
Environmental Studies:

Senior Seminar, Spring 2018

Parking Lot Re-Design

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Executive Summary

The Fox River has served as an economic and social heart of the City of Oshkosh, Wisconsin. In the last couple of years Oshkosh has worked to restore parts of the city, with an emphasis on better stormwater management and reduction of pollution that enters into the Fox River. World wide the the amount of impervious surfaces has been increasing, mainly in many urban cities, along with an increase of concrete and asphalt, there has been an increase with pollution, metals and oils running into waterways.

Parking is essential for economic growth and business success. However, parking lots come with just as many disadvantage, like excess stormwater runoff, flooding, excessive heat absorption, and they occupy large areas. Our goal for Oshkosh is to have more green and previous spaces within parking lots. With a focus on limiting runoff through better stormwater management and focusing on the three pillars of sustainability. There are many different types of green infrastructure that can be added to parking lots and on- street parking, depending on the goal and community preference. Infrastructure such as stormwater planters, previous pavers, rain gardens, and green walls, all play a different role in reducing the impacts of an urban environment.

Through extensive research we found that the use of native plants would provide both drainage and stability to the soil, thus reducing the amount of erosion along shorelines of the water bodies that surround Oshkosh.

Background

In February of 2012, the Sustainability Plan Steering Committee published the *City of Oshkosh Sustainability Plan*, a document that compiled the goals and the management plan for Oshkosh. They had ideas make Oshkosh a more sustainable community to live in and how the city can begin to achieve these goals. Some of the goals involved were increasing energy production from renewable resources, local food production, natural resource usage, efficient transportation, and other assets of the city that have implications on environmental health.

The focus of our research surrounds stormwater management in Oshkosh, another topic that is discussed within the Sustainability Plan. Oshkosh's stormwater (the surface runoff caused by heavy rain or snow) feeds into Lake Winnebago, Lake Butte des Morts, the Fox River, and other local bodies of water and carries anthropogenic pollutants with it. The Wisconsin Department of Natural Resources has listed Lake Winnebago as an impaired water body under the criteria of the Clean Water Act. In an

effort to alleviate the water degradation caused by Oshkosh, the Sustainability Plan targeted stormwater management as a key focus for improvement.

Oshkosh contains 22 miles of shoreline along Lake Winnebago, and is critically important that the city aim to improve stormwater management tactics. Renovations in stormwater management will not only help Oshkosh meet the federal standards issued under the Clean Water Act, but will also promote natural ecological services and economic functions while promoting the recreational and scenic benefits the river and lake systems have to offer.

One of the main causes of stormwater runoff is impervious surface cover in urban areas. This includes any pavement used for parking lots, roads, and sidewalks that does not allow rain or snow to filtrate through and be absorbed by the earth. In recent years, permeable pavers have become increasingly popular among several cities in the US and even private homeowners. However, the city of Oshkosh and its local facilities have not yet invested much into this technology primarily due to financial, spatial, and maintenance costs. In order to inspire change and renovation for better stormwater management in Oshkosh, we have narrowed our focus onto parking lot design for both governmental and privately-owned facilities throughout the city.

By researching different cities across the US, we have learned how stormwater management technologies such as permeable pavers, bioswales, rain gardens, natural buffers, and native vegetation have been utilized in recent history and how Oshkosh could benefit from implementing them as well. We have spoken to a number of local businesses to get their input on parking lot re-design and took the challenges they face into consideration. Although the financial cost and the reduction in number of parking spaces are the main deterrents for many businesses in Oshkosh, we believe that even small changes will improve the city's stormwater management. In this document we have provided a review of stakeholders, multiple comparative case studies, a cost/benefit analysis, a list of potential barriers, and a write-up on the significance of sustainable stormwater management for profit, people, and the planet. With enough research, thoughtfulness, and consideration, the city of Oshkosh could soon be able to better manage their stormwater runoff and protect Lake Winnebago and other water bodies located around the city, by using more efficient and sustainable parking lot designs.

Recommendations

Our plan for the city would be to replace retention cells with bioswales or rain gardens. This would help increase the amount of wildlife and biodiversity and native plants in the area. Another change we would like to implement that parking lots have permeable pavements used within them. This recommendation would only be for lots with more than five stalls in them, mainly for business use not private. The last recommendation that we would like to implement would be to adapt the point system that the city already has in place. We would like to increase the points required for green infrastructure by ten points per ten stalls or per ten thousand square feet. This would increase the amount of green space like bioswales and rain gardens in parking lots across the community. This point increase is not a drastic one, but will still be effective for the filtration of the stormwater. The types of parking lots that we would like to increase the points for are the urban mixed use, central mixed use, and the riverfront mixed use. These are the most common three types of lots in the city. These recommendations do not require a drastic change on the stakeholders part, but the community will see a great benefit from these changes.

