Health Impact Assessment of the Madison Sustainability Plan – Natural Systems Section

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Client:

City of Madison, Sustainable Madison Committee

Introduction

Since 2004, the City of Madison, Wisconsin has made great progress towards sustainability. Specifically, the City's creation and implementation of the *Building a Green Capital City: A Blueprint for Madison's Sustainable Design and Energy Future (Blueprint)*, and adoption of The Natural Step (TNS) framework which encourages a "systems thinking" approach to sustainability and decision-making, established the City as a national sustainability exemplar and laid the foundation for the City's future initiatives (City of Madison, n.d. - b; National League of Cities, 2014; Fey et al., 2011). In 2009, a committee was established to update and expand the applicability of the previously mentioned Blueprint report (Fey et al., 2011). Over the course of the next two years, this committee worked with a diverse set of stakeholders representing the public, private, and non-profit sectors, as well as a group of graduate students from University of Wisconsin Madison in order to create Madison's first holistic sustainability plan (Fey et al., 2011). In 2011 the *Madison Sustainability Plan: Fostering Environmental, Economic and Social Resilience*, the product of this committee's efforts, was published (Fey et al., 2011).

The City of Madison defines sustainability as "meeting the current environmental, social and economic needs of our community without compromising the ability of future generations to meet their needs. Sustainability represents a desire to pass on to our children and grandchildren a world that is as good as, if not better than, the one we found" (Fey et al., 2011). This plan represents a critical step forward in realizing this definition, and is intended to act as an adjunct to the City's current comprehensive plan (Fey et al., 2011). Divided into ten sections, Natural Systems, Planning and Design, Transportation, Carbon and Energy, Economic Development, Employment and Workforce Development, Education, Affordable Housing, Health, and Arts, Design and Culture, this plan provides guidance on how the City of Madison can become more sustainable by creating a broad vision, as well as goals and specific actions that can be taken in order to achieve these ends for each section (Fey et al., 2011).

The Natural Systems portion of the Madison Sustainability Plan encompasses seven goals which include: 1. improvement of air, ground, drinking, and surface water quality, 2. enhanced stormwater management,

3. habitat restoration, 4. waste reduction, and 5. increased water conservation (Fey et al., 2011). These goals reflect the City's established vision for its natural systems which calls for the creations of a "balance between the natural and built environment wherein human, plant and animal communities can live in harmony" (Fey et al., 2011). In addition, the City envisions Madison as a place in which "residents breathe clean air, drink clean water, swim and boat in clean water and enjoy those waters from the shore" (Fey et al., 2011). In order to realize these goals, the Sustainable Madison Committee proposed more than 87 actions that could be taken (Fey et al., 2011). These actions varied widely in terms of their specificity, clarity, implementation timeline. For example, action 6-7 of the Natural Systems portion of the Madison Sustainability Plan calls on the city to "require all events that occur in public buildings or parks, or that require a street permit, to provide recycling and composting facilities" (Fey et al., 2011). This action is specific, well defined, and actionable in that it would simply require a change to an existing permitting system. In contrast, action 3-2 of the Natural Systems portion of the plan advises the City to "Continue in the same direction as Yahara Capital Lakes Environmental Assessment and Needs (CLEAN) Memorandum of Understanding, and subsequent MOUs, to implement strategies enumerated in the master planning effort, which will help the Clean Lakes Alliance find resources to implement projects" (Fey et al., 2011). This action is ambiguous, and as a result, is difficult to implement and assess.

Problem Addressed by this Health Impact Assessment

The City of Madison, Wisconsin has invested significant amounts of time and energy into developing its sustainability goals and vision for the City's natural resources. The scope of the actions recommended in the Natural Systems portion of the Madison Sustainability Plan are very broad; prioritization of these actions is needed in order to maximize the city's return on investment as well as the benefits afforded to residents. The purpose of this paper is to assist in the prioritization process by evaluating the public health impacts of the Natural Systems portion of the Madison Sustainability Plan. This paper was produced by an interdisciplinary student group, whose areas of expertise are in environmental management, veterinary medicine, and public health. This paper is one of eight produced by students enrolled in the 2016 Spring

Semester of Public Health 740, a class entitled "Health Impact Assessment of Global Environmental Change."

Establishing the Necessity of a Health Impact Assessment for the Natural Systems Portion of the Madison Sustainability Plan:

Health Impact Assessment (HIA) is a flexible frame used to prospectively analyze the health impacts of a policy or project (Gottlieb, Egerter, and Braveman, 2011; Ross et al., 2014). The ultimate goal of an HIA is to influence the way in which the policy or project in question is implemented in order to minimize adverse health impacts and maximize health benefits (Gottlieb, Egerter, and Braveman, 2011; Ross et al., 2014). The HIA process is typically comprised of six steps: screening, scoping, assessment, recommendations, reporting, and monitoring (Gottlieb, Egerter, and Braveman, 2011; Ross et al., 2014). The use of this framework to evaluate the Natural Systems Portion of the Madison Sustainability Plan is appropriate, because the environment is one of the key determinants of health (Center for Disease Control and Prevention, 2014; U.S. Department of Health and Human Services, 2006; World Health Organization, no date). Specifically, the physical environment in which individuals live, work and play, is one of the causal factors which can explain incidents of disease occurrence within a community (U.S. Department of Health and Human Services, 2006; World Health Organization, no date). Because the physical environment is fundamentally related to human health, assessing the health impacts of the actions proposed by the Natural Systems portion of the Madison Sustainability Plan is both logical and necessary in order to ensure that these actions promote the health and wellbeing of citizens of the City of Madison (EPA, 2014).

Actions Addressed by this Health Impact Assessment and Criteria for Selection

As was previously mentioned, the Natural Systems portion of the Madison Sustainability Plan contained 87 actions to promote the sustainability of Madison's natural resources (Fey et al., 2011). In an effort to assess the potential impacts of these 87 actions, students completed a Scoping Map (Appendix A) which identified common positive and negative health impacts associated with implementation of these actions (Fey et al., 2011). Also critical to the scoping map process was that it allowed students to identify actions

that had little to no effect on human health. Due to the limited time available to students to complete this analysis, it was infeasible to complete a holistic assessment of all 87 actions. As a result, four criteria were utilized in order to select the actions included in this analysis. These four criteria were: 1. clear connection between environmental and human health, 2. ability to execute, 3. data availability, and 4. availability of relevant published literature. These criteria were utilized in order to ensure that the HIA would be both data-driven and focused on actions that have tangible impacts on the health of Madisonians.

In total three actions from the Natural Systems portion of the Madison Sustainability Plan were evaluated in this HIA, these actions are as follows: 1. Action 3-3 "Encourage infiltration, where appropriate, through the use of pervious surfaces, the creation of rain gardens, bio-swales and other natural water purification methods;" 2. Action 7-1 "Use linking parks, bike trail system, and stormwater management systems to expand trail recreation, physical activity, and nature study opportunities. Link all parks and open spaces to the maximum extent possible;" and 3. Action 7-11 "Promote usage of public rights-of-way (public land) and parks as edible landscapes, sculpture gardens, community gardens, prairie, etc." (Fey et al., 2011). All data utilized to complete this HIA were retrieved from the City of Madison, Wisconsin Department of Health Services, Wisconsin Open Data Initiative webpage, the University of Wisconsin - Madison Robinson Map Library data inventory, and from various federal agencies including the United States Department of Agriculture Natural Resource Conservation Service (NRCS) and the Federal Emergency Management Agency (FEMA) (Appendix B).

