.0	June 2011	Climate Action Plan
Missouri State University-Springfield		
Missouri State Operating Permit MO-R04C000	October 2021	NPDES affiliated document
Long-Range Plan 2021-26: Embracing the Entrepreneurial Spirit (webpage information) • Long-Range Plan Introduction • Evolving Academic Directions for Future Careers • Fueling Partnerships Through Innovation and Collaboration • Professional Doctorate Offers Academic and Professional Benefits • Preparing Citizen Bears for the World • Lifelong Student Subscription Eases Career Change • Skill Up or Re-Skill: Academic Credentials Answer the Call • Focused Hiring Practice Launches New Program • Global Engagement • After Years of Growth, International Student Enrollment Leveled Off, Then Dropped • Faculty Research Collaboration on a Global Level • International Students Enrich Colleges' Cultures and Budgets • Global Engagement Through the International Student Experience • International Experiences Help With Employment, Personal Growth • U.S. Student's Career Came Into Focus Through International Experience • Inclusive Excellence Driving University Success • Advance Findings of Campus Climate Study • Campus Culture Transforms Perspectives • Rising Generation Brings Increased Challenges • Investing in Resources • Community Leadership and Partnerships • Preparing Citizen Bears For The World	*webpage info acquired on 09/30/2022	Strategic Plan

• efactory and IDEA Commons Create Inviting Environment For Young Professionals • Fueling Partnerships Through Innovation and Collaboration • Service-Learning Inspires Student to Pursue Medical Degree • The Primary Responsibilities of MSU Faculty are Teaching, Research and Service • Arts Scholls Allows Student To Pursue Passion		
College of Natural and Applied Sciences Master Plan	September 2020	Physical master plan
Design Standards	*multiple dates	Design standards & guidelines
Sustainability Guidelines for Construction Projects	February 2018	Design standards & guidelines
University of Missouri-Columbia		
Missouri State Operating Permit MO-0136557	July 2020	NPDES affiliated document
Joint Stormwater Management Program: MS4 Permit #MO-0136557	March 2022	NPDES affiliated document
University of Missouri 2015 Stormwater Master Plan	August 2015	Stormwater master plan
University of Missouri System Strategic Priorities (webpage information)	August 2019	Strategic Plan (university system)
University for Missouri: The Flagship of the Future	September 2018	Strategic Plan
Consultant Procedures and Design Guidelines Manual	*multiple dates	Design standards & guidelines
University of Missouri Design Principles	September 2017	Design standards & guidelines
MU Sustainability Policy (webpage information)	March 2010	Sustainability strategic plan
The Ohio State University-Columbus		
Authorization for Small Municipal Separate Storm Sewer Systems to Discharge Storm Water Under the National Pollutant Discharge Elimination System	April 2021	NPDES affiliated document
Stormwater Management Plan The Ohio State University Columbus Campus	February 2022	NPDES affiliated document
Stormwater Master Plan	June 2020	Stormwater master plan
Ohio State's Strategic Plan Time and Change	n.d.	Strategic Plan
The Ohio State University Framework 2.0	January 2017	Physical master plan
Building Design Standards for Architects and Engineers	July 2022	Design standards & guidelines
Design Guidelines for Buildings and Landscape	February 2016	Design standards & guidelines
Ohio State Sustainability Goals	February 2021	Sustainability strategic plan
Path to Carbon Neutrality: Ohio State Climate Action Plan	April 2020	Climate Action Plan
The University of Toledo		
Authorization for Small Municipal Separate Storm Sewer Systems to Discharge Storm Water Under the National Pollutant Discharge Elimination System	April 2021	NPDES affiliated document
Storm Water Management Program (SWMP) Procedure No: HM-08-041	October 2016	NPDES affiliated document
Energy Management and Sustainability	February 2019	University policy
The University of Toledo's Path to Excellence: Strategic Plan 2017-2022	n.d.	Strategic Plan
Multiple-Campus Master Plan Executive Summary	February 2017	Physical master plan

The University of Toledo Construction Design Standards Manual	September 2020	Design standards & guidelines
University of Toledo Department of Construction Resources Standard Conditions of Contract for Construction Building Standards	August 2006	Design standards & guidelines
Sustainability Strategic Plan	n.d.	Sustainability strategic plan
University of Wisconsin-Madison		
Individual Permit to Discharge Under the Wisconsin Pollutant Discharge Elimination System WPDES Permit No. WI-S058416-4	July 2019	NPDES affiliated document
Stormwater Management Plan Campus – 2022 (Rev. 1)	2022	NPDES affiliated document
Green Infrastructure & Stormwater Management Master Plan	2015	GSI plan
UW–Madison Strategic Framework 2020–2025	n.d.	Strategic Plan
Campus Master Plan Technical Document	2015	Physical master plan
Guidelines for Planning and Design of UW Madison Facilities	April 2019	Design standards & guidelines
Campus Design Guidelines & Standards An Approach to a Pleasing Composition	August 2017	Design standards & guidelines
Utility Master Plan	2015	Utilities plan
Long Range Transportation Plan	2015	Transportation plan
Landscape Master Plan	2015	Landscape plan
University of Wisconsin-Green Bay		
General Permit to Discharge Under the Wisconsin Pollutant Discharge Elimination System WPDES Permit No. WI-S050075-3	February 2022	NPDES affiliated document
University of Wisconsin Green Bay Stormwater Management Plan	April 2006	NPDES affiliated document
University of Wisconsin – Green Bay Public Education & Outreach Program	December 2008	NPDES affiliated document
University of Wisconsin -Green Bay Stormwater Pollution Prevention Program	September 2009	NPDES affiliated document
Civil Design Guidelines	n.d.	Design standards & guidelines
Climate Action Plan	December 2013	Climate Action Plan

APPENDIX B: Case Study Analyses Interview Questions

1) Please give a short statement about how long you have been working here and your primary job responsibilities.

2) Aside from [Document(s) Name], do you know if [University Name] currently uses any other formally adopted campus plans or operating documents that clearly identify green infrastructure as a strategy for stormwater management?

3) To my understanding, X, Y, and Z etc. seem to have been the primary factors that incentivized [University Name]'s investments in green stormwater infrastructure. From your perspective, how else have discussions of utilizing green infrastructure for stormwater management arisen?

4) What strategies has [University Name] used to obtain the financial resources, administrative support, and buy-in from university leadership needed to successfully adopt green stormwater infrastructure?

5) To my understanding, [University Name] uses X, Y, and Z etc. to measure the effects of green stormwater infrastructure. Are you aware of any additional monitoring or performance measures that the university uses to track the effects of green stormwater infrastructure, especially as they relate to effects on students and/or campus culture?

6) While working at [University Name], have you been made aware of any financial, administrative, or public engagement challenges or barriers for adopting green stormwater infrastructure?

7) Is there anything else you think is important to provide context for the actions that [University Name] has taken to incorporate green infrastructure as a solution for stormwater management?

8) Is there anyone else at [University Name] who you believe would provide additional insight about green stormwater infrastructure?