Stakeholders

Below is a summary of the conversations we had with the stakeholders expressing their perspectives and opinions on stormwater management in parking lot design in the city of Oshkosh and the people we thought would have a say in our recommendation for the city.

Business

We focused on the business owners along Main Street, north of the bridge, as primary stakeholders. Primary stakeholders are people or groups that stand to be directly affected with change to parking lot redevelopment or design. We used these stakeholders because of the immediate effect they would experience if any alternatives to parking lot design or regulation that would be changed, such as construction or maintenance. We spoke to Daniel Schetter, the General Manager at the Best Western, Sarrah Larson the Owner of the Wagner Market, and Ben Rennert the Owner of Winnebago Bicycle. We spoke to these stakeholders because they experience different demands on the parking lots that are used by their customers. Each of these stakeholder took the time to talk to us about their thoughts and opinions, regarding possible changes to the parking lots regulations or policy changes directed at the minimum of greenery within a parking lot, none of the parking lots associated with

these businesses are owned by the city of Oshkosh, but might be maintained by them.

Best Western identified as a primary stakeholder because of their proximity to the river and the amount of business they acquire over a yearly basis. We spoke to the manager Daniel Schetter of the Oshkosh Best Western, and he has concerns that any changes to the parking lots could further stress the lots they have available to all the summer traffic. They are also one of the business that uses affected the most to the amount of parking spaces available at a time, they are also the only business that has primary access to the only parking ramp in downtown Oshkosh. When first asked whether there is a perceived benefit or cost to redevelopment of the parking lots, Mr. Schetters mentioned that a reduction of the number of available parking spaces could harm the Best Western. Mr. Schetter is the only stakeholder that we spoke to that mentioned a struggle and limited supply of parking. This was for the Best Western and the Convention Center, with added pressure because of the Ground round restaurant within the hotel. We asked Mr. Schetter how he thinks the customers of the hotel would feel about adding a buffer zone by the river, to help with filtering pollution and trash. He was not very optimistic that a buffer zone with be supported because the main draw for the hotel is the view of the river and any obstruction could harm business.

Sarrah Larson owns the land surrounding the Wagner Market and leases spaces for others that work downtown including Ben Rennert the owner of Winnebago bicycle and neighboring business along with residents that live on the property. Both Mrs. Larson and Mr. Rennert has similar concerns, while still supportive of possible changes to parking lots downtown. We noticed that her property is one of the only privately owned green space, that is separate from the trees along the road. Talking with Mrs. Larson, she mentioned that she has difficulties in the winter with pooling of water that causes slippery areas. We mentioned permeable surfaces to her and she was very receptive to the idea, one of her reservations she mentioned that her property is listed as a brown site. Her concerns were regarding loans and funding when the land has pollution embedded. When asked whether the parking lot provides enough parking spaces for her patrons, she said that the majority of the time there is enough space except for farmer's market days and that was not an issue. She would rather people be downtown than worry about who is parking in the lot. Mrs. Larson mentioned that in her lot she has space for a garden, and that was rare for downtown. She makes an effort to plant greenery and to maintain not only the aesthetics but the atmosphere. We mentioned some of the benefits of planting native grasses and plants, and how that might help with the absorption of water in the parking lot. Mrs. Larson was very interested to hear about how she would be able to incorporate native

plants into the already established garden. In her opinion having the garden by her business, brighten people's day and bring more people to experience downtown. Mrs. Larson and Mr. Rennert believes that increase green spaces is important to bringing new people downtown, but did comment that other than her personal garden there is a lack of future possible areas for increased green space on main street itself but rather in the parking lots behind the buildings. So the only available space for redevelopment and adding green spaces with better stormwater management would be in the parking lots that are owned and maintained by the city.

Public/ Wagner Report

When it comes to green parking lots it is important to consider the needs of the public, specifically the people who are using these parking lots every day. If the city of Oshkosh is looking at changing their parking lots or other parking into a more green and sustainable design, the community will have an opinion on the matter. As a city issue the public's opinion will have to be addressed. Walker Parking Consultants did just that. Walker Parking Consultants are a company commissioned by the city of Oshkosh, who carried out a study on Oshkosh's parking back in 2016 specifically looking at Oshkosh's downtown area (Fig 1).