Baseline Assessment of Madison Environmental and Human Health

Current State of Madison Parkland

The City of Madison, Wisconsin was established in 1836 on the isthmus between Lake Mendota and Monona. What was once just a speculative subdivision plat, has now grown to a thriving urban area which is home to more than 245,000 individuals (United States Census Bureau, no date; Briski & Rutledge, 2012). Presently, the City of Madison Parks Division is responsible for the management of

2,602 acres of parkland, 2,990 acres of additional open space, and 1,193 acres of greenways. In total, these natural areas make up approximately 13.6% of the total land area of the City of Madison (Briski & Rutledge, 2012; Madison Area Transportation Planning Board, no date). These natural areas have continued to grow over the course of the last ten years. Since 2005, the City of Madison has opened 5 new parks, constructed 20,000 linear feet of new trails, planted over 1,900 trees, and approved 5 new parks for community gardens and/or edible landscape sites (Briski & Rutledge, 2012). That said, anticipated declines in operating budget allocations and increases in land-management responsibilities have been indicated as potential limiting factors to new land acquisition and development by the City of Madison Parks Division (Briski & Rutledge, 2012).

Current State of Madison's Surface Waters

According to the Wisconsin Department of Natural Resources, several waterways within the Madison city limits are listed as impaired, under section 303(d) of the United States Clean Water Act (EPA, 2016; WI DNR, 2016). Meaning, they contain concentrations of one or more pollutants that degrade the water so much so that it does not meet federal water quality standards (EPA, 2016; WI DNR, 2016). Major impaired waterways include Lake Monona, Lake Mendota, Lake Wingra, Odana Pond, Wingra Creek, and Starkweather Creek (WI DNR, n.d. - a-f). These water bodies are impaired for a variety of reasons including but not limited to: excessive algae growth, eutrophication, chlorides, metals including mercury, total suspended solids, harmful algal blooms, and polychlorinated biphenyls (PCBs) (WI DNR, n.d. - a-f). Between 2007 and 2010 a reported 58 beach closures were initiated as a result of harmful algal blooms, leading to 182 lost beach days (WI DNR, n.d. - a). In addition, Lake Mendota, Lake Monona, and Lake Wingra, each have fish consumption advisories in place for several species of game fish (WI DNR, 2015). These impairments have the potential to negatively impact the health and wellbeing of Madisonians, further examination of these adverse impacts will be provided in the literature review of this report.

Current State of Madison Urban Heat Island and Air Quality

Cities are generally warmer than their surrounding areas, which include agricultural lands, forested areas and rural settlements. This increased warmth is called the Urban Heat Island (UHI) (Nowak & Gordon,

2010). Madison experiences UHI in the spring and summer months, where maximum temperature differences between rural and urban areas can reach 10+ degrees Fahrenheit (Schatz & Kucharik, 2014). Temporally, UHI intensity peaks in the late summer, and diurnally, is strongest at night. As impervious surfaces radiate heat at night, air temperatures increase (Levy & Patz 2015). Looking at Madison spatially, the density of the built environment is the main driver of temperature and precipitation patterns. Additionally, temperatures in Madison show a positive correlation between the density of the built environment and the sparsity of vegetation (Schatz & Kucharik, 2014). Hydrology can reduce the effect of UHI. Water bodies within the urban boundary of Madison were found to slightly offset the effects of UHI.

The City of Madison's air quality is consistently rated as 'good' by the Wisconsin Department of Natural Resources (WI DNR) and the Environmental Protection Agency (EPA) Air Quality Index (AQI). The AQI is an index that measures and reports the daily air quality of each county within the United States (Air Now: *AQI Guide,* 2016). The AQI measures major air pollutants regulated by the Clean Air Act on a scale from 0 to 500. If the air quality index values are divided as follows: between 0-50, the air quality conditions are considered 'good', 51-100 'moderate', 101-150 'unhealthy for sensitive groups', 151-200 'unhealthy', 201-300 is 'very unhealthy' for all populations, and 301-500 would be considered 'hazardous'. The four air pollutants measured in the AQI include ground level ozone, particle pollution (particulate matter), carbon monoxide, and sulfur dioxide (Air Now: *AQI Guide,* 2016). As previously mentioned, Madison's air quality is consistently rated as 'good,' which means air quality poses little to no threat to human health. Within the last five years, there have been 11 County Air Quality Notices, meaning levels of pollutants have risen to a level that is considered unhealthy for sensitive groups (WDNR: *Dane County Air Quality Notice History*, 2016). Sensitive groups can include children, the elderly, those with asthma or heart disease, or those who suffer from auto-immune diseases.

Current State of Madison Residents Mental and Physical Health

In terms of overall health and well-being, Madison can be proud of its accomplishments as a city and leader in Wisconsin. Madison is highly regarded consistently for its "green" transformation as well as being a generally healthy city. This has been shown in studies and polls such as being ranked one of the Best Cities on Earth to Bike, third on the list of Top Ten Healthiest U.S. Cities, ranked eighth on the Happiest, Healthiest Cities in America (Greater Madison Convention and Visitors Bureau, no date), and most recently, was ranked as the Fittest City in America by Fitbit, using 2015 data provided by over 10 million Fitbit users across the country (Fitbit Staff, 2016). However, Madison knows that there is always room for improvement. A widely used tool in assessing the health of communities on a county level is the County Health Rankings and Roadmaps, appropriately founded here at the University of Wisconsin Madison (County Health Rankings and Roadmaps, no date). Being that Madison's population is approximately half of Dane County (United States Census Bureau, no date), broad assessment of Dane County will reflect the Madison population. The data supports the notion that Madison is one of the healthiest cities in the country; however, Dane County ranks 28th out of 72 Wisconsin counties on the measurement of physical environment, and so green infrastructure can still be a goal of the community. Though Fitbit showed Madison topped other U.S. cities in physical activity, data in 2012 showed that 45.5% of 7th-12th graders were active for only an hour at least five days per week (DCYA, 2012). In regards to mental health, data showed that about 1 in 5 Madisonians felt badly about themselves (Madison, Wisconsin, no date). These conflicting data show that more research needs to be done in the City of Madison to determine the health of all citizens.

Assessment Part 1. Literature Review

Urban Heat Island and Impacts of Urban Trees and Parks on Air Quality Effects

The urban heat island (UHI) phenomenon can have significant effects on air temperature, air quality, and overall human health. The intensity of UHI varies depending on soil classification, the type of built environment, density of that built environment, and human and industrial activities (Levy & Patz, 2015; Schaz & Kucharik, 2014). Dark, impervious mediums, such as parking lots, roofs, and black asphalt

absorb and retain more heat and raise the ambient air temperature more so than light, reflective surfaces (Levy & Patz, 2015). Taking these factors into account, researchers are confident that air temperature patterns throughout a city will differ according to land use type. For example, in Schatz & Kucharik (2014), a study that placed 151 fixed sensors around urban Madison, found just that. In addition, areas of high tree cover are usually cooler than areas of impervious cover. UHI is usually strongest after sundown when skies are free of clouds and wind speeds are low. That said, in moist, temperate climates the UHI effect causes cities to be warmer in midday than rural areas. The urban heat island is exacerbated by the increased threat of heat waves to cities. Heat wave trends and characteristics have changed over the last five decades. The annual number of heat waves for the average U.S. city is noticeably rising each decade. The length of each heat wave has also increased by a fifth of a day (Habeeb, Vargo & Stone, 2015). Additionally, the length of 'heat wave season', which includes the time between the first and last heat wave, has also extended. Extreme heat events are responsible for more annual fatalities in the United States than any other extreme weather. And during heat waves in the United States, mortality increases about four percent (Levy & Patz, 2014). UHI effect worsens the impact of heat waves on human health by increasing both daytime and nighttime temperatures.

