Audit of the City of Oshkosh's Use of Permeable Material

University of Wisconsin Oshkosh

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1.) Executive Summary

Stormwater runoff has multiple negative implications in urban settings such as: chemical pollution, wetland contamination, biodiversity loss, and flooding. Financial investments are made to pay for the sewer systems and water treatment that goes into maintaining and managing stormwater runoff. Stormwater is greatly impacted by the use of impermeable materials. In order construct permeable pavements the city must allow the use of permeable pavements.

We are proposing to change or add new city codes and ordinances to include permeable pavements. Allowing the option for permeable pavements can help make Oshkosh more efficient and sustainable. This will benefit the city of Oshkosh both from an environmental standpoint and an economic standpoint. The amount of stormwater can be reduced by implementing permeable pavements in areas of high flood risk and appropriate soil type. Putting permeable materials in areas of low volume traffic areas such as smaller streets, driveways, and parking lots could greatly benefit the city.

2.) Background/Context/Problem Identification

We will be looking into Section 30-175(19) of Oshkosh Zoning Ordinances which covers how streets, parking areas, and driveways are to be paved. Section 30-172(N)(2)(a) will also be looked at specifically for information regarding driveways and their potential for permeable pavement. Section 30-161(10) shows more openness to using permeable materials when it comes to constructing driveways. DNR Technical Specifications 1008 are used as a reference for permeable pavement and will be discussed further in the audit along with the previously mentioned ordinances.

Stormwater runoff has multiple negative implications in urban settings. Impermeable materials create flooding risks in urban areas. Storm water runoff in urban areas is greatly

affected by impervious surfaces. Issues that are associated with impervious surfaces and stormwater runoff include the following: chemical pollution, wetland contamination, biodiversity loss, and flooding. Chemical pollution of the local waterways happens from metals that come from vehicles using the roads and parking lots. Polycyclic aromatic hydrocarbons, PAHs, are found from fossil based fuels and in coal tar sealant that is placed on top of parking lots (Englehaupt, 2009).

PAHs are considered hazardous and carcinogens. They are known to be toxic and can cause developmental issues within children. Tar sealants wear down over years and water runoff will take the chemicals and metals into the local waterways. The concentration of pollutants is incredibly high in periods of initial rainfall or snowmelt. Pollutants negatively affect the surrounding wetlands, streams, and rivers (Sievers, 2018). Animals living in these environments, such as frogs or macroinvertebrates, suffer from these implications (Colton, 2014).

Having impervious surfaces in urban areas increases the risk for flooding. Flood damage can affect homes, streets and other structures. Buildings along rivers or wetlands are more at risk for flood damage if the runoff is not handled appropriately. Flood repairs are costly to the individuals living in the area and should be dealt with properly. Soil erosion from flooding can happen as the stormwater runoffs moves not only chemicals, but sediments in certain areas (Hellman, 2018).

Switching to permeable surfaces could help protect our local waterways. The limited amount of chemicals and metals going into the water will result in a healthier ecosystem. Less investment can be put towards cleaning the water from these toxic compounds. The result could also be a cost reduction for stormwater management and maintenance. Less runoff will result in

smaller sewer lines and pipes. The City of Oshkosh can end up saving money in the long run for the investment of permeable pavement.

3.) **Audit**

The goal auditing Oshkosh Zoning Ordinances and codes was to gain an understanding of what is allowed or not allowed when surfacing, roads, parking lots and any other hard surface. After initial base information was found, an overall grade was given based on the information that allowed, prohibited or did not mention permeable pavement. Specific recommendations are given so the city of Oshkosh can be better prepared for the implementation of permeable materials.

Does the municipality have experience with permeable material, curbless streets or other green infrastructure measures?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Local Knowledge	Taking a group tour to a permeable paving site or bringing in university or state departments of natural resources or environmental protection staff to talk about options can help build knowledge.	Yes - See Coughlin Center, Senior Center, Menominee Nation Arena. No code prohibiting permeable pavers.	Some experience and work has been done with permeable material. Most has been done with parking lots and private companies.	B+

Are standard specifications or performance standards adopted or referenced for permeable materials?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Public Works standards Local Knowledge	Many state departments of natural resources or environmental protection and the American Society of Civil Engineers publish standards that can be reference in local standards or codes.	City of Oshkosh follows DNR Technical Specifications 1008	The standards allow for permeable pavement in places which have stormwater flooding and appropriate soil. Permeable pavement practice is allowed but has not been followed through.	C