Walker started with a series of public opinion surveys to gauge the community's attitude towards parking demands in Oshkosh. While doing these surveys they took the public's opinion into consideration. The community was asked their major concerns and what they thought of the issue. One of the major trends the consultants found was the public tended to agree that there is a surplus of parking downtown, during most of the hours in the day as well as most days of the week. The second major trend in the public's opinion is that there is an issue with proper signage as well as parking limitations as far as hour or minute limits and the citations that go with both of those regulations. They found that many business owners and employees are being cited while at work or their own business because they are parking in timed parking spots too long. However, if too many owners and employees park in close proximity to the businesses, there is a potential issue of the consumers having to walk further to access those businesses, if they can not park close enough. The analysis came back that any walking distance further than two blocks was too long. Members of the community complained about the distance and inconvenience and didn't want to deal with longer walking distances. With this information, it was recognized that there were a few blocks that showed constraints with the number of parking spaces. However, many more blocks showed a large surplus, during any time of day and any day of the week, less than 50% of spaces were being used.

This information is helpful to us in multiple ways because in the areas where parking strain is an issue we can look at how to create more efficient parking and perhaps creating permeable spaces but doing so in a green sustainable ways, such as bioretention cell, rain gardens, and permeable pavers. Where there is parking surplus however, we could maybe look at the specific lots, case by case and find out how many spaces each lot realistically needs. Once we determine demand, we can figure out how redesigning or adding of green space can be used to create a parking lot, that not only suits the needs of the public. redesigns with an emphasis on native plants also have the ability to creates small ecosystems providing insects and vegetation a place to thrive, all while providing an environment that looks nice and provides adequate space for water to flow, substantially decreasing the amount of stormwater and pollution runoff.

Case Studies

Olympia, Washington

The case study from Olympia Washington is beneficial when it comes to looking at Oshkosh's parking situation because both cities are relatively similar in a few key ways. One of the ways the two cities are similar is population. Olympia's population is a bit lower at roughly 48,000 while Oshkosh sits at around a population of roughly 66,000 people. With that little difference in mind adjustments to the plan can be made to accommodate for the difference in traffic flow and pedestrians creating sustainable safe environment. Another key similarity is the precipitation these two locations experience, with Oshkosh experiencing 31.5 inches of rainfall and Olympia accumulate roughly 49.95 inches annually.

Climate is a key component when talking about parking lot design because it affects specific elements and effectiveness of the actual design. For example, if a climate has a cold season with rain, snow and ice, could affect the design of the parking lot. If the location lacks this cold and wet season, but the precipitation levels are increased, are limited and are determined by the general climate. The last significant similarity that these two cities share when looking at parking is, that both Olympia as well as Oshkosh are looking at redeveloping and reviving their downtown areas.

Olympia looked as accommodating more walking and bicycle lanes, to promote the area as more convenient, by highlighting their local farmers markets. That is helping when it comes to Oshkosh's downtown area because Oshkosh also has a farmers market that is held every Saturday on Main Street during the summer months. Although our group is not focused on adding biking and walking lanes, many have expressed concern about the lack of parking downtown during these events such as farmers market days.

This case study gave a few suggestions as to how they overcame a situation similar and even demonstrated a few specific parking lot designs that could potentially be implemented into a city like Oshkosh.

In the introduction of the case study, they laid out a few of the major issues that the area experiences. A lot of the underlying issues seem to stem from the lack of green space such as trees and shrubs. Which accelerates the issue of lack of natural filtration throughout the whole downtown area. After the issues were laid out the city went to the design aspect and the potential approaches they could take for each section of downtown they were looking at. As mentioned before many of the areas they were looking at lacked greenspace and natural filtration so as a result the city focused a lot of their new design options around adding more natural filtration, through more green spaces. They then went over each of the areas they had been looking at in depth and went over how they were

going to specifically improve each area. The details of a few of these sections are less important to our study because some of them are related specifically to the Olympia area. We found their approach and implementation of the plans helpful to our research. They present many pictures as well as specific layouts as to how they implanted or plan to implement greenspace and trees in the area as well as how natural filtration can be implemented in the Oshkosh area.

At the end they went over how they were thinking about funding the project but found this less helpful in our situation because the funding for these parking lots are more than likely going to be on a case to case basis. It does give a general perspective on what a project like this could cost though and we took that into account as a rough estimate when thinking of how we could use these designs in the city of Oshkosh.

Sanford, Maine

Sanford, Maine published a report that identified significant areas that could be repurposed to use green infrastructure. The report focused on two specific areas in the community that could be repurposed, Washington Street corridor and Gateway Park. The report starts by explaining how green infrastructure can be beneficial to the community. The three reasons it lists are, the pleasing aesthetics, safety and reduced crime, and increased property value. The aesthetics provides people with

more of an enjoyable experience when traveling outside, and people are more willing to walk farther distances which also increases people's health. The safety and crime reduction comes from the amount of green space, studies show that the calming effects of trees have the potential to decrease driving speeds and help prevent a majority of accidents as well. The last thing that the green infrastructure influences are higher property values. In this report they found based on other studies that the increase can be below one percent to an upwards of thirty percent. It is all dependant on what and how much green infrastructure is incorporated to predicted how much increase in property value a neighborhood experiences.