APPENDIX C: Filtering the CCIHE Database for the Study Sample

Filtering for Public Four-Year Midwestern Universities		
Name	**City**	**State**
Chicago State University	Chicago	IL
Northeastern Illinois University	Chicago	IL
Southern Illinois University-Carbondale	Carbondale	IL
University of Illinois-Chicago	Chicago	IL
University of Illinois-Springfield	Springfield	IL
University of Illinois Urbana-Champaign	Champaign	IL
Ball State University	Muncie	IN
Indiana State University	Terre Haute	IN
Indiana University-Bloomington	Bloomington	IN
Indiana University-Kokomo	Kokomo	IN
Indiana University-Northwest	Gary	IN
Indiana University-Purdue University-Indianapolis	Indianapolis	IN
Indiana University-South Bend	South Bend	IN
Purdue University-Fort Wayne	Fort Wayne	IN
Purdue University-West Lafayette	West Lafayette	IN
Iowa State University	Ames	IA
University of Iowa	Iowa City	IA
University of Northern Iowa	Cedar Falls	IA
Michigan State University	East Lansing	MI
University of Michigan-Ann Arbor	Ann Arbor	MI
University of Michigan-Dearborn	Dearborn	MI
University of Michigan-Flint	Flint	MI
Wayne State University	Detroit	MI
Western Michigan University	Kalamazoo	MI
Metropolitan State University	Saint Paul	MN
Minnesota State University-Mankato	Mankato	MN
Saint Cloud State University	Saint Cloud	MN
University of Minnesota-Duluth	Duluth	MN
University of Minnesota-Rochester	Rochester	MN
University of Minnesota-Twin Cities	Minneapolis	MN
Harris-Stowe State University	Saint Louis	MO
Lincoln University	Jefferson City	MO
Missouri Southern State University	Joplin	MO
Missouri State University-Springfield	Springfield	MO
Missouri Western State University	Saint Joseph	MO
Southeast Missouri State University	Cape Girardeau	MO
University of Missouri-Columbia	Columbia	MO
University of Missouri-Kansas City	Kansas City	MO
Cleveland State University	Cleveland	OH
The Ohio State University-Columbus	Columbus	OH
University of Akron-Main Campus	Akron	OH
University of Cincinnati-Main Campus	Cincinnati	OH
University of Toledo	Toledo	OH

Youngstown State University	Youngstown	OH
University of Wisconsin-Eau Claire	Eau Claire	WI
University of Wisconsin-Green Bay	Green Bay	WI
University of Wisconsin-La Crosse	La Crosse	WI
University of Wisconsin-Madison	Madison	WI
University of Wisconsin-Milwaukee	Milwaukee	WI
University of Wisconsin-Oshkosh	Oshkosh	WI

Filtering for Universities with a GSI-Specific Plan, Stormwater Master Plan, or NPDES MS4 Permit Program Documentation Specific to Post-Construction Stormwater Runoff Control

Name	City	State
University of Illinois-Chicago	Chicago	IL
University of Illinois Urbana-Champaign	Champaign	IL
Indiana State University	Terre Haute	IN
Purdue University-Fort Wayne	Fort Wayne	IN
Purdue University-West Lafayette	West Lafayette	IN
Iowa State University	Ames	IA
University of Iowa	Iowa City	IA
University of Northern Iowa	Cedar Falls	IA
Michigan State University	East Lansing	MI
University of Michigan-Ann Arbor	Ann Arbor	MI
University of Michigan-Dearborn	Dearborn	MI
University of Michigan-Flint	Flint	MI
Western Michigan University	Kalamazoo	MI
Metropolitan State University	Saint Paul	MN
Minnesota State University-Mankato	Mankato	MN
Saint Cloud State University	Saint Cloud	MN
University of Minnesota-Duluth	Duluth	MN
University of Minnesota-Twin Cities	Minneapolis	MN
Missouri State University-Springfield	Springfield	MO
Southeast Missouri State University	Cape Girardeau	MO
University of Missouri-Columbia	Columbia	MO
The Ohio State University-Columbus	Columbus	OH
University of Toledo	Toledo	OH
University of Wisconsin-Green Bay	Green Bay	WI
University of Wisconsin-La Crosse	La Crosse	WI
University of Wisconsin-Madison	Madison	WI

APPENDIX D: Search Terms Used in the Campus Planning Document Collection Process

ID	Search Term	Reason for Inclusion and Exclusion Criteria
1	strategic plan	Dalton & Davis (2018) describe strategic planning as a fundamental long-range planning strategy guiding the overall mission and investment agenda for higher education institutions. The importance of the strategic plan is also supported by Albright (n.d.). *Exclusion Criteria:* Plans had to apply to the entirety of campus. Strategic plans adopted by a specific university Office, Department, or School were not considered.
2	campus master plan	Dalton & Davis (2018) identify the campus master plan as the most common label used to describe a physical master plan. They define physical master plans as plans that provide the highest level of guidance directing the physical development and management of higher education institution campuses.
3	development plan	Dalton & Davis (2018) note that a physical master plan can also be labeled as a "physical development plan" or "long-range development plan." Because of this, "development plan" was added to the list. *Exclusion Criteria:* Plans related to this search query had to be some variant of a physical master plan. Development plans unrelated to physical grounds development (e.g., career development plans) were not considered.
4	facilities plan	Dalton & Davis (2018) note that a physical master plan can also be labeled as a "facilities master plan" or "master facilities plan." This type of planning document is also supported by Tysseling & Boyce (n.d.). Because of this, "facilities plan" was added to the list.
5	utilities plan	Dalton & Davis (2018) identify utility plans as a more specific type of high-level plan commonly adopted by higher education institutions. This type of planning document is also supported by Tysseling & Boyce (n.d.). Because of this, "utilities plan" was added to the list.
6a 6b	implementation strategy implementation program	Dalton & Davis (2018) identify implementation strategies and programs as the mechanism for moving forward with the vision outlined in the campus master plan, as well as other physical master plans. Because of this, "implementation strategy" and "implementation program" were added to the list. They were used as two separate search queries. *Exclusion Criteria:* These had to be specific to the implementation of the strategic plan or any of the physical master plans. Implementation strategies/programs for other programmatic plans were not considered.
7	long-range plan	Dalton & Davis (2018) explain the importance of long-range plans, which are derived from the strategic and physical master planning documents. Each higher education institution will have its own definition of long-range planning, so the long-range plan may be found under different names. Because of this, "long-range plan" was added to the list as a catch-all term to increase the likelihood of accessing relevant results.
8a 8b	design guidelines design standards	Design documents provide the technical standards for building and grounds design, operations, and maintenance. These documents were

8c	design manual	desirable because they would potentially provide technical information about specific GSI technologies and practices. “design guidelines,” “design standards,” and “design manual” were used as three separate search queries. *Exclusion Criteria:* These had to be created by the university under review. Design standards created by state departments, municipalities, or other outside parties were not considered.
9	landscape plan	Dalton & Davis (2018) identify landscape plans as a more specific type of high-level plan commonly adopted by higher education institutions.
10	climate action plan	Since many municipalities have also adopted climate action-related agendas (White, 2014), I also decided to expand my search criteria to include climate action plans. *Exclusion Criteria:* These had to be formally adopted climate goals or plans. Committee “Recommendations” or “Charges” were not considered.
11	sustainability goals	After having explored the websites of the higher education institutions, I noticed that some of them had adopted sustainability-related goals. Therefore, I expanded my search criteria to include “sustainability goals”. This is also in line with findings on university sustainability planning by Orenstein et al. (2019), where they find that successful sustainability plans and policies often align with clearly identified sustainability goals. *Exclusion Criteria:* These had to be formally adopted sustainability goals or plans. Committee “Recommendations” or “Charges” were not considered.
12	green stormwater infrastructure plan	This search query was used to provide a more targeted search for campus plans that focus specifically on GSI.
13	green infrastructure plan	The U.S. EPA (2022) commonly uses the term “green infrastructure” to describe GSI. Because of this, “green infrastructure plan” was added to the list to increase the likelihood of accessing relevant results.
14a 14b	stormwater plan storm water plan	The original intent of this search query was to find campus master plans related to stormwater management.
15	water plan	This was added to the list as a “catch-all” term to increase the likelihood of accessing relevant results.