The effects of parks, vegetation and especially tree cover within and surrounding parkland can have significant effects on air quality; including air temperature, air pollution, ultra violet (UV) radiation, and carbon dioxide. All of these factors, in turn, lead to ramifications on the health of the local population. The overall effects of individual parks will vary based on the size, tree cover and variety, length of growing season, amount of existing pollution, and land use of the space (Nowak & Heisler, 2010). Open spaces or vacant land in cities can also have an effect on air quality. Open spaces and vacant land could become future parkland that would further increase air quality improvement practices. Although difficult to quantify, combined park surveys have estimated billions of dollars are saved annually in terms of improved environmental quality and human health (Nowak & Heisler, 2010).

Park lands have lower air temperatures than surrounding areas, with the coolest temperatures found in the center of the park. Cool air from the park will then disperse into surrounding neighborhoods. The intensity of cooling within a park system is related to the size of parkland and canopy coverage. Studies measuring the effects of parks on air temperature have found maximum differences in temperature between park centers and surrounding urban areas as high as 13 degrees Fahrenheit (Nowak & Heisler, 2010). In addition, a park's influence on temperature can extend as far as its width away from its borders.

Reducing air temperatures through the establishment of parks and tree planting can have significant effects on human populations. Parks with multiple uses and sight conditions, such as tight canopy cover, open fields, and garden areas will maximize options and functionality for visitors (Nowak & Heisler, 2010). Mentioned above, the frequency and intensity of heat waves for UHIs is projected to increase, therefore cooler park areas can be used as a refuge for residents during heat waves. Cooler temperatures from parks can also reach neighborhoods at nighttime, when UHI is strongest. This effect can provide respite for vulnerable populations, including people of low socioeconomic status, young children, the elderly, and populations with reduced immune systems. Other disease symptoms are exacerbated during heat events, including cardiovascular diseases, respiratory diseases, diabetes, neuropsychiatric disorders and kidney disorders (Levy & Patz, 2015). Although difficult to estimate, studies have pointed to relationships between energy use and tree density of parks. Trees will cut down and slow the speed of winter winds, therefore reducing energy use for heating. The cooling effect of parks is also related to lower energy use of air conditioning appliances in the summer via dispersal of cool air into surrounding neighborhoods.

Trees and vegetation in parks can reduce air pollution both directly and indirectly. Tree canopies and park vegetation is adept at sequestering and storing carbon. Studies have found that the total annual carbon storage from the atmosphere by urban park trees and soils in the United States is equivalent to about 177 million tons. Monetarily, this can be estimated at $3.7 billion dollars (Nowak & Heisler, 2010). The annual amount of carbon sequestration and removal by urban park trees and soils in the US is estimated at

2.4 million tons, or $50 million. Values of pollution removal are based on estimates of 'externality values,' which can be defined as a system of calculations used to quantify differences in economic benefits or costs and society's valuation of benefits and costs (Koomey & Krause, 1997). For this topic, studies attempt to place monetary value to the negative side effects of air pollution on society. Contrary, the positive environmental and health effects of parks and tree cover can be quantified in different valuations. For example, on a per acre basis, trees and soil can store about 73 tons of carbon annually in United States parks, estimated at $1450 per acre. This would equate to a carbon removal of 1.2 tons, or $25 per acre (Nowak & Heisler, 2010). Quantified in this manner, the environmental effects of parks and tree cover are extremely substantial in mitigating urban temperatures and air quality issues.

Air pollution can have significant effects on human and environmental health. Some of the health effects are similar to those felt by heat waves and UHI. Human health impacts of air pollution include the aggravation of respiratory and cardiovascular diseases, decreased lung function, increased susceptibility to respiratory infections, potential effects to the nervous system, cancer from UV radiation (Nowak & Heisler, 2010). Some of these diseases can also be attributed to premature death. People with pre-existing conditions are even more susceptible to pollution related health effects (Levy & Patz, 2015). Effects of air pollution on the natural environment include damage from ground level ozone, stress on vegetation due to changes in hydrologic and soil properties, and in extreme cases, acid rain (Nowak & Heisler, 2010). One additional note, tree leaves can absorb about 95% of UV radiation, which can greatly protect park visitors from cancer-causing radiation (Nowak & Heisler, 2010). Although the overall economic effect is unknown, studies still estimate the value of UV protection is substantial, especially when compared to skin cancer and cataract disease treatments.

Impact of Open Spaces and Parks on Water Quality, Quantity, and Human Health

Several of the previously mentioned water quality impairments found in Madison's urban lakes and streams, have known adverse impacts on human health. For example Mercury is a neurotoxin that can have adverse impacts on cardiovascular health, and PCBs are a known carcinogen that has been linked to

endocrine disruption as well as developmental delays (Christensen et al., 2015). Mercury exists naturally in the environment but is primarily emitted by human activities including metal smelting, coal-fire power plants, and fossil fuel combustion (EPA, 1997). Mercury enters into aquatic ecosystems through wet and dry deposition, where it can be bound to soil particles or dissolved organic carbon (EPA, 1997). An estimated 25-60% of mercury in aquatic ecosystems is bound to suspended particles within the water column (EPA, 1997). When present in aquatic ecosystems mercury bioaccumulates in the tissues of fish (Christensen et al., 2015; USGS, 2013; Davis, 2014). A study of male anglers in Wisconsin demonstrated that regular consumption of fish from local sources within the state or the great lakes was associated with elevated blood mercury levels (Christensen et al., 2015).

In addition, previously mentioned nutrient pollution and resulting eutrophication has led to excessive cyanobacterial growth in Lake Mendota (Wisconsin Department of Health Services, 2014). These blooms of cyanobacteria (blue-green algae), also known as Harmful Algal Blooms (HABs) are an issue of emerging concern due to their potential to produce potent toxins, which can have an adverse health impact if ingested, aspirated, or come into contact with the skin of humans (Levy & Patz, 2015; Wisconsin Department of Health Services, 2014). HABs are typically believed to be driven largely by the increase in total phosphorous entering into aquatic ecosystems (Davis, 2014; Soldat and Petrovic, 2008). While agricultural landscapes are thought to be the primary sources of phosphorous loading, lawn clippings, pet waste, and lawn fertilizers from urban areas are also contributors (Davis, 2014; Soldat and Petrovic, 2008). Phosphorous binds to soil particles, and as a result typically enters into aquatic ecosystems during rainfall events. Total suspended solids is an inexpensive measure that is frequently used as a proxy measurement for pollutants like metals, mercury, and phosphorous which bind with soil particles **(**Eckley and Branfireun, 2008; Jaffe et al., 2010; Williamson et al., 2007).