Must a sealant be used on improved surfaces, and, if so, can that provision be waived?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Public Works Standards	When adding allowances for permeable surfacing, communities must ensure that any requirement for sealants is modified or waived for permeable surfacing.	No code found for sealant requirement on pavement.	Permeable pavements would need to have a waiver in order to be effective. Code should be written to specify what pavements use or cannot use sealants.	F

Are low volume street sections allowed or encouraged to be permeable?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Zoning Subdivision Public works standards and specifications	A good place to start can be to write a general waiver in the code allowing permeable surfacing "upon review and approval of the village/city engineer," or making an as-of-right allowance in parking stalls, with other areas allowed with engineering review	Section 30-175(19) of Oshkosh Zoning Ordinances "All off-street parking, loading, and traffic circulation areas shall be graded and surfaced… hard, all-weather or other surface" "All driveways and parking areas shall be surfaced with... asphaltic concrete, concrete, or any other surfacing... as approved by the Department of Public Works." Section 900.2.2.1 of Public Work Standard Specifications: "Concrete shall be composed of Portland Cement, aggregates and water."	The way the code is written currently only directs roads to be paved in either concrete or asphalt. Paving of low volume streets in permeable pavement hasn't been done. It is important to construct and design the road not to conflict with underground services. Zoning did not mention permeable pavement but left door open Public Works concrete specifications contradict Zoning	C-

Can parking lanes along streets be constructed with permeable surfacing?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Zoning Subdivision Public Works standards and specifications	A good place to start can be to write a general waiver in the code allowing permeable surfacing "upon review and approval of the village/city engineer," or making an as-of-right allowance in parking stalls, with other areas allowed with engineering review.	Section 30-175(19) of Oshkosh Zoning Ordinances "All off-street parking, loading, and traffic circulation areas shall be graded and surfaced… hard, all-weather or other surface"	Similar restrictions of pavement is found with street parking. Code can be changed to include permeable pavement. Construction conflicts should be considered before proceeding.	C-

Is the width or total surface area of driveways limited (e.g, as percent of lot area)?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Zoning (lot coverage or general regulations) Public works standards	Many communities limit driveway widths to 20 feet for residential and 24 or 30 feet for non-residential uses, or limited as a	Section 30-172(N)(2)(a) Maximum width of 24 feet at front lot line, can be max of 12 feet wide or no more than the width of the	Code has limitation for max width of driveways. The previous code mentions the requirement that driveways have to be concrete or asphalt. It does say that the driveway can be another material approved by	B

	percent of total lot area. In dense settings, permeable driveways may be allowed to exceed limits.	garage. Section 30-161(10) of Oshkosh Zoning "New driveways must be constructed with durable materials such as concrete, asphalt, brick, stone and permeable pavers."	Public Works. New parking or traffic circulation areas must be constructed with permeable pavement unless proven to be ineffective. Permeable materials could be written into the code if approved by Public Works.	

Are driveway aprons allowed or encouraged to be permeable?

Barriers	Tips	Codes References and Language	Notes, Ideas and Strategies	Grade
Zoning (lot coverage or general regulations) Public Works standards	Many communities require all driveway aprons to be constructed of concrete. This can have the effect of prohibiting installation of French drains at driveway aprons.	Currently this is not practice and we have not allowed this nor do we appear to have anything in our code allowing it.	Code would need to be updated and written in detail. The codes referring to driveways do show some leniency to allow permeable pavements. Public Works would need to consider this.	D

4.) **Stakeholder Identification**

David Stertz is a civil engineer who works as Chief of Design for the Wisconsin Department of Transportation. He has twenty seven years experience as an engineer in the field of road construction and water management. Stertz learned about hydraulics and water drainage somewhat while in school at UW Platteville. Stertz would be considered an expert stakeholder as he does have knowledge about pavement techniques and city operations. However, he does not have an extensive knowledge in the subject of permeable materials in colder climates. Some of his staff in his department are more oriented in the subject.

Stertz is not in favor a permeable pavement unless they are tested to and hold up against frost damage. The issue of stormwater runoff is a concern that he feels should be addressed. Flooding in urban areas are a serious issue that are being affected by paved surfaces. "Any time we can reduce runoff we can lessen our infrastructure investment." The city can save money and maintenance costs if there is more drainage happening. By reducing the amount of runoff Oshkosh can maintain or reduce its hydraulic infrastructure such as pipes and ditches.