On Washington Street, the city planned on putting in bioretention cells which are used to filter a large amount of stormwater runoff. With these locations being right next to the Mousam River the bioretention cells would help keep the pollutants from the runoff down and keep the river cleaner. The cells would be made of native, noninvasive plants that are used to an urban environment. The cells can be used on either the street sides or they can be adapted to be placed in parking lots as well (Fig 2). These bioretention cells could also be used in Oshkosh as well to help reduce the amount of pollution from runoff from entering the Fox River (Fig 3+4). This report has a large amount of information about where they put the bioretention cells and how they are comprised of, whether they used

native trees or shrubs, along with the soil composition that was used to create the best filtration process for the runoff.

This report is a great example to use for Oshkosh because of its similar climate and they have a greater annual precipitation. If the plan is executed and functioning properly, then a similar plan could work in Oshkosh as well. The green infrastructure could be used to filter the water runoff from the parking lots that are located along the Fox River and prevent further pollution.

Minnetonka, Minnesota

Minnetonka is located southwest of the Twin Cities area and is home to about 50,000 people. In 2013, the city was aiming to update its parking policy in order to achieve more efficient land uses and higher density development as well as encourage conservation design techniques and reduce stormwater runoff from surface parking. A few years earlier in 2009, the city approved a management plan that included the Minimal Impact Design Standards (MIDS) which set performance goals for their parking lots. For example, these standards set up requirements for stormwater runoff rates, volumes, and pollutants. With the city's goals and the MIDS standards in mind, a research team began to examine the parking lot management strategies in similar neighboring cities. They examined the

city of Hopkins, MN for example because it contains a similar population size and they observed Golden Valley, MN because the city had very similar parking regulations.

After reviewing Minnetonka's neighboring cities, the researchers noticed a number of strengths and weaknesses that were present within their own parking lot regulations. Minnetonka succeeds at reducing parking space needs by allowing shared parking, including regulations on bicycle parking, and they also already have the MIDS standards in place that control runoff flow, volume, and pollutant thresholds. Areas of improvement for the city could include combining a mix of land uses in order to encourage shared parking areas, having residential parking permits and enforcement, and having more effective requirements of conservation design techniques to manage stormwater.

Through this research, eight applicable changes were found that could be implemented for Minnetonka. A few of these changes include lifting minimal parking requirements in order to encourage parking space reduction, offering alternate infrastructure that support various types of transportation, and offering greater incentives to implement stormwater technologies such as pervious pavers, rain gardens, filter strips, and green roofs (Fig 5). Since there have been concerns about parking availability in Oshkosh, these goals and observations that the research team has presented for Minnetonka can also be applicable here and help Oshkosh

make the reductions necessary to implement more sustainable stormwater management technologies.

Richmond, Virginia

The city of Richmond has created a set of guidelines that are used to help with the preparation of new building project and help create a more efficient city. One of the main sections of this report is about the environment and how some green infrastructure can help better the city and the life of the people in it. The way they are doing this is by implementing three different guidelines, more public parks, more enriched landscaping, and with stormwater management. The first one, implementing more parks, will help encourage people to come outside more and help some people get closer to nature even though they have never really been able to experience nature to a full extent. They also say in the report that these parks don't have to be too extensive, they can just be a trail or a field for sports. The next major topic the report, landscaping, brings up is what plants to use for these parks or for any natural setting. The report goes through guidelines about how close the plants can be to the sidewalk and how tall they can be also. The diversity of the plants is also one of their guidelines, they recommend native, noninvasive plants to prevent any other issues. This section also talks about the maintenance

that is needed for these plants. The city would like to have volunteer groups, such as adopt-a-tree, come in and have them take care of the trees and plants. This would help reduce the cost on the city and have the community give back. The last section that the report has on the environment is about stormwater management and low-impact development. The report describes low-impact development, with regards to stormwater management, as small areas in the urban environment that mimics nature and uses small pockets of green space that filters the stormwater to help reduce runoff pollution.