Parks, open spaces, and other types of *green infrastructure,* defined as stormwater infrastructure that seeks to trap and infiltrate water where it falls, have the potential to mitigate the previously mentioned adverse health impacts of water quality impairments (EPA, 2014). Green infrastructure encourages water

to infiltrate into the soil, and in doing this, capitalize on the soil's inherent ability to filter pollutants out of the water (EPA, 2014). Furthermore, open spaces, parks, and green infrastructure effectively slow down the flow runoff. In doing this, they encourage sediments that are entrained in the flow of water to settle out, thereby reducing amount sediment and as a result the amount of pollutants that enter Madison's lakes and streams (Jaffe et al., 2010). A study by researchers at the University of Illinois - Chicago attempted to quantify the magnitude of these benefits (Jaffe et al., 2010). Through their research they found that green infrastructure has the potential to remove anywhere between 58-80% of TSS (Jaffe et al., 2010). Because mercury, phosphorous, and other pollutants are frequently bound to particles runoff, green infrastructure can have significant benefits with respect to water quality (Jaffe et al., 2010; David, 2014; Eckley and Branfireun, 2008; Williamson et al., 2007). Finally, the same study found that green infrastructure mitigated anywhere between 57-85% of total runoff volume (Jaffe et al., 2010).

Impact of Open Spaces and Sustainable Transportation on Obesity and Mental Health

Obesity is a serious health problem with serious health implications. Simply being overweight or obese is a health risk factor for cardiovascular disease, Type II diabetes, stroke, and a number of other negative health outcomes. It is well documented in the literature that increased exercise leads to decreased obesity. A study previously conducted in Lisbon, Portugal showed a strong association between people that are overweight/obese and environmental factors like amount of physical activity, which is considered a key-mediator in terms of health behavior (Santana, 2009). As previously mentioned, Madison is, for the most part, a very active and healthy city. The data supports that with increased access to physical fitness (i.e. recreational facilities, sports associations, bike paths) comes a decrease in population BMI scores in a given community. To be more specific, an analysis conducted using 2010 data from the CDC's Behavioral Risk Factor Surveillance System in conjunction with data from the American Communities Survey looked at the relationship of walking/biking to obesity rates. The study also controlled for median household income, travel time, higher education, and other factors. The study found a statistically significant correlation between people that walk or bike to work and a healthy weight (Governing, 2012). A similar study in 2004 supports the notion that the built environment and travel patterns can have

significant impacts on weight and that efforts to increase the amount of distance walked by individuals while reducing the amount of time spent in a vehicle will have positive health impacts (Frank, 2004).

If obesity wasn't enough of an issue in this country, mental health has been a growing concern in public health fields. Data from the Substance Abuse and Mental Health Services Administration found that 44.6% of the over 750,000 Wisconsin residents suffering from any mental illness (AMI) were treated for said mental illness (Center for Mental Health Services, 2015). That is a very large number of residents who are both suffering from a mental disease as well as not receiving treatment for that disease. Researchers in 2013 conducted a study on the effects of increased physical activity on mental illnesses and found that by increasing physical activity, factors such as stress relief, mood improvements, and decreased suicidal ideations were associated with increased exercise (Zschucke, 2013). However, a separate study found that similar effects could be seen when incorporating internet or telecommunication-based support in tandem with physical activity (Mailey, 2010). It is also essential to recognize the importance of indoor versus outdoor physical activity. In areas where obesity rates remain high, it may seem easier to construct a physical recreation center instead of invest money in bike paths/trails and parks. However, studies have shown that outdoor physical activity increases the rate of self-reported mental wellbeing following exercise more than indoor physical activity, though the study states that further research is needed (Thompson Coon, 2011). With all things considered, Madison would be wise to continue investing in its bike trails and parks to increase the physical and mental wellbeing of Madison residents and visitors.

Assessment Part 2. Geospatial Analysis of Actions

Methods and Mapping Rationale

Geospatial analysis was conducted using a simple overlay analysis ESRI's ArcGIS mapping tool. A basemap of Dane county was used to map the three actions. All data utilized for this analysis were publically available, and to the extent possible we used sources that were produced by the City of Madison in order allow the to build upon this analysis with ease. After downloading relevant data, they

were imported into the Arc GIS mapping tool and then sorted based on their relevancy to each action. Those data layers were mapped together to provide a visual medium in which to analyze the actions of the HIA. This methodological approach is appropriate for this type of analysis because of the inherently spatial characteristics of natural resources, including park lands and open space.

Thirteen relevant data layers utilized in the geospatial analysis of the three Natural Systems actions included in this HIA. These layers included: 1. City of Madison municipal boundaries, 2. City of Madison existing bus routes, 3. City of Madison existing bike paths, 4. City of Madison B-cycle stations, 5. City of Madison parks, gardens, zoos and cemeteries, 6. FEMA 100-year flood zone, 7. FEMA 500-year flood zone, 8. NRCS Hydrologic Soil Group A, 9. NRCS Hydrologic Soil Group B, 10. City of Madison vacant land sales, 11. Dane County's Heat Vulnerability Index created by the Wisconsin Health Department, 12. City of Madison municipal boundary, and 13. Dane county hydrography. A comprehensive list of data sources used to obtain these data layers can be found in Appendix B.

Action 3-3 Mapping Rationale

Action 3-3 is focused on increasing opportunities for infiltration "where appropriate" (Fey et al., 2011). In this action the Sustainable Madison Committee also specified that they would like to encourage infiltration through the use of infiltration technologies that can generally be characterized as green infrastructure (Fey et al., 2011). In order to identify areas in which new green infrastructure could be placed, the previously mentioned data layer for parks, cemeteries and zoos, FEMA flood zones, and soils data were overlaid in order to identify areas that are 1. vulnerable to flooding and 2. appropriate for green infrastructure. We characterized areas that are vulnerable to flooding as within existing FEMA flood zones because in accordance with FEMA flood models, these are the areas that have a high to moderate risk of flooding and may be subject to regulation under the National Flood Insurance Program (FEMA, 2016; Dane County Planning and Development, 2009). Areas that are appropriate for green infrastructure were characterized as having an underlying soil type that falls within the NRCS's definition of Hydrologic

Soil Group A or B, because these soils have the moderate to high infiltration rates required in order to make green infrastructure effective (NRCS, 1986; EPA, 2013).

Action 7-1 Mapping Rationale

Action 7-1 is focused on increasing the connectivity of Madison's parks, bike trails, and stormwater management systems to expand trail recreation, increase physical activity, and increase nature study opportunities to the maximum extent (Fey et al., 2011). This action was chosen from the many options as it serves a purpose for improving the health of the environment (investment in green infrastructure) as well as the people (increased physical activity, connectivity with nature). Similar to the other actions, geospatial analysis was done in order to determine where proper interventions should take place in order to increase the connectivity of Madison's parks and bike trails. The data sets that were used to complete the analysis included City of Madison parks, gardens, zoo and cemeteries, City of Madison existing bike paths with a 0.10 mile buffer, City of Madison B-cycle stations, and City of Madison existing bus routes. These maps were overlain across the City of Madison boundary lines to determine a number of factors: 1. areas where parks can be increased in size in order to increase their proximity to existing bike paths or bus routes, 2. in the same area, possibility of increasing bike paths in order to close the gap between parks and the pre-existing trails, and 3. areas where more B-cycle stations can be added to increase the use of bicycles. These data sets were used so that the Sustainable Madison Committee can address specific areas where improvements could be made.