A potential issue in putting in permeable material is oversaturation of the ground during heavy rain periods. The heavy rains could make the runoff not as effective. Heavy rain years could also oversaturate the soil in the road grade and this could weaken the pavements stability. In his opinion, frost heaves that happen in this climate could disrupt the placement of permeable pavement as well.

Stertz has not implemented or handled permeable pavement specifically, although he is in favor of infiltration basins, french drains, and infiltration ditches. He feels that Oshkosh could benefit from permeable pavement and it would work well it's done correctly. Stertz remains skeptical of permeable materials, but believes they could be used more in Wisconsin as a whole if more research and attention is given to the subject.

Lisa Mick works for the Facilities Management on the University of Wisconsin Oshkosh campus. She is the supervisor for the Ground and Automotive department. Most of her knowledge comes from the city engineer John Ferris. She feels that porous asphalt and porous concrete are not a wise decision for the University to use. Porous material may get clogged with other material and not let the water pass through all the way. Another potential issue she finds could be the cost of implementing the new paving system.

Mick has not had any personal experience in using permeable material in her job. She would be a primary stakeholder as she is directly affected by the permeable pavement ordinances in Oshkosh. She feels that permeable pavements would be beneficial on campus to reduce the amount of standing water in certain areas. It would be incredibly useful in winter because standing water turns into ice that causes hazards for students and pedestrians. Personally Mick would be in support of permeable pavers which are thin layers of concrete or brick that are laid out in a interlocking pattern. The layout of pavers it similar to cobblestone as it will let water to infiltrate into the ground through the gaps. Mick is in favor of and supports permeable pavement. Mick feels that the city of Oshkosh is capable of allowing permeable pavements.

Tom Kraus owner of Kraus equipment explains that permeable pavement is a great technological advancement to the standard use of concrete, he understands what's it take to install concrete around the eastern part of Wisconsin. Kraus states that converting to permeable pavement systems in the business perspective is a cost-intensive process. The amount of money that needs to convert over to tools that are needed are a lot to take on, especially without incentives to do so. Equipment needed for installing concrete starts at thousands of dollars to hundred thousands of dollars. The capital needed he estimated to be around a couple of million dollars or so but even if they would convert over what use is all the equipment that they bought

for standard concrete. The technology for the construction business continuously changes, but the older stuff still works just as well.

Tom states that once the technology becomes cheaper than what it is at, or incentives to help purchase it the only way that people will move away from conventional concrete. Permeable pavement is a great idea he stated people have asked him about the idea and process it will take for it to work. He has incorporated some of the processes to make permeable pavement efficient by incorporating drainage systems within the concrete system they install. By allowing water to be drained into a drainage system under the concrete that disperses the water into the gravel base layer helps water from onto and in close proximity. In the future hopefully, his business can convert to a more sustainable product but until the price of materials and operation can decreases that change to it will be a slow process.

Jennifer Foster the director of urban planning at York University in Toronto explains that largest limitation of permeable pavement is the cost of the product but also the cost of a company doing it well. Where permeable pavement works well are in governmental facilities or in heavy budgeted parking lots. Professor Foster states that the best example is a site that can have the perpetration and and paving to be able to handle the large climatic range. She says that there are sites that have been a great example site where political will to invest in the site and a budget that allows for the preparations are the most successful. Small practice sites are great for a baseline study and creation of regulations to lead to a greater push for more people to be inclined to want to do the green way. The long term plan to permeable pavements is that it does not provide a present a direct cost saving, but with a political will to invest and incentives to create a more sustainable system.

Foster believes that as technology of permeable pavement and the knowledge advances the cost for such products will as well. This will lead to more contractors and private ownership will be better trained and prepared for building around permeable pavement. Permeable pavement is becoming a more attractive product. She referenced the Menominee river valley that uses permeable pavement and a large underground catchment tank , and other small sites that help put a frame of reference to how to construct a site correctly.

5.) **Benchmarking**

La Crosse has implemented a program to mitigate flooding, promote water quality and advance the sustainability goals called the green street program. The green street program incorporates green infrastructure within the right of way to manage the water runoff. La Crosse baseline street flooding result in storm events for the 3 month rain event totaling 0.83 of an inch. a one year in 2.23 inches, a ten year rainfall of 4.40 inches and a ten year in a 2 hour period 2.86 inches.