References

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APPENDIX E: Search Results for Determining NPDES MS4 Permit Program Coverage

State	Search Process Findings	Prompt Responses[1]
Illinois	The Illinois Environmental Protection Agency's IEPA Document Explorer was used to find information about the Illinois universities being considered for inclusion in the study sample. The word "university" was searched in the "Name" search field, and all other search fields were left blank.	Prompt A: No • No information for all universities Prompt B: No
Indiana	A webpage from the Indiana Department of Environmental Management was found that provided an Excel sheet of the state issued MS4 permits. The Excel file was downloaded on June 22, 2022.	Prompt A: No • No information for IUPUI Prompt B: No
Iowa	The Iowa Department of Natural Resources Wastewater Permit Information Exchange (WWPIE) system was used to find information about the Indiana universities being considered for inclusion in the study sample. The university name was searched in the "Facility Name" search field, and all other search fields were left blank.	Prompt A: Yes Prompt B: Yes
Michigan	A webpage from the Michigan Department of Environment, Great Lakes, and Energy, Water Resources Division was found that provided an Excel sheet of the state issued MS4 permits. The Excel file was downloaded on September 18, 2022.	Prompt A: No • No information for Wayne State University Prompt B: No
Minnesota	The Minnesota Pollution Control Agency MS4 Mapping Tool was used to find information about the Minnesota universities being considered for inclusion in the study sample. The institution name was searched in the "MS4 permit number or city" search bar.	Prompt A: No • No information for the University of Minnesota-Rochester Prompt B: No
Missouri	The Missouri Department of Natural Resources Clean Water Information System was used to find information about the Missouri universities being considered for inclusion in the study sample. The word "university" was searched in the "Facility Name:" search field, and all other search fields were left blank.	Prompt A: No • No information for all universities Prompt B: No
Ohio	A webpage from the Ohio Environmental Protection Agency was found that provided two Excel sheets of the state issued MS4 permits. The Excel file with a listing of the state's permittees was downloaded on June 20, 2022, and the Excel file with a listing of the state's co-permittees was downloaded on September 18, 2022.	Prompt A: No • No information for all universities Prompt B: No
Wisconsin	A webpage from the Wisconsin Department of Natural Resources was found that provided an Excel sheet of the state issued MS4 permits. The Excel file was downloaded on May 1, 2022.	Prompt A: Yes Prompt B: No

[1] Prompt Responses:

A. Were all the universities under being considered for inclusion in the study sample included in the database?
B. Were electronic copies of the NPDES MS4 permit available to download?

APPENDIX F: Search Terms Used in the NPDES MS4 Permit Program Document Collection Process

Chicago State University		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "chicago state university" • "noi" AND "chicago state university" • "storm water management program" AND "chicago state university" • "stormwater management program" AND "chicago state university" • "SWMP" AND "chicago state university"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "storm water management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*"	• "notice of intent" AND "storm*" AND "chicago state university" • "noi" AND "storm*" AND "chicago state university" • "storm water management program" AND "chicago state university" • "stormwater management program" AND "chicago state university" • "SWMP" AND "chicago state university" • ("best management practice*" OR "BMP*") AND "storm*" AND "chicago state university"
Northeastern Illinois University		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "northeastern illinois university" • "noi" AND "northeastern illinois university" • "storm water management program" AND "northeastern illinois university" • "stormwater management program" AND "northeastern illinois university" • "SWMP" AND "northeastern illinois university"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "notice of intent" AND "storm*" AND "northeastern illinois university" • "noi" AND "storm*" AND "northeastern illinois university" • "storm water management program" AND "northeastern illinois university" • "stormwater management program" AND "northeastern illinois university" • "SWMP" AND "northeastern illinois university" • ("best management practice*" OR "BMP*") AND "storm*" AND "northeastern illinois university"
Southern Illinois University-Carbondale		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "southern illinois university carbondale" • "noi" AND "southern illinois university carbondale"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program"	• "notice of intent" AND "storm*" AND "southern illinois university carbondale" • "noi" AND "storm*" AND "southern illinois university carbondale"

• "storm water management program" AND "southern illinois university carbondale" • "stormwater management program" AND "southern illinois university carbondale" • "SWMP" AND "southern illinois university carbondale"	• "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*"	• "storm water management program" AND "southern illinois university carbondale" • "stormwater management program" AND "southern illinois university carbondale" • "SWMP" AND "southern illinois university carbondale" • ("best management practice*" OR "BMP*") AND "storm*" AND "southern illinois university carbondale"
University of Illinois-Chicago		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of illinois chicago" • "noi" AND "university of illinois chicago" • "storm water management program" AND "university of illinois chicago" • "stormwater management program" AND "university of illinois chicago" • "SWMP" AND "university of illinois chicago"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*"	• "notice of intent" AND "storm*" AND "university of illinois chicago" • "noi" AND "storm*" AND "university of illinois chicago" • "storm water management program" AND "university of illinois chicago" • "stormwater management program" AND "university of illinois chicago" • "SWMP" AND "university of illinois chicago" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of illinois chicago"
University of Illinois-Springfield		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of illinois springfield" • "noi" AND "university of illinois springfield" • "storm water management program" AND "university of illinois springfield" • "stormwater management program" AND "university of illinois springfield" • "SWMP" AND "university of illinois springfield"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "notice of intent" AND "storm*" AND "university of illinois springfield" • "noi" AND "storm*" AND "university of illinois springfield" • "storm water management program" AND "university of illinois springfield" • "stormwater management program" AND "university of illinois springfield" • "SWMP" AND "university of illinois springfield" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of illinois springfield"

University of Illinois-Urbana-Champaign		
Illinois Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of illinois urbana champaign" • "noi" AND "university of illinois urbana champaign" • "storm water management program" AND "university of illinois urbana champaign" • "stormwater management program" AND "university of illinois urbana champaign" • "SWMP" AND "university of illinois urbana champaign" *Additional searches*[1] • "university of illinois at urbana champaign" AND "ILR400523" • "ILR400523"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*" • "minimum control measure*" OR "mcm*" *Additional searches*[1] • "ILR400523"	• "notice of intent" AND "storm*" AND "university of illinois urbana champaign" • "noi" AND "storm*" AND "university of illinois urbana champaign" • "storm water management program" AND "university of illinois urbana champaign" • "stormwater management program" AND "university of illinois urbana champaign" • "SWMP" AND "university of illinois urbana champaign" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of illinois urbana champaign" *Additional searches*[1] • "ILR400523" • "university of illinois at urbana champaign" AND "ILR400523"
Ball State University		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040084" • "ball state university" AND "INR040084" • "stormwater quality management program" AND "ball state university" • "storm water quality management program" AND "ball state university" • "SWQMP" AND "ball state university" • "notice of intent" AND "ball state university" • "noi" AND "ball state university"	• "INR040084" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "ball state university" AND "INR040084" • "INR040084" • "stormwater quality management program" AND "ball state university" • "storm water quality management program" AND "ball state university" • "SWQMP" AND "ball state university" • "notice of intent" AND "storm*" AND "ball state university" • "noi" AND "storm*" AND "ball state university"
Indiana State University		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040092" • "indiana state university" AND "INR040092"	• "INR040092" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan"	• "indiana state university" AND "INR040092" • "INR040092"