Action 7-11 Mapping Rationale

Action 7-11 is focused on promoting the usage of public lands and parks as mixed-use areas, which can include edible landscapes, sculpture gardens, community gardens, and prairie lands (Fey et al., 2011). This action would provide for the expansion and/or creation of multi-use land areas serving a variety of functions that benefit natural habitats and social and public health of the surrounding neighborhoods. We wanted to conduct geospatial analysis to identify areas or neighborhoods that would most benefit from multi-use parks. The previously mentioned data sets including: parks, gardens, zoos and cemeteries, City of Madison vacant land sales, City of Madison existing bike paths, City of Madison B-cycle stations, City

of Madison existing bus routes, and Dane County Heat Vulnerability Index were overlaid in order to identify 1. areas most susceptible to heat vulnerability, 2. vulnerable areas where public lands and parks are absent, 3. gaps in transportation systems which would move individuals in vulnerable areas to public lands, and 4. examples of potential vacant lands that could be transformed into new parks to added to expand an existing park. One point of note; the City of Madison vacant land sales data layer was last updated in 2013, and does not include current vacant land for sale. This data set was incorporated for the Sustainable Madison Committee to assess the costs associated with purchasing land in those neighborhoods.

Results and Action-Specific Recommendations

Findings Action 3-3 (Appendix C): "Encourage infiltration, where appropriate, through the use of pervious surfaces, the creation of rain gardens, bio-swales and other natural water purification methods."

As is evident by examining the map, there are many opportunities for infiltration within the City of Madison, because a majority of the underlying soil type have moderate to high infiltration rates (NRCS, 1986). In addition, there are also several neighborhoods in North Eastern Madison near East Washington Avenue which are in mapped FEMA flood zones. In the short term, the City of Madison could use these findings in order to target their outreach for their existing 1,000 raingarden initiative (City of Madison, n.d. - a; EPA, 2013). In the mid term, the City of Madison should utilize these maps to aid in their planning of new parks and green infrastructure projects (EPA, 2013). To the maximum extent possible, all new green infrastructure projects (including raingardens) and parks should be built in areas with underlying hydrologic soil type A or B as these areas have the highest infiltration rates (NRCS, 1986; EPA, 2013). Finally, in the long term the city should consider buying out and relocating homeowners and businesses within neighborhoods identified on this map which are located in existing flood zones and converting these areas to open space or parkland in order to reduce their vulnerability to flooding. Implementation of these recommendations could contribute to fewer beach closures, healthier fisheries, and lowered risk of flooding.

Findings Action 7-1 (Appendix D): "Use linking parks, bike trail systems, and stormwater management systems to expand trail recreation, physical activity, and nature study opportunities. Link all parks and open spaces to the maximum extent possible."

The combination of the data sets and the City of Madison boundary line have provided sufficient areas that need improvement, at least in the sense of Action 7-1. Using this map, certain areas can be identified where parks do not lie in close proximity to existing bike trails, bus routes, or B-cycle stations. In order to evaluate proximity to bike trails we created a 0.10 mile buffer around existing trails using ArcGIS. This was the distance that we rationalized as being feasible for vulnerable populations such as the disabled, the elderly and the very young, being able to travel in order to access a park. Some of these areas include southwest of West Towne Mall, on the north side between Cherokee Marsh South and Warner Park, northeast of the Dane County Regional Airport, and on the southeast side between Stoughton Road and I-90. In the short term, Madison should consider investing in more B-cycle stations in these residential areas. If the goal is to reduce car traffic and increase bike/foot traffic, then people will need access to these bikes near their homes, not multiple miles away. Mid-term goals will be to assess whether current parks, pathways, bike trails, and bus routes can be connected further. Specifically the City of Madison will need to determine what permissions need to be granted in order to enhance connectivity to the outskirts of the city. As a general observation, the farther away from the Capital a person gets, the less dense the bike trails become and the less frequent B-cycle stations become. A long-term goal of the city should be to make the distribution of B-cycle stations and bike trails directly correlated to residential population density, no matter the neighborhood, thereby ensuring that all Madison residents have equal and adequate access to these resources. By doing so, Madison will see increased physical and mental health benefits as well as a reduction in obesity, hereby ensuring that Madison remains a top-ranked healthy city in the U.S. and world.

Findings Action 7-11 (Appendix E): "Promote usage of public rights-of-way (public land) and parks as edible landscapes, sculpture gardens, community gardens, prairie, etc."

By looking at the map, many inferences can me made about the heat vulnerability of various Madison neighborhoods, the number of and accessibility of public lands in those neighborhoods, as well as the

potential land available for the expansion of current park land or the creation of new parks as multi-use spaces. In the short term, the City of Madison could use findings to further and more precisely identify the most heat vulnerable neighborhoods using the Dane County Heat Vulnerability Index (HVI). The HVI assesses four different indicators to develop a vulnerability index in which to identify areas of the greatest risk for negative health impacts of heat events and UHI (Wisconsin Department of Health Services: W HVI, 2016). These indicators include population density, health factors, the natural and built environment, and demographic and socioeconomic factors. For further information of the description of these indicators and how they affect heat vulnerability, visit the Wisconsin Department of Health Services website. In the mid term, the City of Madison should prioritize the expansion of existing parks and the creation of new parks in order to increase accessibility for more residents. In addition, the Madison Sustainability Plan aims to provide access to 'recreational opportunities' within a 10-minute walk of each Madisonian (Faye et al., 2011). Planning for future mixed-use parks should be conducted. By examining this initial baseline map, vulnerable areas of intervention should include the North East neighborhoods as well as the South West corridor of the city boundaries. Finally, in the long term, the City of Madison should purchase vacant land in planned areas and convert them to multi-functional public lands. Priority of this development should be focused in the most vulnerable and isolated communities. The number of parks and recreational opportunities within a community, and the proximity and/or access of those parks are the main contributors of park use and physical activity levels (NRPA: Parks and Recreation in Underserved Areas, 2015).

Conclusion, Recommendations, and Communication Plan

Recommendations and Conclusions

The most general, but significant recommendation for the Sustainable Madison Committee is to prioritize the actions of the Natural Systems portion of the Madison Sustainability Plan. Redefining the scope of the goals and prioritizing specific actions will aid in maximizing the city's return on investment as well as increase the benefits to the residents of Madison. Actions must have clear, definable outcomes, the ability to be implemented, a detailed timeline of implementation, available data and information to use as

resources and baselines, and means of monitoring, analysis and evaluation. This assessment should be used to identify vulnerable communities in Madison that would best benefit from the establishment and/or expansion of parks. This assessment should also be used as a baseline study in order to target future investments in parks, public lands, trails, and green infrastructure. Further in depth geospatial analysis should be conducted in order to refine the initial analysis and aid in decision-making moving forward.

Communication Strategy

To encourage the implementation of these recommendations the Natural Systems HIA Group intends to present their findings to the Sustainable Madison Committee on Monday May, 16. During this meeting we will also share maps, data, and final report. To further communicate the findings of this analysis we recommend that the Sustainable Madison Committee utilize the student-produced maps in order to start a dialog around the potential health benefits of increased investments in parks, open spaces, and green infrastructure. Relevant stakeholders should be involved in this dialog and assist in implementing the recommendations made throughout this report can be found in Appendix E.