The design of the low-impact development areas can be used in Oshkosh as well to help reduce the amount of runoff created in larger parking lots. The other ways that they talk about to reduce runoff pollution could as be used in Oshkosh's plan for a greener city like, the native plants to be used in areas closer to the river to help filter the water before it enters the river. Another idea that the report brings up is the use of permeable pavers to help reduce the water puddling on large parking lots. The permeable pavers can be used in Oshkosh to help with not only water filtration and clearing but also to help with snow buildup. When the snow would melt it would flow through the pavement and then be filtered so that there is no harm to any part of the environment

Burlington, Vermont

Burlington Vermont is another one of those cities that we found was trying to do something when it came to their parking downtown, and at the same time possessed some of the similarities to Oshkosh that we were looking for. As discussed earlier we felt that matching the climate of Oshkosh to a city that experiences relatively the same thing is important because of materials used and maintenance needed throughout the seasons. Burlington is also a bit smaller in population but in many ways still comparable to Oshkosh. Our group found this case study more useful when it came to parking minimums and maximums of certain areas of the city in compared to Oshkosh. We also used this case study as a basis of information regarding safety and parking lot fluidity.

The couple main purposes of this article are both to make sure that businesses and other facilities in the downtown area have adequate parking for their customers as well as employees. Another purpose of this case study is to make sure their parking lots are safe and that pedestrians can maneuver through them as safely as possible. Our group was most focused however on the first point of making sure there is adequate parking because in Wagner's company's final report we read that some were complaining about not being able to park at their own place of employment, or that they were being ticketed for parking violations while

they were at work. Although the tickets might be regulation and policy issue, the adequate parking issue is not and we wanted to see if there was any way we could learn from Burlington in this situation as well as taking note of the dimensions they use for their parking lot spaces.

After looking through the case study and then looking at Oshkosh's situation, we found it was relatively difficult to find a clear solution to the problem by just attempting to compare the two cities and the issues both is facing at the individual level. We came to the conclusion that when looking at parking and the scenario where a city might lack an adequate amount of parking at during certain times of the day or certain days of the week, it is going to be more beneficial to take it case by case and look at the individual city's situation. Although we did not get quit what we were looking for out of this case study we were able to get some insight on how to approach the problem.

New York, New York

In 2007, the New York City Department of City Planning published a document titled "Design Standards for Commercial and Community Facility Parking Lots". The overall goal of these standards was to improve design of parking lots in New York City while minimizing impact on commercial and community facility developments. In order to make these refinements, the

department decided that they should focus on three key aspects of parking lot design. The aesthetics could be improved by mitigating vast expanses of pavement through better landscaping and improving the quality of local streetscapes, the environmental quality of parking lots could be improved by increasing tree cover to reduce Heat Island Effect (small areas that are hotter than its surroundings due to land surfaces) and increasing permeability for stormwater mitigation, and finally parking lots could improve pedestrian and vehicular circulation for public safety.

To achieve all of these improvements, the department looked to enhance interior landscaping in public parking lots. This means that the lots would be redesigned to maximize the amount of trees, shrubs, and groundcover planting while keeping the percent of total parking spaces lost to a minimum. They found that for every eight parking spaces in a standard lot, 150 square feet of planting area could be implemented for vegetation cover. Along with natural vegetation, stormwater retention cells (bioswales) were also considered by New York City. They would have several advantages, including higher stormwater absorption, less taxation on city sewers, lower plant material replacement costs, and a natural filter for oil, heavy metals, and other pollutants.

The department also conducted three case studies and created three design blueprints for different sized parking lots to determine how land use would change following these possible stormwater management

improvements. These case studies included Fourth Avenue in Brooklyn (88,380 sq. ft. lot), 37th Avenue in Queens (190,162 sq. ft. lot), and Tysen Park in Staten Island (545,822 sq. ft. lot). After analyzing these parking lots, New York City concluded that these improvements would result in a loss of 2% of total parking spaces on average, but an average 9.85% increase of parking area permeability and an average 16.15% increase in tree canopy cover. Using these statistics and models, Oshkosh could also visualize making similar improvements in its parking lots by observing how and where New York City decided to implement stormwater management technologies.

Village of Egg Harbor, Wisconsin

The Village of Egg Harbor is a resort community located on the Wisconsin peninsula, north of Sturgeon Bay. The village is surrounded by water and experience a lot of snow and rain in the off seasons. To protect the water they proposed permeable surfaces for their parking lots that are located by the water to limit the amount of water that runs into the bay, while filtering toxins with native planting and preserving the scenery that draws tourists to the village. Egg Harbor used H₂O Pro Pavers, along with slowing down the stormwater and filtering the water before it reaches the beaches, the village noticed an additional benefit not considered before.

The permeable pavers offered an aesthetically pleasing alternative to black asphalt installed before. The beaches attract families and people of all ages looking to relax and experience the beauty and activities of the water. The Village worked with Door County to not only add permeable surfaces but also to install retention ponds to increase the efficiency of the stormwater runoff filtration, before it has a chance in to enter the lake. As the water and the beaches were cleaned because of the changes made to the water run off the Village of Egg Harbor and Door County saw an increase in the number of visitor, decreasing the initial cost for construction.