• "stormwater quality management program" AND "indiana state university" • "storm water quality management program" AND "indiana state university" • "SWQMP" AND "indiana state university" • "notice of intent" AND "indiana state university" • "noi" AND "indiana state university"	• "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*"	• "stormwater quality management program" AND "indiana state university" • "storm water quality management program" AND "indiana state university" • "SWQMP" AND "indiana state university" • "notice of intent" AND "storm*" AND "indiana state university" • "noi" AND "storm*" AND "indiana state university"
Indiana University-Bloomington		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040123" • "indiana university bloomington" AND "INR040123" • "stormwater quality management program" AND "indiana university bloomington" • "storm water quality management program" AND "indiana university bloomington" • "SWQMP" AND "indiana university bloomington" • "notice of intent" AND "indiana university bloomington" • "noi" AND "indiana university bloomington"	• "INR040123" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "indiana university bloomington" AND "INR040123" • "INR040123" • "stormwater quality management program" AND "indiana university bloomington" • "storm water quality management program" AND "indiana university bloomington" • "SWQMP" AND "indiana university bloomington" • "notice of intent" AND "storm*" AND "indiana university bloomington" • "noi" AND "storm*" AND "indiana university bloomington"
Indiana University-Kokomo		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040148" • "indiana university kokomo" AND "INR040148" • "stormwater quality management program" AND "indiana university kokomo" • "storm water quality management program" AND "indiana university kokomo" • "SWQMP" AND "indiana university kokomo" • "notice of intent" AND "indiana university kokomo" • "noi" AND "indiana university kokomo"	• "INR040148" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*"	• "indiana university kokomo" AND "INR040148" • "INR040148" • "stormwater quality management program" AND "indiana university kokomo" • "storm water quality management program" AND "indiana university kokomo" • "SWQMP" AND "indiana university kokomo" • "notice of intent" AND "storm*" AND "indiana university kokomo" • "noi" AND "storm*" AND "indiana university kokomo"
Indiana University-Northwest		

Indiana Department of Environmental Management website	*Main university website*	*Startpage search engine*
• "INR040145" • "indiana university northwest" AND "INR040145" • "stormwater quality management program" AND "indiana university northwest" • "storm water quality management program" AND "indiana university northwest" • "SWQMP" AND "indiana university northwest" • "notice of intent" AND "indiana university northwest" • "noi" AND "indiana university northwest"	• "INR040145" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "indiana university northwest" AND "INR040145" • "INR040145" • "stormwater quality management program" AND "indiana university northwest" • "storm water quality management program" AND "indiana university northwest" • "SWQMP" AND "indiana university northwest" • "notice of intent" AND "storm*" AND "indiana university northwest" • "noi" AND "storm*" AND "indiana university northwest"
Indiana University-Purdue University-Indianapolis		
Indiana Department of Environmental Management website	*Main university website*	*Startpage search engine*
• "notice of intent" AND "indiana university purdue university indianapolis" • "notice of intent" AND "iupui" • "noi" AND "indiana university purdue university indianapolis" • "noi" AND "iupui" • "stormwater quality management plan" AND "indiana university purdue university indianapolis" • "stormwater quality management plan" AND "iupui" • "storm water quality management plan" AND "indiana university purdue university indianapolis" • "storm water quality management plan" AND "iupui" • "SWQMP" AND "indiana university purdue university indianapolis" • "SWQMP" AND "iupui"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "notice of intent" AND "storm*" AND "indiana university purdue university indianapolis" • "notice of intent" AND "storm*" AND "iupui" • "noi" AND "storm*" AND "indiana university purdue university indianapolis" • "noi" AND "storm*" AND "iupui" • "stormwater quality management plan" AND "indiana university purdue university indianapolis" • "stormwater quality management plan" AND "iupui" • "storm water quality management program" AND "indiana university purdue university indianapolis" • "storm water quality management program" AND "iupui" • "SWQMP" AND "indiana university purdue university indianapolis" • "SWQMP" AND "iupui"
Indiana University-South Bend		
Indiana Department of Environmental Management website	*Main university website*	*Startpage search engine*
• "INR040146" • "indiana university south bend" AND "INR040146"	• "INR040146" • "notice of intent" AND "storm*" • "noi" AND "storm*"	• "indiana university south bend" AND "INR040146" • "INR040146"

• "stormwater quality management program" AND "indiana university south bend" • "storm water quality management program" AND "indiana university south bend" • "SWQMP" AND "indiana university south bend" • "notice of intent" AND "indiana university south bend" • "noi" AND "indiana university south bend"	• "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*"	• "stormwater quality management program" AND "indiana university south bend" • "storm water quality management program" AND "indiana university south bend" • "SWQMP" AND "indiana university south bend" • "notice of intent" AND "storm*" AND "indiana university south bend" • "noi" AND "storm*" AND "indiana university south bend"
Purdue University-Fort Wayne		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040029" • "purdue university fort wayne" AND "INR040029" • "stormwater quality management program" AND "purdue university fort wayne" • "storm water quality management program" AND "purdue university fort wayne" • "SWQMP" AND "purdue university fort wayne" • "notice of intent" AND "purdue university fort wayne" • "noi" AND "purdue university fort wayne"	• "INR040029" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "purdue university fort wayne" AND "INR040029" • "INR040029" • "stormwater quality management program" AND "purdue university fort wayne" • "storm water quality management program" AND "purdue university fort wayne" • "SWQMP" AND "purdue university fort wayne" • "notice of intent" AND "storm*" AND "purdue university fort wayne" • "noi" AND "storm*" AND "purdue university fort wayne"
Purdue University-West Lafayette		
Indiana Department of Environmental Management website	***Main university website***	***Startpage search engine***
• "INR040129" • "purdue university main campus" AND "INR040129" • "purdue university west lafayette" AND "INR040129" • "purdue university" AND "INR040129" • "notice of intent" AND "purdue university main campus" • "notice of intent" AND "purdue university west lafayette" • "notice of intent" AND "purdue university" • "noi" AND "purdue university main campus" • "noi" AND "purdue university west lafayette" • "noi" AND "purdue university"	• "INR040129" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "stormwater quality management plan" • "storm water quality management plan" • "SWQMP" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• "purdue university main campus" AND "INR040129" • "purdue university west lafayette" AND "INR040129" • "purdue university" AND "INR040129" • "INR040129" • "stormwater quality management program" AND "purdue university main campus" • "stormwater quality management program" AND "purdue university west lafayette" • "stormwater quality management program" AND "purdue university"