Madison, Wisconsin the permeable paver project at the Sycamore dog park in September 2014. This test plot site was requested by the WDNR and WDOT to develop technical standards. Without technical standards to specialty permeable pavers, engineers and the general public may hesitate to use them. The test site overall cost is $640,000, process rain event that collected water runoff for two years that approximated 20 storms to improve implantation and effective recommendation. Permeable pavers can significantly reduces amount of salt that undos up in the water supply some say by up to 70% stated in the county material website.

The village of Egg Harbor, Wisconsin a small resort community located in the Door Peninsula that worked to improve Beach park boat trailer parking lot water runoff management. The project restrictions needed the parking lot to provide more parking space, aesthetically

pleasing and effectively in managing Stormwater runoff. In 2011 construction of a 13,000 sq. ft section of parking lot was converted from conventual asphalt to permeable pavers. Based on the doubling the capacity from before Egg Harbor has experience an increased attendance to the beach and providing the push for more green infrastructure around the village.

6.) **Costs**

La Crosse breaks down the cost of the green infrastructure into three different section. On a 20 year cycle there is the initial cost of construction also called the probable construction cost. The annual cost to maintain and operate the infrastructure and thirdly the repair and replacement cost. In EPA green infrastructure assistance program states that "the variability in cost can be attributed to the level of experience of designers and contractors... quality of construction and

Cost parameter	Unit	Permeable pavement		
		Low	Median	High
Net present Value = (A+B)	$/SF	$12	$16	$20
(A)Probable construction cost	$/SF	$8	$12	$16
(B) O and M present Value	$/SF	$4	$4	$4
O and M annual cost	$/SF	$0.28	$0.28	$0.28

supplies and equipment" (La Crosse). La Crosse's cost analysis for permeable pavement was valued lowed compared to bioretention systems while reducing flooding by over 50%. Permeable pavement has a greater effectiveness as the increase implantation represents the most effective green street option.

Wisconsin salt storage needs report for 2015-2016 year stated that the state spends more than 28 million dollars on salt, while increasing each year. The report also states that the state

also pays a monthly fee for vendor storage of $10/month per ton of salt. The WDOT states that in 2016-2017 526,199 tons of salt, 3,018,207 gals of liquid salt was used with an average of $68.74 per ton total winter cost of $87,836,693. A study in Madison conclude that permeable pavement have the ability to reduce salt amount by 70%. At that rate the total amount of saving would result in a savings of 61.5 billion dollars.

UC Davis tested permeable pavements to placed standards and regulations, this implementation would theoretically increase water infiltration into underground storage. Installation of permeable pavements will be more costly at initially compared to standard asphalt, how ever the long term cost benefits of permeable pavement while also improving water quality.

Permeable Pavers vs. Asphalt Parking Lot Construction/Maintenance:

1/2 Acre Parking Lot Costs over 25 Years				
	Frequency in 25 Years	Permeable Pavements	Frequency in 25 Years	Asphalt
Installation	1	$165,350.00	1	$109,000.00
Detention	1	$15,000.00	0	$0.00
Vaccum Sweep	25	$400.00	0	$0.00
Restore Permeability	5	$1,750.00	0	$0.00
Refresh Base	1	$8,100.00	0	$0.00
Crack Sealing	0	$0.00	25	$250.00
Seal Coat	0	$0.00	5	$20,000.00
Stripping	0	$0.00	1	$3,125.00
Patching	0	$0.00	5	$100.00
Replace Surface		$0.00	1	$32,000.00
	Total for 2003	*$207,200.00*	**Total for 2003**	*$250,875.00*
	Total for 2015	*$306,706.62*	**Total for 2015**	*$371,356.28*
	2015 Cost per Square Foot	*$14.08*	Cost per Square Foot	*$17.05*
	2015 Cost per Acre	*$613,413.23*	Cost per Acre	*$742,712.57*

The cost breakdown above shows the cost difference between permeable pavement compared to conventional asphalt. The cost per square foot for permeable pavement is $3 less then convention asphalt, while being roughly $65,000 cheaper over a 25 year span for a ½ acre. UC Davis analyzes that permeable pavement is associated with higher upfront cost due to need of infrastructure of base layers. Johnathon Murphy states in the report that “these upkeep costs are related to cracking and patching of worn out surfaces. Asphalt has a high surface tension (very little flexibility) that is highly affected by weathering, temperature and geologic stress

(earthquakes, ground uplift and sinkholes). The surface of asphalt cracks regularly under the different stressors and requires constant maintenance to maintain safe roads. This upkeep over the asphalt lifetime makes it a more expensive choice than permeable pavements, without offering the benefit of water recharge and filtration" (Murphy).