Monitoring and Evaluation

Monitoring progress towards the recommendations made in this HIA can be achieved with some relatively simple measures. The first measure is the extent to which strategic investments are made in vulnerable communities. The Madison Park Division already inventories and analyzes its park land in a variety of different ways, first by the number of different parks and their acreage and classification and second, by accessibility and services area (Briski and Rutledge, 2012). The Parks Division has be capability to identify areas in which there are gaps in accessibility (Briski and Rutledge, 2012). Using the maps created in this HIA can help to inform their analyses going forward. In addition, the City of Madison would benefit by continuing to monitor air quality and changes in urban heat island effects. These factors will indicate the effectiveness of new or expanded parkland and vegetation in reducing air temperature, air pollution reduction, and carbon storage. Water quality within the city, damages caused by flooding, and stormwater infrastructure failures should also be monitored. As a way to evaluate citizen

health and engagement, residents within vulnerable neighborhoods should be identified via surveys or public meetings. These assessments will help in determining how changes in access to parks and open spaces are impacting their health and behavior.

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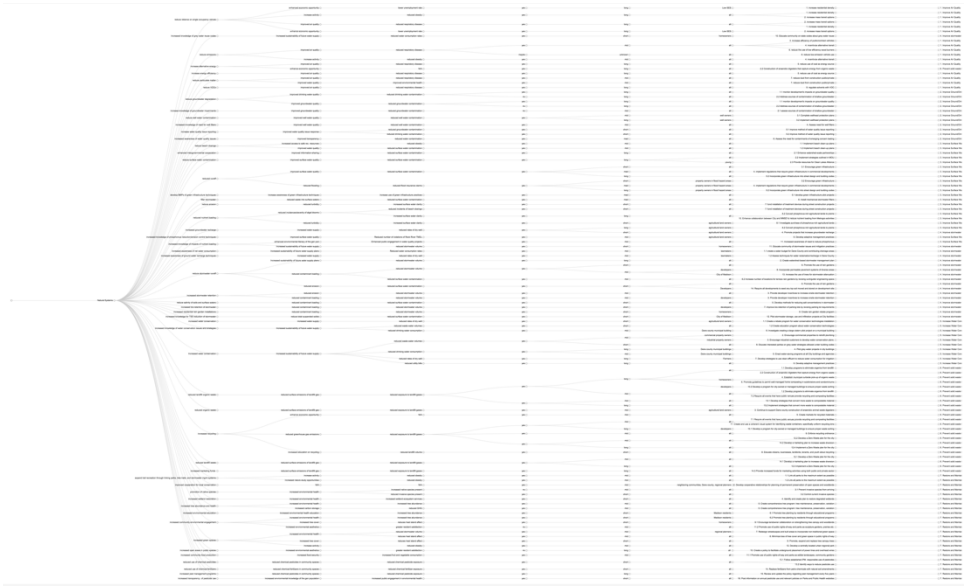
Appendices:

Appendix A. HIA Scoping Map



Appendix B. Comprehensive List of Data Sources Used in GIS Analysis

1. WI Legislative Technology Services Bureau. (2016). Municipal Boundaries, Wisconsin 2016.

Retrieved from: http://legis.wisconsin.gov/ltsb/gis/data/.

2. Madison Area Transportaion Planning Board. (2016). Bus Routes City of Madison, 2016. Retrieved from http://maps.sco.wisc.edu/opengeoportal/

3. City of Madison - Metropolitan Planning Organization (MPO). (2014). Bike Paths Dane County, WI 2014. Retrieved from http://maps.sco.wisc.edu/opengeoportal/

4. City of Madison - Metropolitan Planning Organization (MPO). (2014). Parks City of Madison, WI 2014. Retrieved from http://maps.sco.wisc.edu/opengeoportal/

5. Federal Emergency Management Agency. (2016). National Flood Hazard Layer. Retrieved from http://hazards.fema.gov/gis/nfhl/rest/services/public/NFHL/MapServer

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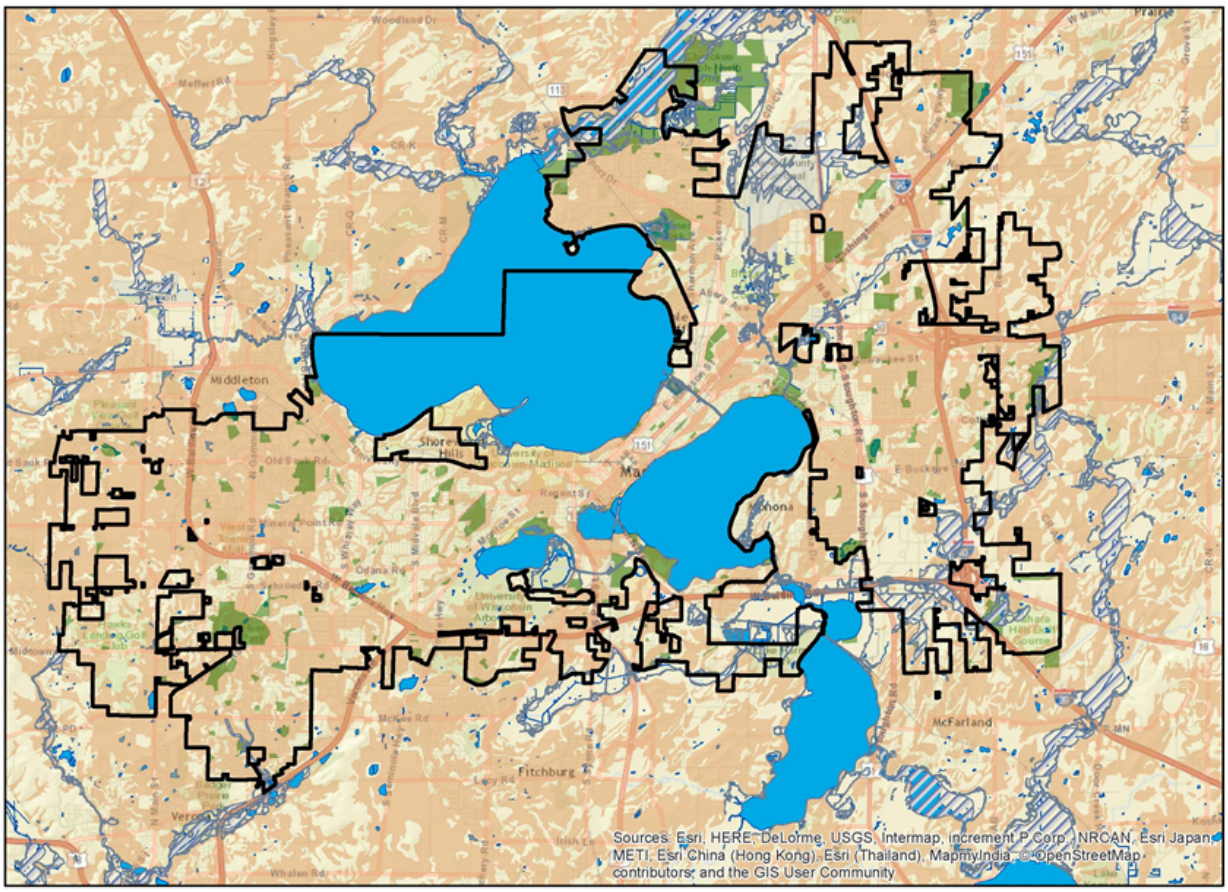
8. Wisconsin Heat Vulnerability Index. (2016) Dane County's Heat Vulnerability Index. Retrieved from Professor Jason Vargo.