• "stormwater quality management plan" AND "purdue university main campus" • "stormwater quality management plan" AND "purdue university west lafayette" • "stormwater quality management plan" AND "purdue university" • "storm water quality management plan" AND "purdue university main campus" • "storm water quality management plan" AND "purdue university west lafayette" • "storm water quality management plan" AND "purdue university" • "SWQMP" AND "purdue university main campus" • "SWQMP" AND "purdue university west lafayette" • "SWQMP" AND "purdue university"		• "storm water quality management program" AND "purdue university main campus" • "storm water quality management program" AND "purdue university west lafayette" • "storm water quality management program" AND "purdue university" • "SWQMP" AND "purdue university main campus" • "SWQMP" AND "purdue university west lafayette" • "SWQMP" AND "purdue university" • "notice of intent" AND "storm*" AND "purdue university main campus" • "notice of intent" AND "storm*" AND "purdue university west lafayette" • "notice of intent" AND "storm*" AND "purdue university" • "noi" AND "storm*" AND "purdue university main campus" • "noi" AND "storm*" AND "purdue university west lafayette" • "noi" AND "storm*" AND "purdue university"
Iowa State University		
Iowa Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "construction site runoff control policy statement" AND “iowa state university” • "best management practice*" AND “iowa state university” • "bmp*" AND “iowa state university”	• "construction site runoff control policy statement" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "construction site runoff control policy statement" AND “iowa state university” • "best management practice*" AND “iowa state university” • "bmp*" AND “iowa state university”
University of Iowa		
Iowa Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "construction site runoff control policy statement" AND “university of iowa” • "best management practice*" AND “university of iowa” • "bmp*" AND “university of iowa”	• "post-construction runoff control policy statement" • "post construction runoff control policy statement" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "construction site runoff control policy statement" AND “university of iowa” • "best management practice*" AND “university of iowa” • "bmp*" AND “university of iowa”

University of Northern Iowa		
Iowa Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "construction site runoff control policy statement" AND "university of northern iowa" • "best management practice*" AND "university of northern iowa" • "bmp*" AND "university of northern iowa"	• "post - construction runoff control policy statement" • "post construction runoff control policy statement" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "construction site runoff control policy statement" AND "university of northern iowa" • "best management practice*" AND "university of northern iowa" • "bmp*" AND "university of northern iowa"
Michigan State University		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "michigan state university" • "stormwater management program" AND "michigan state university" • "storm water management plan" AND "michigan state university" • "stormwater management plan" AND "michigan state university" • "notice of intent" AND "michigan state university" • "noi" AND "michigan state university" • "certificate of coverage" AND "michigan state university" • "coc" AND "michigan state university"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • ("certificate of coverage" OR "coc") AND ("storm*) • "best management practice*" OR "bmp*" • ("best management practice*" OR "BMP*") AND "storm*"	• "storm water management program" AND "michigan state university" • "stormwater management program" AND "michigan state university" • "storm water management plan" AND "michigan state university" • "stormwater management plan" AND "michigan state university" • "notice of intent" AND "storm*" AND "michigan state university" • "noi" AND "storm*" AND "michigan state university" • "certificate of coverage" AND "michigan state university" • "coc" AND "michigan state university"
University of Michigan-Ann Arbor		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of michigan ann arbor" • "stormwater management program" AND "university of michigan ann arbor" • "storm water management plan" AND "university of michigan ann arbor" • "stormwater management plan" AND "university of michigan ann arbor" • "notice of intent" AND "university of michigan ann arbor" • "noi" AND "university of michigan ann arbor"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • ("certificate of coverage" OR "coc") AND ("storm*) • "best management practice*" OR "bmp*"	• "storm water management program" AND "university of michigan ann arbor" • "stormwater management program" AND "university of michigan ann arbor" • "storm water management plan" AND "university of michigan ann arbor" • "stormwater management plan" AND "university of michigan ann arbor" • "notice of intent" AND "storm*" AND "university of michigan ann arbor"

• "certificate of coverage" AND "university of michigan ann arbor" • "coc" AND "university of michigan ann arbor"		• "noi" AND "storm*" AND "university of michigan ann arbor" • "certificate of coverage" AND "university of michigan ann arbor" • "coc" AND "university of michigan ann arbor"
University of Michigan-Dearborn		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of michigan dearborn" • "stormwater management program" AND "university of michigan dearborn" • "storm water management plan" AND "university of michigan dearborn" • "stormwater management plan" AND "university of michigan dearborn" • "notice of intent" AND "university of michigan dearborn" • "noi" AND "university of michigan dearborn" • "certificate of coverage" AND "university of michigan dearborn" • "coc" AND "university of michigan dearborn"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • "best management practice*" OR "bmp*"	• "storm water management program" AND "university of michigan dearborn" • "stormwater management program" AND "university of michigan dearborn" • "storm water management plan" AND "university of michigan dearborn" • "stormwater management plan" AND "university of michigan dearborn" • "notice of intent" AND "storm*" AND "university of michigan dearborn" • "noi" AND "storm*" AND "university of michigan dearborn" • "certificate of coverage" AND "university of michigan dearborn" • "coc" AND "university of michigan dearborn"
University of Michigan-Flint		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of michigan flint" • "stormwater management program" AND "university of michigan flint" • "storm water management plan" AND "university of michigan flint" • "stormwater management plan" AND "university of michigan flint" • "notice of intent" AND "university of michigan flint"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • "best management practice*" OR "bmp*"	• "storm water management program" AND "university of michigan flint" • "stormwater management program" AND "university of michigan flint" • "storm water management plan" AND "university of michigan flint" • "stormwater management plan" AND "university of michigan flint" • "notice of intent" AND "storm*" AND "university of michigan flint"

• "noi" AND "university of michigan flint""noi" AND "university of michigan flint" • "certificate of coverage" AND "university of michigan flint" • "coc" AND "university of michigan flint"		• "noi" AND "storm*" AND "university of michigan flint" • "certificate of coverage" AND "university of michigan flint" • "coc" AND "university of michigan flint"
Wayne State University		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "wayne state university" • "stormwater management program" AND "wayne state university" • "storm water management plan" AND "wayne state university" • "stormwater management plan" AND "wayne state university" • "notice of intent" AND "wayne state university" • "noi" AND "wayne state university" • "certificate of coverage" AND "wayne state university" • "coc" AND "wayne state university"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • ("certificate of coverage" OR "coc") AND ("storm*) • "best management practice*" OR "bmp*" • ("best management practice*" OR "BMP*") AND "storm*"	• "storm water management program" AND "wayne state university" • "stormwater management program" AND "wayne state university" • "storm water management plan" AND "wayne state university" • "stormwater management plan" AND "wayne state university" • "notice of intent" AND "storm*" AND "wayne state university" • "noi" AND "storm*" AND "wayne state university" • "certificate of coverage" AND "wayne state university" • "coc" AND "wayne state university"
Western Michigan University		
Michigan Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "western michigan university" • "stormwater management program" AND "western michigan university" • "storm water management plan" AND "western michigan university" • "stormwater management plan" AND "western michigan university" • "notice of intent" AND "western michigan university" • "noi" AND "western michigan university" • "certificate of coverage" AND "western michigan university" • "coc" AND "western michigan university"	• "storm water management program" • "stormwater management program" • "storm water management plan" • "stormwater management plan" • "notice of intent" AND "storm*" • "noi" AND "storm*" • "certificate of coverage" OR "coc" • "best management practice*" OR "bmp*" • ("best management practice*" OR "BMP*") AND "storm*"	• "storm water management program" AND "western michigan university" • "stormwater management program" AND "western michigan university" • "storm water management plan" AND "western michigan university" • "stormwater management plan" AND "western michigan university" • "notice of intent" AND "storm*" AND "western michigan university" • "noi" AND "storm*" AND "western michigan university" • "certificate of coverage" AND "western michigan university" • "coc" AND "western michigan university"