The city of Oshkosh could benefit from the implementation of similar permeable surfaces and mitigate the effects of toxins flowing into the rivers and lakes that draw people to the city. There is also a benefit of adding aesthetically pleasing alternative to the area that is dominated by asphalt and limited in the availability for increased green spaces. Downtown Oshkosh is an area within the city that draws a large amount of both residents and tourists throughout the year. An increase in both retention ponds and permeable surfaces as shown in Egg Harbor, will increase the efficiency of the filtration of the stormwater and increase the aesthetic appeal of downtown.

Menasha, Wisconsin

In Menasha there was a house owner that wanted to build his dream retirement home near Lake Winnebago, but being able to meet the DNR's stormwater regulations posed a challenge to the owner. He was able to find a local construction company that had experience in permeable pavers, and had them install a driveway that was able to meet the DNR's standards and look aesthetically pleasing. The way that the company was able to get this accomplished was by making layers under the driveway before putting the tiling down. Towards the bottom they dug out a stone reservoir that was used as the filter for the water runoff that came from the driveway. After that they had multiple layers for clear stone and on the top layer they used smaller stone in between the tiling for even more filtering. Now this project has since won awards for the design of the driveway and for management of the water runoff.

This project is a great example of how we can get residential areas near the Fox River to help with filtering stormwater before it even gets to the river. This project has started a trend with residents around the area to get people not only nicer driveways but also to have even cleaner water. This project could also be applied to a larger scale like parking lots. If we could use this same process and apply it to the parking lots around

Oshkosh that would help with stormwater filtration and prevent most pollution from entering the river.

Green Parking Lot Resource Guide - EPA

This document has a great deal of information regarding green infrastructure in parking lots. It starts out by explaining the impacts that parking lots can have on the local area, both environmentally and financial costs to the city. Some of the environmental impacts that they discuss are the runoff and stormwater issues, the heat island effect which is when the parking lot is made mainly of black asphalt and on a sunny day the amount of heat captured by the parking lot can create a dangerous environment for people that need to park and travel through the parking lot. Another issue that is discussed is the air quality near parking lots, which is very poor because of the amount of emissions from cars in the area. The last thing that they discuss about the environmental impacts of parking lots is the loss of habitat space, when a new lot come through and destroys what ecosystem is there. The document then goes on the talk about how green infrastructure techniques can be used to combat these issues.

Some ways that solve these issues is by creating more green space in parking lots along with better planning for parking space allocation. When

you add more green space to the parking lot you can create area that are used to filter the water runoff before it enters the ground or nearby body of water. These bioretention areas are not only able to clean runoff, but also they provide a habitat for small wildlife to live in. The bioretention areas also provide shade from the sun to reduce the heat island effect and keep pedestrians safer. Another way that pedestrians are safer with the bioretention area is because this reduce the speed at which the vehicles travel through the parking lot and can help prevent accidents from happening. The way that this document suggests building these bioretention areas is by using native and noninvasive plant life to filter the runoff. These bioretention area can also help with the overall layout of the parking lot because if you can arrange the lot's spaces to flow more towards the retention areas then you can get even more filtration without the loss of spaces. This document from the EPA can be a key resource with the construction of new green infrastructure in parking lots, because of its vast amount of information and also it shows examples of these green infrastructure ideas in practice and showing great results from them. Oshkosh can use this document to help it with their own green infrastructure plans for parking lots and for stormwater management.

Barriers

When it comes to the barriers on a project like this, there were a few that we found were going to be bigger than others. One of the obstacles that we found we were going to climb over, and one that we predicted we were going to face was the public. Although some express that there is a parking issue in downtown Oshkosh, and express that green space is a positive thing for the city in general. We found that there really is not an overwhelming demand when it comes to the want for these changes to happen.

One thing that people are afraid of, and perhaps the biggest variable that we feel we would face with the public is just the overall potential inconvenience of re-doing of parking lots throughout the city. With the city re-designing parking lots it could cause certain areas to be under construction for lengthy periods of time, as well as the obvious shutting down of the parking lot as well. Although we do recognize this issue the Wagner Company's report showed that overall, other than a few areas during certain times there is an abundance of parking in many areas of the city with far less than half of the parking lot being used at any given time. This is important information because these are the parking lots we would be looking to redo. The reason behind this is if there is a parking lot that is almost never more than 50% full, why not re-design it in

a way that uses that extra space for green space and places for potential natural drainage. In areas where parking is more in demand we realize that some of these ideas for adding green space might not be top priority or feasible at all, but for the areas of lesser demand this could be more beneficial.