7.) **Barriers ***

There are many barriers to permeable pavements which can make them difficult to implement even though the environmental impacts are well documented. Permeable pavement is a relatively new green infrastructure tool that can be used in a variety of settings. In Oshkosh specifically, there are concerns about how permeable pavements perform in the winter. These concerns stem from freeze and thaw cycles, salt or ice that could clog the pores and if they viable on clay like soils.

Permeable pavements have been shown to reduce many negative environmental impacts of stormwater water runoff. There is often a concern in Wisconsin that permeable pavements will not be able to perform adequately due to our poor draining clay soils and harsh winters. However, many studies have been done in areas where there are clay soils and cold climates. All of these studies have shown that permeable pavements have been able to reduce the amount of stormwater runoff and certain types of pollutants. There is a decrease in the amount of outflow from the pavement as much of stormwater is being infiltrated into the soil below. Infiltration rates are lowered when soils are still wet which is something to consider during wet seasons. There is differing research on the amount of stormwater that can be infiltrated. Some research showed that storms over 50mm will cause some runoff while another study found that permeable pavements can handle 100 year storms of 2.3mm/min. The differences likely have to do with different varying soil or temperature type from study to study.

Freeze and thaw cycles, winter salting/sanding and winter effectiveness are also concerns for permeable pavement in Wisconsin. Many studies found that permeable pavements provided temporary storage for salt and releasing it slowly into the waterways rather than all at once. The release rate is dependent on the type of permeable pavement. Porous asphalt was found to decrease the amount of salt because it does not allow any standing water that could form black ice.. Porous asphalt was predicted to outlast traditional pavement lifetime in northern climates due to the lack of heaving found in one study. A long term performance study found that after 10 years the permeability dropped by 10-25% but was still able to handle 100 year storms and was also predicted to have a longer lifespan than previously thought.

Clogging of permeable pavement in the winter is a concern if sand is the medium to deal with snow. However, with proper maintenance of vacuuming or power washing decreased this issue on minimally driven roads. Oshkosh does not use sand currently to deal with snow and ice but this should noted in case there was thought of switching de icing techniques. While heavily trafficked roads maintenance had less of an effect due to the number of cars bringing in more debris.

Cost of the long term plan of permeable pavement or permeable concrete can cost up to $6 a square foot, at an up-front cost. The long term cost vs the upfront cost can detruire the decision of choosing the environmentally friendly option. When looking at breakdown of permeable pavement many companies have shown after construction permeable pavement options are less expensive than conventional options. Future cost implications have been stated in price of maintaining permeable pavements as more cost intensive. La Crosse has implemented green infrastructure with the benefit of the EPA, to receive assistance with code review, green

infrastructure design, and cost-benefit assessments. Assistance programs, political investment will create a system where price of green technology to become available to everyone.

This research review has shown that permeable pavements have been able to reduce the negative effects of pollutants and stormwater runoff. Many of the studies focused on soils or climate separately so a small test area could be good as a start in Oshkosh. There are many different types of permeable pavement that would be up to the city engineer for review what would be the most suitable type of pavement for each situation. It was also shown that permeable pavements in tandem with other types of stormwater management systems are more effective at reducing stormwater runoff. This is another consideration for the city planners especially in parking lots where many permeable pavement developments start.

8.) Specific Recommendations

#1.) *Create a small test/sample area that allows the City of Oshkosh to test the effectiveness of permeable pavement in reduce stormwater and managing pollutants.* This would allow for localized numbers to produced and used for future permeable pavement projects or ordinances changes. Starting small and controlled would allow the City of Oshkosh to be confident in the technology and to see how it will help meet its sustainability goals while also saving them money. Sampling could also be done on previously implemented permeable pavements like at the Menominee arena, the Senior Center.

#2.) *Add language into the code allowing and encouraging permeable pavement, especially for new developments.* Adding language in the code that specifically allows, encourages or requires permeable pavement will increase the likelihood that permeable pavements will be implemented. In the current state, Zoning and Codes and Public Works Standards have some contradictions

that could make it more difficult for developers to use permeable pavers. Accepting permeable pavement into standard practice in the code will allow for ease of green development.