Metropolitan State University		
Minnesota Pollution Control Agency website	***Main university website***	***Startpage search engine***
• ("best management practice*" OR "bmp*") AND "metropolitan state university" • ("minimum control measure*" OR "mcm*") AND "metropolitan state university"	• "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• ("best management practice*" OR "BMP*") AND "storm*" AND "metropolitan state university" • ("minimum control measure*" OR "MCM*") AND "storm*" AND "metropolitan state university"
Minnesota State University-Mankato		
Minnesota Pollution Control Agency website	***Main university website***	***Startpage search engine***
• ("best management practice*" OR "bmp*") AND "minnesota state univeresity mankato" • ("minimum control measure*" OR "mcm*") AND "minnesota state university mankato"	• "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• ("best management practice*" OR "BMP*") AND "storm*" AND "minnesota state university mankato" • ("minimum control measure*" OR "MCM*") AND "storm*" AND "minnesota state university mankato"
Saint Cloud State University		
Minnesota Pollution Control Agency website	***Main university website***	***Startpage search engine***
• ("best management practice*" OR "bmp*") AND "saint cloud state university" • ("best management practice*" OR "bmp*") AND "st cloud state university" • ("minimum control measure*" OR "mcm*") AND "saint cloud state university" • ("minimum control measure*" OR "mcm*") AND "st cloud state university"	• "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• ("best management practice*" OR "bmp*") AND "storm*" AND "saint cloud state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "st cloud state university" • ("minimum control measure*" OR "mcm*") AND "storm*" AND "saint cloud state university" • ("minimum control measure*" OR "mcm*") AND "storm*" AND "st cloud state university"
University of Minnesota-Duluth		
Minnesota Pollution Control Agency website	***Main university website***	***Startpage search engine***
• ("best management practice*" OR "bmp*") AND "university of minnesota duluth" • ("minimum control measure*" OR "mcm*") AND "university of minnesota duluth"	• "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• ("best management practice*" OR "bmp*") AND "university of minnesota duluth" • ("minimum control measure*" OR "mcm*") AND "university of minnesota duluth"
University of Minnesota-Rochester		

Minnesota Pollution Control Agency website	*Main university website*	*Startpage search engine*
• "public notice" AND "university of minnesota rochester" • "stormwater pollution prevention program" AND "university of minnesota rochester" • "storm water pollution prevention program" AND "university of minnesota rochester" • "SWPPP" AND "university of minnesota rochester" • ("best management practice*" OR "BMP*") AND "university of minnesota rochester" • ("minimum control measure*" OR "MCM*") AND "university of minnesota rochester"	• "public notice" AND "storm*" • "stormwater pollution prevention program" • "storm water pollution prevention program" • "SWPPP" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "public notice" AND "storm*" AND "university of minnesota rochester" • "stormwater pollution prevention program" AND "university of minnesota rochester" • "storm water pollution prevention program" AND "university of minnesota rochester" • "SWPPP" AND "university of minnesota rochester" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of minnesota rochester" • ("minimum control measure*" OR "MCM*") AND "storm*" AND "university of minnesota rochester"
University of Minnesota-Twin Cities		
Minnesota Pollution Control Agency website	*Main university website*	*Startpage search engine*
• ("best management practice*" OR "bmp*") AND "university of minnesota twin cities" • ("minimum control measure*" OR "mcm*") AND "university of minnesota twin cities"	• "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*" • ("minimum control measure*" OR "mcm*") AND "storm*"	• ("best management practice*" OR "bmp*") AND "university of minnesota twin cities" • ("minimum control measure*" OR "mcm*") AND "university of minnesota twin cities"
Harris-Stowe State University		
Minnesota Pollution Control Agency website	*Main university website*	*Startpage search engine*
• "stormwater management program" AND "harris stowe state university" • "storm water management program" AND "harris stowe state university" • "stormwater management plan" AND "harris stowe state university" • "storm water management plan" AND "harris stowe state university" • "SWMP" AND "harris stowe state university" • "public notice" AND "harris stowe state university"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "harris stowe state university" • "storm water management program" AND "harris stowe state university" • "stormwater management plan" AND "harris stowe state university" • "storm water management plan" AND "harris stowe state university" • "SWMP" AND "harris stowe state university"

		• "public notice" AND "storm*" AND "harris stowe state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "harris stowe state university"
Lincoln University		
Missouri Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "stormwater management program" AND "lincoln university" • "storm water management program" AND "lincoln university" • "stormwater management plan" AND "lincoln university" • "storm water management plan" AND "lincoln university" • "SWMP" AND "lincoln university" • "public notice" AND "lincoln university"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "lincoln university" • "storm water management program" AND "lincoln university" • "stormwater management plan" AND "lincoln university" • "storm water management plan" AND "lincoln university" • "SWMP" AND "lincoln university" • "public notice" AND "storm*" AND "lincoln university" • ("best management practice*" OR "bmp*") AND "storm*" AND "lincoln university"
Missouri Southern State University		
Missouri Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "stormwater management program" AND "missouri southern state university" • "storm water management program" AND "missouri southern state university" • "stormwater management plan" AND "missouri southern state university" • "storm water management plan" AND "missouri southern state university" • "SWMP" AND "missouri southern state university" • "public notice" AND "missouri southern state university"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "missouri southern state university" • "storm water management program" AND "missouri southern state university" • "stormwater management plan" AND "missouri southern state university" • "storm water management plan" AND "missouri southern state university" • "SWMP" AND "missouri southern state university" • "public notice" AND "storm*" AND "missouri southern state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "missouri southern state university"
Missouri State University-Springfield		

Missouri Department of Natural Resources website	*Main university website*	*Startpage search engine*
• "stormwater management program" AND "missouri state university springfield" • "storm water management program" AND "missouri state university springfield" • "stormwater management plan" AND "missouri state university springfield" • "storm water management plan" AND "missouri state university springfield" • "SWMP" AND "missouri state university springfield" • "public notice" AND "missouri state university springfield"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "missouri state university springfield" • "storm water management program" AND "missouri state university springfield" • "stormwater management plan" AND "missouri state university springfield" • "storm water management plan" AND "missouri state university springfield" • "SWMP" AND "missouri state university springfield" • "public notice" AND "storm*" AND "missouri state university springfield" • ("best management practice*" OR "bmp*") AND "storm*" AND "missouri state university sprinigfield"
Missouri Western State University		
Missouri Department of Natural Resources website	*Main university website*	*Startpage search engine*
• "stormwater management program" AND "missouri western state university" • "storm water management program" AND "missouri western state university" • "stormwater management plan" AND "missouri western state university" • "storm water management plan" AND "missouri western state university" • "SWMP" AND "missouri western state university" • "public notice" AND "missouri western state university"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "missouri western state university" • "storm water management program" AND "missouri western state university" • "stormwater management plan" AND "missouri western state university" • "storm water management plan" AND "missouri western state university" • "SWMP" AND "missouri western state university" • "public notice" AND "storm*" AND "missouri western state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "missouri western state university"
Southeast Missouri State University		
Missouri Department of Natural Resources website	*Main university website*	*Startpage search engine*