Another potential barrier that our group came up with was the issue of getting everybody on the same page. When it comes to these new parking lot designs and the ideas behind them of the possibilities, many different departments have to be willing to approve of the same design. For example, the fire department and police department have to approve of the design as far as the safety and dimensions of the parking lot to ensure that they can efficiently maneuver their vehicles through the parking lot if they need to. On the other hand with more green space within a parking lot could come more maintenance during certain seasons of the year. For a majority of the year natural filtration devices such as bio swales do tend to maintain themselves due to the fact they water themselves and maintain a green healthy look. However in the month or two following a winter or maybe even a little in fall months the maintenance could be higher due to the some plants needing to be pulled or trimmed. This would mean the grounds crew would have to spend more time on them potentially needing to hire help around those seasons which could be difficult.

The last barrier and potentially the biggest, is also one that we predicted was going to be a large push back from the start. The cost of redoing and re-designing a new parking lot is not going to be cheap. In fact many of these parking lots that are more on the greener side tend to be rather expensive. A lot of these expenses take place at the beginning and have long term benefits that actually end up saving money. A lot of the cost comes with the materials for the new parking lot such as permeable pavers. Many permeable surfaces tend to be more expensive from the start but the long term effects on the environment as well as storm water runoff if done right can have many benefits.

Cost is such a strong barrier because someone or a group of people could have the best idea in the world but yet the idea is not feasible because of money. In this case being a parking lot design, someone could have a really good idea of the perfect parking lot design where it incorporates the perfect amount of green space, natural filtration, and native plants to filter water but if the money just simply is not there it really does not matter at that current time. Cost is such a big barrier for any project that is being tackled not just parking lots. That is why it is important many times to create the budget and then see what can reasonably be done with the amount of money available, which is the direction we believe the city would have to take pursuing a project like this.

Cost/Benefit

The research has shown that the costs to stormwater mitigation through the addition of permeable surfaces and redevelopment of the parking lots with the inclusion of increased greenspaces and retentions ponds, are outweighed by the benefits to the city, community and the environment.

Costs

The costs to redevelopment and installation of greening parking lots are the initial costs and the possible reduction in the number of parking spaces for retention ponds and better implementation of water runoff. Downtown Oshkosh experiences large amounts of traffic in the summer with the river flowing through Main Street, while the parking is sufficient the further away from the river one goes, there are parking restrictions for businesses and commuters that are staying around the Fox River. There are some costs associated with the maintenance of landscaping within parking lots but when comparing the current maintenance to green infrastructure the cost although more intense in the spring, are self-sustained throughout the summer. Only some light maintenance will be needed throughout the rest of the year.

Benefits

Less runoff into the river which results in a healthy river tributaries that reach all the way to Green Bay. Natural filtration to mitigate stormwater natural processes maintain themselves, while providing habitat for both native and migratory species that stopover and use Oshkosh, giving Oshkosh the designation of a bird city. There is also enhanced air quality. With an emphasis on native plants, could reduce the amount of greenhouse gas emissions from cars. Increases the aesthetic appeal while creating additional benefit not seen with only asphalt.

Residents living in apartments that were surrounded with greenery and vegetated areas reported significant more use of the area in the surrounding area than individuals living with little to no vegetation. (Hastie 2003). Research found that people in greener neighborhoods, tended to walk longer distance and were more likely to walk instead of driving for shorter trips (Wolf 2008). Placing an emphasis on the green infrastructure downtown has the potential to create a more pedestrian friendly environment that would encourage walking and physical activity.

Significance for Sustainability

Profit

Long-term investments in permeable pavements and water retention techniques will eventually become a more economically sustainable alternative in the future due to lower maintenance costs. Keeping traditional concrete intact and functional requires resurfacing and in some cases complete replacement of the pavement, which adds thousands of dollars onto their long-term cost. Permeable pavements avoid these added maintenance costs almost completely and only need to be vacuumed over about once a year. Other forms green infrastructure such as bioswales and retention ponds can be considered investments as well because they can prevent the costs of cleaning up local water bodies in the future.

People

People will be able to enjoy green infrastructure in parking lots if they implemented in a safe, efficient, and aesthetically pleasing way. The addition of more native plants in urban areas will also increase mental health of the population and might even influence community involvement if people understand the ecological benefits of these installments. The

long-term durability of permeable pavement will also reduce the frequency of construction on local roads and be less of an inconvenience to residents. In order to make parking lot design changes that are socially sustainable, parking availability must be kept in mind and requirements should be adjusted on a case by case basis.