#3.) *New parking lots should have permeable pavement stalls.* By having permeable stalls in parking lots, the amount of pollutants that run off from parking lots would be significantly reduced. Also if the stalls are permeable this would reduce the amount of wear and tear on the permeable pavement allowing it to last longer making it a good long term investment.

9.) **Significance for Sustainability**

The city of Oshkosh is currently following a practice of using impermeable pavements unsustainably. A standard definition of sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability is created when three essential needs are fulfilled. Society needs to work with the environment, and the economy in order to create a sustainable circumstance. Stormwater runoff is much more prevalent in urban settings than it is in a natural environment. Effects of water runoff cause damage to the cities surrounding waterways and ecosystem. Stormwater management and maintenance is costing citizens money for a system that is not the most efficient. Flood damage from the overflow causes damage to both the natural environment as well as citizens homes and property (Martinez, 2017).

Water is an essential resource and every person has a right to clean drinking water. Stormwater carrying trace heavy metals and toxic chemicals is detrimental to native wildlife and human health. A study sampled fifty different rain events on a highway over the course of a year. It found that hydrocarbons, zinc, and lead are found in the water runoff from the gasoline from cars. Oshkosh is right along interstate 41 and there is a large amount of water runoff from roads and highways that go into our local area. It is much harder to regulate everyone's individual cars

than it is to manage stormwater. These substances are accumulating over time and can have detrimental effect on our environment (Legret, 1999).

The issue with water contamination needs to be dealt with as citizens of Oshkosh get their water from the Fox River and Lake Winnebago. Another study was conducted to to find out if rain intensity on impermeable pavement would affect the toxicity of urban runoff. Simulated rainfall was manipulated on three different parking lots to test the duration and intensity of rain. Higher intensity of rain diluted the stormwater and the water was considered less toxic. However all three parking lots tested, regardless of intensity and duration, tested to have toxic water runoff. The point to be made by using this article is that dilution cannot cure the problem of toxicity in water. By lessening the runoff from roads we can limit the amount of chemicals and metals going into our water. The city could potentially save money on waste water treatment as well (Greenstein, 2004).

In periods of heavy rains flooding naturally increases and can cause severe damage to the landscape. Flooding can cause soil erosion as certain types of sediments are more likely to be displaced into different locations. In impervious surface areas this causes hazardous conditions when driving. Hydroplaning becomes a risk, especially during the initial rainfall, and puts drivers in danger of crashing. There are quite a few homes along the Fox River and Lake Winnebago. Diverting runoff from naturally infiltrating the ground and sending it to the river and lake causes the water levels to rise. Basements become flooded, lawns can be damaged, and houses will need repairs. In some cases water damage can cause upwards of $10,000. This situation needs to be addressed as it can cause not only physical and fiscal damage, but damaged items within the homes can create a whole other issue for the homeowner (Hellman, 2018).

The economic issues and environmental issues that are caused from stormwater runoff affect social problems. Citizens of Oshkosh have concerns over their own health and financial issues. If the city fails to protect their drinking water or their land there will be a serious issue. Citizens will be critical of local officials if their tax money funding stormwater fails to protect their property. Sustainability will fail if there is no balance of society, economy and environment.

10.) **Summary/Conclusion**

Impermeable surfaces cause negative impacts on the environments health. The maintaining and management of stormwater runoff is a costly investment that for local citizens. Stormwater management is not currently efficient and fool proof. The environmental and economic issues caused by stormwater runoff creates social issues within the community. Citizens want and deserve a sufficient system for managing stormwater. Looking into the future the investment of permeable pavement can result in long term benefits.

Permeable pavements can reduce harmful urban stormwater runoff, reduce the need for deicing roads, and potentially last longer that current pavements. Working with Public Works, city planners, and city engineers is the way to find a solution. The idea of permeable pavement should be take part in a serious discussion at city hall. The current system of using impermeable materials is not sustainable. The impermeable surfaces cause stormwater runoff which contributes to negative effects on the environment, the economy, and public health. Stormwater runoff can be lessened greatly by making changes from impermeable surfaces to permeable surfaces. Changing a few lines in some zoning and ordinance codes can cause a butterfly effect. We can change the future of Oshkosh's green infrastructure to be more sustainable, manageable, and efficient.

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