• "stormwater management program" AND "southeast missouri state university" • "storm water management program" AND "southeast missouri state university" • "stormwater management plan" AND "southeast missouri state university" • "storm water management plan" AND "southeast missouri state university" • "SWMP" AND "southeast missouri state university" • "public notice" AND "southeast missouri state university"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • "minimum control measure*" OR "mcm*"	• "stormwater management program" AND "southeast missouri state university" • "storm water management program" AND "southeast missouri state university" • "stormwater management plan" AND "southeast missouri state university" • "storm water management plan" AND "southeast missouri state university" • "SWMP" AND "southeast missouri state university" • "public notice" AND "storm*" AND "southeast missouri state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "southeast missouri state university"
University of Missouri-Columbia		
Missouri Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "stormwater management program" AND "university of missouri columbia" • "storm water management program" AND "university of missouri columbia" • "stormwater management plan" AND "university of missouri columbia" • "storm water management plan" AND "university of missouri columbia" • "SWMP" AND "university of missouri columbia" • "public notice" AND "university of missouri columbia" *Additional searches[1]* • "university of missouri columbia" AND "MO0136557" • "MO0136557"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*" *Additional searches[1]* • "MO0136557"	• "stormwater management program" AND "university of missouri columbia" • "storm water management program" AND "university of missouri columbia" • "stormwater management plan" AND "university of missouri columbia" • "storm water management plan" AND "university of missouri columbia" • "SWMP" AND "university of missouri columbia" • "public notice" AND "storm*" AND "university of missouri columbia" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of missouri columbia" *Additional searches[1]* • "university of missouri columbia" AND "MO0136557" • "MO0136557"
University of Missouri-Kansas City		
Missouri Department of Natural Resources website	***Main university website***	***Startpage search engine***

• "stormwater management program" AND "university of missouri kansas city" • "storm water management program" AND "university of missouri kansas city" • "stormwater management plan" AND "university of missouri kansas city" • "storm water management plan" AND "university of missouri kansas city" • "SWMP" AND "university of missouri kansas city" • "public notice" AND "university of missouri kansas city" *Additional searches[1]* • "MO0130516"	• "stormwater management program" • "storm water management program" • "stormwater management plan" • "storm water management plan" • "SWMP" • "public notice" AND "storm*" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*" OR "mcm*" *Additional searches[1]* • "MO0130516"	• "stormwater management program" AND "university of missouri kansas city" • "storm water management program" AND "university of missouri kansas city" • "stormwater management plan" AND "university of missouri kansas city" • "storm water management plan" AND "university of missouri kansas city" • "SWMP" AND "university of missouri kansas city" • "public notice" AND "storm*" AND "university of missouri kansas city" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of missouri kansas city" *Additional searches[1]* • "MO0130516"
Cleveland State University		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "cleveland state university" • "noi" AND "cleveland state university" • "storm water management program" AND "cleveland state university" • "stormwater management program" AND "cleveland state unviersity" • "SWMP" AND "cleveland state university"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "notice of intent" AND "storm*" AND "cleveland state university" • "noi" AND "storm*" AND "cleveland state university" • "storm water management program" AND "cleveland state university" • "stormwater management program" AND "cleveland state unviersity" • "SWMP" AND "cleveland state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "cleveland state university"
The Ohio State University-Columbus		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "ohio state university main campus" • "notice of intent" AND "ohio state university" • "noi" AND "ohio state university main campus" • "noi" AND "ohio state university"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP"	• "notice of intent" AND "storm*" AND "ohio state university main campus" • "notice of intent" AND "storm*" AND "ohio state university" • "noi" AND "storm*" AND "ohio state university main campus"

• "storm water management program" AND "ohio state university main campus" • "storm water management program" AND "ohio state university" • "stormwater management program" AND "ohio state university main campus" • "stormwater management program" AND "ohio state university" • "SWMP" AND "ohio state university main campus" • "SWMP" AND "ohio state university"	• "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "noi" AND "storm*" AND "ohio state university" • "storm water management program" AND "ohio state university main campus" • "storm water management program" AND "ohio state university" • "stormwater management program" AND "ohio state university main campus" • "stormwater management program" AND "ohio state university" • "SWMP" AND "ohio state university main campus" • "SWMP" AND "ohio state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "ohio state university main campus" • ("best management practice*" OR "bmp*") AND "storm*" AND "ohio state university"
University of Akron-Main Campus		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of akron main campus" • "notice of intent" AND "university of akron" • "noi" AND "university of akron main campus" • "noi" AND "university of akron" • "storm water management program" AND "university of akron main campus" • "storm water management program" AND "university of akron" • "stormwater management program" AND "university of akron main campus" • "stormwater management program" AND "university of akron" • "SWMP" AND "university of akron main campus" • "SWMP" AND "university of akron"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP” • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "notice of intent" AND "storm*" AND "university of akron main campus" • "notice of intent" AND "storm*" AND "university of akron" • "noi" AND "storm*" AND "university of akron main campus" • "noi" AND "storm*" AND "university of akron" • "storm water management program" AND "university of akron main campus" • "storm water management program" AND "university of akron" • "stormwater management program" AND "university of akron main campus" • "stormwater management program" AND "university of akron" • "SWMP" AND "university of akron main campus"

		• "SWMP" AND "university of akron" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of akron main campus" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of akron"
University of Cincinnati-Main Campus		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of cincinnati main campus" • "notice of intent" AND "university of cincinnati" • "noi" AND "university of cincinnati main campus" • "noi" AND "university of cincinnati" • "storm water management program" AND "university of cincinnati main campus" • "storm water management program" AND "university of cincinnati" • "stormwater management program" AND "university of cincinnati main campus" • "stormwater management program" AND "university of cincinnati" • "SWMP" AND "university of cincinnati main campus" • "SWMP" AND "university of cincinnati"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "notice of intent" AND "storm*" AND "university of cincinnati main campus" • "notice of intent" AND "storm*" AND "university of cincinnati" • "noi" AND "storm*" AND "university of cincinnati main campus" • "noi" AND "storm*" AND "university of cincinnati" • "storm water management program" AND "university of cincinnati main campus" • "storm water management program" AND "university of cincinnati" • "stormwater management program" AND "university of cincinnati main campus" • "stormwater management program" AND "university of cincinnati" • "SWMP" AND "university of cincinnati main campus" • "SWMP" AND "university of cincinnati" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of cincinnati main campus" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of cincinnati"
University of Toledo		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "university of toledo" • "noi" AND "university of toledo"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program"	• "notice of intent" AND "storm*" AND "university of toledo" • "noi" AND "storm*" AND "university of toledo"