Planet

Fresh water conservation will become a more significant and pressing issue for people all around the planet in the near future. Keeping Lake Winnebago and other local bodies of water clean will keep local residents healthy, protect marine wildlife, encourage more natural vegetation growth, and provide a more naturally healthy environment. As urban development on Earth expands in the future, stormwater management will become increasingly relevant on a global scale and affect people from all different regions on the planet. Although the topics and concerns we have discussed in this document were specifically catered to the needs and interests of Oshkosh, water systems near urban environments exist all over the planet and need to be managed properly for stormwater pollution. As communities around the world start opening up to the idea of stormwater management, permeable pavers will hopefully become a standard of the future.

Conclusion

We firmly believe that pollution from stormwater runoff should be mitigated and prevented in Oshkosh by using the recommendations we provided in this report. Both the spatial and financial investments that are needed to install these parking lot redesign alternatives are important for the health of water bodies such as Lake Winnebago and Lake Butte des Morts, and other local water bodies. New regulations should especially target areas and facilities that have a surplus of parking space, and city planners should keep the needs of private businesses (like Best Western) in mind when considering these alternatives. After our collective research as a class, we have concluded that installing permeable pavement and retention ponds both in and out of parking lots will be an investment that pays itself off in the near future both financially and environmentally. Please consider our recommendations and aim to make Oshkosh a more green and sustainable place to live.

Appendix



Fig 1. Area of focus for Walker Parking Consultants. Survey company that ran a study on the parking situation in the city of Oshkosh



Fig 2. Bioretention incorporated into a right-of-way. This can be incorporated either on streets leading towards main

street or used as buffer zones in parking lots.

Bioretention Cell	Total Inflow (in)	Surface Overflow (in)	Drain Outflow (in)	Final Storage (in)	Percent Treated
01	17.8	1.9	12.5	3.5	89.5%
02	17.3	1.6	12.3	3.4	90.7%
03	17.5	1.7	12.4	3.4	90.2%
04	27.9	8.2	15.8	4.0	70.7%
05	17.4	1.7	12.3	3.4	90.4%
06	19.9	3.1	13.3	3.6	84.5%

Fig 3. Bioretention Performance summary. 2 year summary. The runoff treated was significant. After 2 years the the average amount of runoff treated before flowing into the river was 86%.

Bioretention Cell	Total Inflow (in)	Surface Overflow (in)	Drain Outflow (in)	Final Storage (in)	Percent Treated
01	27.4	7.7	15.8	3.9	71.8%
02	26.7	7.2	15.6	3.9	72.9%
03	27.0	7.5	15.7	3.9	72.4%
04	43.0	19.2	19.2	4.6	55.3%
05	26.8	7.4	15.6	3.9	72.6%
06	30.7	10.0	16.7	4.0	67.4%

Fig 4. Bioretention performance summary. 10 years summary. Although, the amount of filtration was reduced after 10 years, the average amount of runoff treated was 68%.

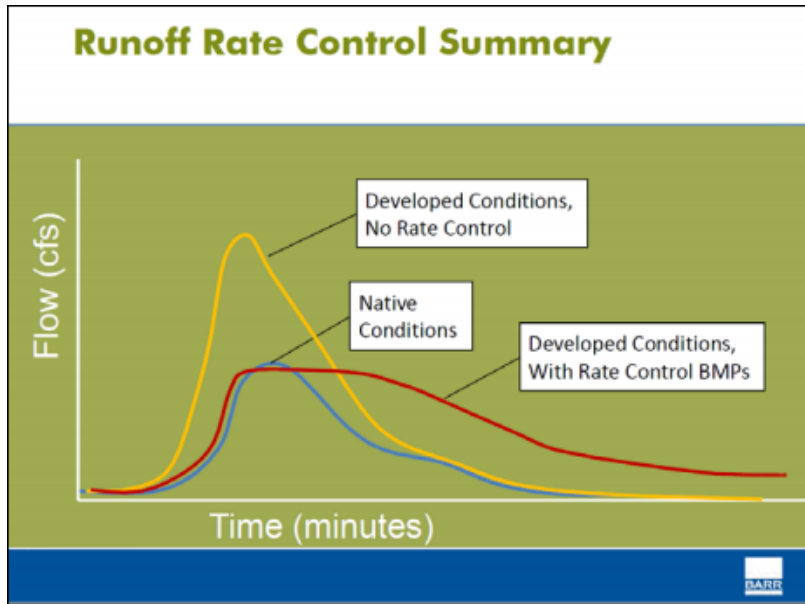


Fig 5. Runoff Rate Comparison. This graphs shows the comparison for native vegetation, development, and developed with best management practices of conservation design. The developed conditions with rate control was able to slow the rate of runoff considerably, allowing groundwater to recharge.

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