9. Dane County Land Information Office. (2014). Hydro (Polygon) Dane County, WI 2014. Retireved from http://maps.sco.wisc.edu/opengeoportal/

Appendix C. Map Action 3-3 "Encourage infiltration, where appropriate, through the use of pervious surfaces, the creation of rain gardens, bio-swales and other natural water purification methods."



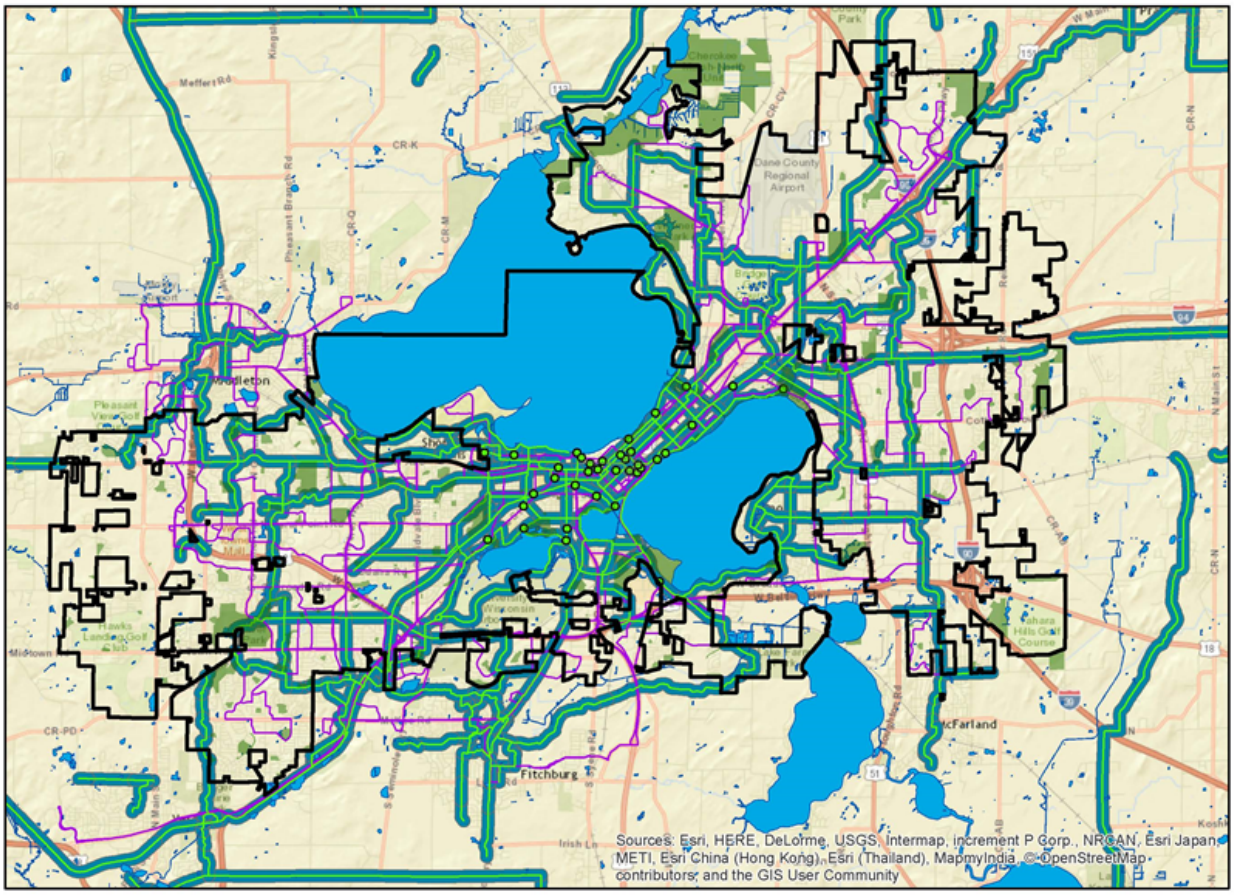
Legend

- Wisconsin_Municipal_Boundaries_Spring_2016
- 500 Year Flood Zone
- 100 Year Flood Zone
- City of Madison Parks, Gardens, Zoos, Cemeteries

Soils

- NRCS Hydrologic Soil Group A (high infiltration capacity)
- NRCS Hydrologic Soil Group B (moderate infiltration capacity)

Appendix D. Map Action 7-1 "Use linking parks, bike trail system, and stormwater management systems to expand trail recreation, physical activity, and nature study opportunities. Link all parks and open spaces to the maximum extent possible."



Legend

- Wisconsin_Municipal_Boundaries_Spring_2016
- City of Madison Parks, Gardens, Zoo, Cemeteries