• "storm water management program" AND "university of toledo" • "stormwater management program" AND "university of toledo" • "SWMP" AND "university of toledo"	• "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "storm water management program" AND "university of toledo" • "stormwater management program" AND "university of toledo" • "SWMP" AND "university of toledo" • ("best management practice*" OR "bmp*") AND "storm*" AND "university of toledo"
Youngstown State University		
Ohio Environmental Protection Agency website	***Main university website***	***Startpage search engine***
• "notice of intent" AND "youngstown state university" • "noi" AND "youngstown state university" • "storm water management program" AND "youngstown state university" • "stormwater management program" AND "youngstown state university" • "SWMP" AND "youngstown state university"	• "notice of intent" AND "storm*" • "noi" AND "storm*" • "storm water management program" • "stormwater management program" • "SWMP" • "best management practice*" OR "bmp*" ("best management practice*" OR "bmp*") AND "storm*"	• "notice of intent" AND "storm*" AND "youngstown state university" • "noi" AND "storm*" AND "youngstown state university" • "storm water management program" AND "youngstown state university" • "stormwater management program" AND "youngstown state university" • "SWMP" AND "youngstown state university" • ("best management practice*" OR "bmp*") AND "storm*" AND "youngstown state university"
University of Wisconsin-Eau Claire		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of wisconsin eau claire" • "stormwater management program" AND "university of wisconsin eau claire"	• "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • "minimum control measure*"	• "storm water management program" AND "university of wisconsin eau claire" • "stormwater management program" AND "university of wisconsin eau claire" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin eau claire" • "minimum control measure*" AND "storm*" AND "university of wisconsin eau claire"
University of Wisconsin-Green Bay		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***

• "storm water management program" AND "university of wisconsin green bay" • "stormwater management program" AND "university of wisconsin green bay"	• "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*"	• "storm water management program" AND "university of wisconsin green bay" • "stormwater management program" AND "university of wisconsin green bay" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin green bay" • "minimum control measure*" AND "storm*" AND "university of wisconsin green bay" • "minimum control measure*" AND "university of wisconsin green bay"
University of Wisconsin-La Crosse		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of wisconsin la crosse" • "stormwater management program" AND "university of wisconsin la crosse"	• "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "storm water management program" AND "university of wisconsin la crosse" • "stormwater management program" AND "university of wisconsin la crosse" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin la crosse" • "minimum control measure*" AND "storm*" AND "university of wisconsin la crosse" • "minimum control measure*" AND "university of wisconsin la crosse"
University of Wisconsin-Madison		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "university of wisconsin madison" AND "S058416" • "S058416" • "Madison Municipal Storm Water Permit" • "storm water management program" AND "university of wisconsin madison" • "stormwater management program" AND "university of wisconsin madison"	• "university of wisconsin madison" AND "S058416" • "S058416" • "Madison Municipal Storm Water Permit" • "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*" • "minimum control measure*"	• "university of wisconsin madison" AND "S058416" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin madison" • "minimum control measure*" AND "storm*" AND "university of wisconsin madison"

University of Wisconsin-Milwaukee		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of wisconsin milwaukee" • "stormwater management program" AND "university of wisconsin milwaukee"	• "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "storm water management program" AND "university of wisconsin milwaukee" • "stormwater management program" AND "university of wisconsin milwaukee" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin milwaukee" • "minimum control measure*" AND "storm*" AND "university of wisconsin milwaukee"
University of Wisconsin-Oshkosh		
Wisconsin Department of Natural Resources website	***Main university website***	***Startpage search engine***
• "storm water management program" AND "university of wisconsin oshkosh" • "stormwater management program" AND "university of wisconsin oshkosh"	• "storm water management program" • "stormwater management program" • "best management practice*" OR "bmp*" • ("best management practice*" OR "bmp*") AND "storm*"	• "storm water management program" AND "university of wisconsin oshkosh" • "stormwater management program" AND "university of wisconsin oshkosh" • ("best management practice*" OR "BMP*") AND "storm*" AND "university of wisconsin oshkosh" • "minimum control measure*" AND "storm*" AND "university of wisconsin oshkosh" • "minimum control measure*" AND "university of wisconsin oshkosh"

[1] If information was found, additional search queries were added to search for more specific information.

APPENDIX G: Documents Converted from Digital Images to Text for the Keyword Search Process

University	Document
Indiana University-Purdue University Indianapolis	• NPDES MS4 Permit No. INS040001
Michigan State University	• NPDES MS4 Permit No. MI0059342
University of Northern Iowa	• South Campus Design Guidelines
Western Michigan University	• Campus Master Plan Technical Report Volume I • Campus Master Plan Technical Report Volume II • College of Engineering and Applied Sciences Campus Master Plan

APPENDIX H: Keywords Used in the Keyword Search Process

General References to Green Stormwater Infrastructure & Stormwater Management		
Category	**ID**	**Keyword and Other Notes**
GSI Stormwater Management Approach	1a	green infrastructure
	1b	low impact development
NPDES MS4 Permit Program	2a	Phase II MS4
	2b	best management practice
	2c	stormwater control measure
Water 1[1]	3a	water management *Other Notes:* This keyword was used to capture the existence of other keyword variations, such as "stormwater management" and "storm water management."
Water 2[1]	3b	runoff
Water 3[1]	3c	water quality

[1] The Water category was included to account for the existence of keywords that related to stormwater management in some way.

Specific Green Stormwater Infrastructure Structural & Non-Structural Controls		
Category	**ID**	**Keyword and Other Notes**
Wetlands	1	wetland *Other Notes:* This keyword was used to capture the existence of other related keywords, such as “constructed wetland,” “wetland basin,” and “wetland channel.”
Bioretention & Bioinfiltration	2a	bioretention
	2b	bioinfiltration
	2c	rain garden
Extended Detention	3a	retention basin
	3b	retention pond
	3c	wet pond *Other Notes:* “wet extended detention” and “detention pond" would also count for existence under this keyword.
	3d	detention basin *Other Notes:* “extended detention basin” would also count for existence under this keyword.
	3e	dry basin *Other Notes:*

		"dry extended detention" and "dry basin" would also count for existence under this keyword.
	X[1]	[other ED]
Water Releases to Groundwater	4a	infiltration basin
	4b	infiltration trench
	4c	percolation trench
	4d	dry well
Landscape Buffers, Medians & Strips	5a	biofilt *Other Notes:* This keyword was used to capture the existence of other related keywords, such as "biofilter" and "biofiltration."
	5b	swale *Other Notes:* This keyword was used to capture the existence of other related keywords, such as "grass swale," "vegetated swale," and "bioswale"
	5c	grass strip
	5d	filter strip
	5e	buffer strip
	5f	grass buffer
	5g	vegetated buffer
Green Roofs	6a	green roof
	6b	vegetated roof
	6c	eco-roof
	6d	nature roof
Permeable Pavement	7a	permeable pavement
	7b	permeable paving
	7c	pervious pavement
	7d	pervious paving
	7e	porous pavement
	7f	porous paving
	7g	reinforced grass
	7h	reinforced turf rings
Stormwater Harvesting Systems	8a	water harvesting
	8b	cistern
	8c	rain barrel

[1] This keyword was used as a placeholder for text that strongly related to the Extended Detention category but was not included as an official keyword. Text that was still considered for existence in the keyword search process included the following:

- "extended detention outlet"
- "flood detention ponds"
- "natural or engineered ponds"
- "stormwater pond"
- "storm water basins"