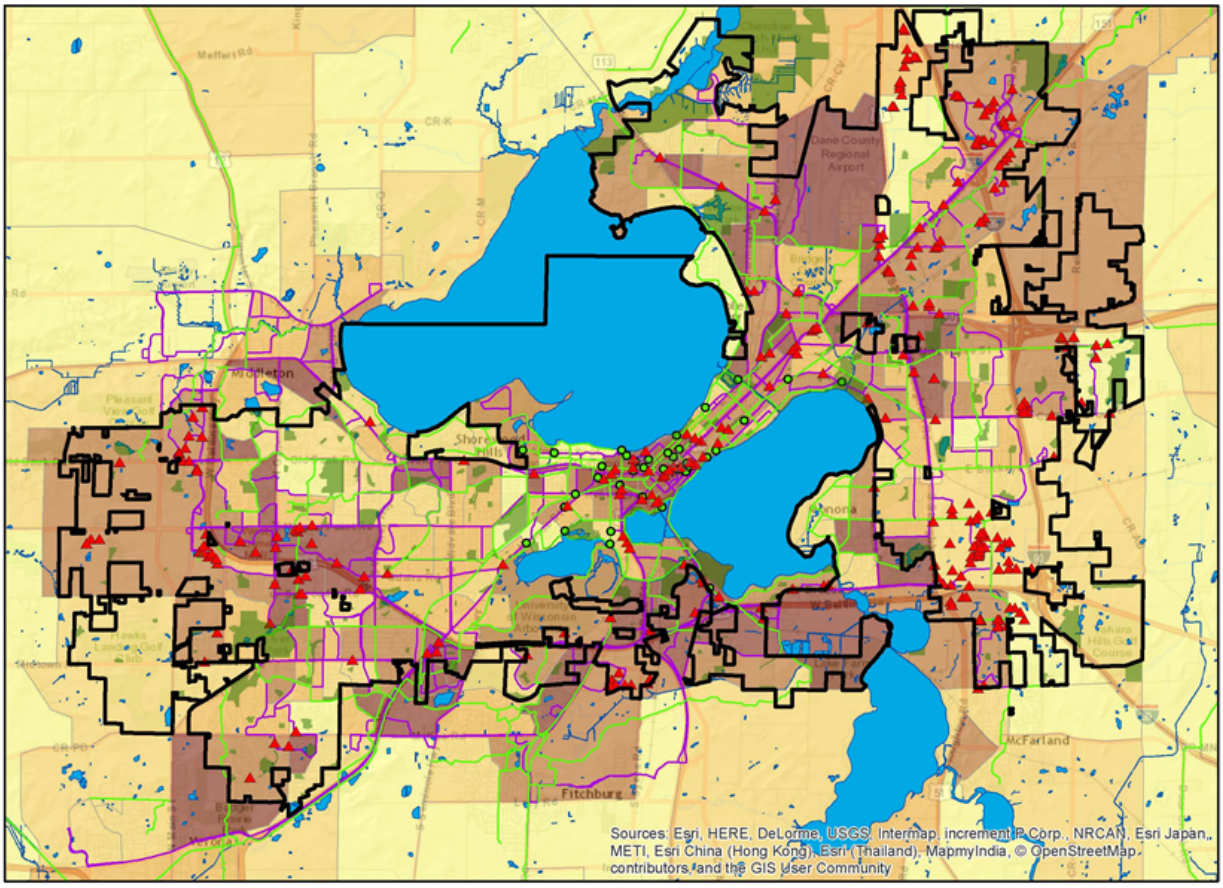
Bicycle

- Existing Bike Routes
- City of Madison B-cycle Stations
- 0.1mi Buffer Around Existing Bike Routes

Bus

- Existing Bus Routes

Appendix E. Map Action 7-11 "Promote usage of public rights-of-way (public land) and parks as edible landscapes, sculpture gardens, community gardens, prairie, etc."



Legend

- Wisconsin_Municipal_Boundaries_Spring_2016
- City of Madison Parks, Gardens, Zoos, Cemeteries
- Madison Vacant Land Sales

Transportation

- Existing Bike Paths
- Madison B-cycle Stations
- Existing Bus Routes

Dane Country Heat Vulnerability (county based quantiles)

- Low (bottom 20%)
- Moderate Low
- Moderate
- Moderate High
- High (top 20%)

Appendix E. Identification of Stakeholders

Land Trusts

- University of Wisconsin-Madison
- Madison Area Community Land Trust (MACLT)
- Natural Heritage Land Trust
- Gathering Waters Conservancy
- The Prairie Enthusiasts

Madison Agencies

- City of Madison Parks Department and Planning Division
- City of Madison Engineering Division
- Wisconsin Department of Health Services
- Madison Area Transportation Planning Board (MPO)
- Wisconsin Department of Natural Resources
- City of Madison- Planning Division
- Stormwater Utility
- Water Utility
- Madison Municipal Sewerage District
- City of Madison Streets Division
- Public Health- Madison and Dane County

Neighborhood Alliances

- City of Madison Neighborhood Associations (See linked map)

https://www.cityofmadison.com/neighborhoods/profile/neighb.pdf

Non-Profit Organizations

- Clean Lakes Alliance
- Community GroundWorks
- University of Wisconsin Foundation
- Wisconsin Association of Lakes
- Association of Floodplain Managers
- Wisconsin Wetlands Association
- The Nature Conservancy
- Friends of Wisconsin State Parks
- River Alliance of Wisconsin
- Sierra Club Foundation- John Muir Chapter

Health Impact Assessment:
Madison Sustainability Plan: Planning and Design

Authors: Kendra Brown, Mikal Drye, Ben Goodwin

Executive Summary: The main goal of the Planning and Design portion of the Madison Sustainability Plan is to utilize urban planning in a way that improves health by encouraging physical activity, increasing access to healthy food, stimulating sustainable building, and promoting mixed-use development. By planning the built environment in a way that promotes healthy living on a daily basis, this team looks to implement lasting changes that will provide health outcomes for communities. Although the initial plan included four goals with many actions, the following HIA is focused on just a few actions from each goal which represent broad changes that can be easily implemented in the near future. Each of these actions has been evaluated based on overall impact, practicality, and the ability to monitor progress. The actions selected represent a starting point for the City of Madison to make changes that will benefit the health and well-being of many community members within the city.

Statement of Problem: The built environment is a crucial determinant of public health. In the past 50 years, the U.S. has seen an astounding increase in chronic diseases such as obesity and

diabetes, and mental illnesses such as ADHD and depression (Dannenburg, Frumkin, and Jackson, 2011: p. xvi-xvii). Many argue that a large reason for these health changes is the rapid change from pedestrian-friendly, mixed-use community environments to car-dependent infrastructure (Dannenburg, Frumkin, and Jackson, 2011: p. xvii-xviii). It is important, then, for Madison's to consider these environmental determinants of health in future city planning and design.

Madison's sustainability plan outlines four key goals in future city planning and design. Goal 1 contains actions to improve transportation planning and systems to provide better access for community needs. Goal 2 fosters holistic land use, while Goal 3 supports sustainable infrastructure and buildings. Goal 4 promotes and develops local food systems. This impact assessment will holistically review the health ramifications of each of these goals. From there, it will recommend specific actions for the City of Madison to take based on the overall health impact and feasibility of each goal. We include suggestions to evaluate and monitor the progress of each action on improving the health of the community.

Identification of Stakeholders: The main stakeholders affected in this issue are the current and future residents of Madison, Wisconsin. These include residents of current neighborhoods as well as residents of neighborhoods that have yet to be built. It is important to note that it is essential all residents of Madison should be viewed as equally important stakeholders regardless of the location of their residence, their socioeconomic status, or whether they choose to involve themselves in the health impact assessment process or not. Another group of major stakeholders include those responsible for implementing the actions recommended by the sustainability report. These include architects, developers, construction agencies, and the City of Madison itself. Less prominent, though no less important, stakeholders include visitors and tourists to Madison.

Magnitude of Problem:

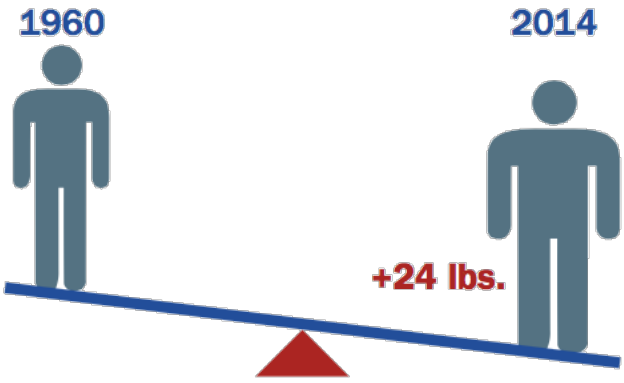


Figure 1: Average American Weighs 24 Pounds More than in 1960

http://stateofobesity.org/obesity-rates-trends-overview/

Since the 1970s, childhood obesity has nearly tripled among US children and adolescents (Dannenburg, Frumkin, and Jackson, 2011: p. xvi). In 2010, two out of three American adults were overweight or obese (Dannenburg, Frumkin, and Jackson, 2011: p. xvi). Obesity is a serious health concern that increases the risk of other diseases such as cancer, heart disease, and diabetes (Dannenburg, Frumkin, and Jackson, 2011: p. xvi). Rates of mental illness such as depression and ADHD have also climbed (Dannenburg, Frumkin, and Jackson, 2011: p. xvi). Many of these illnesses are in part due to environments which discourage healthy eating, physical activity, increase social isolation, and have little greenspace (Dannenburg, Frumkin, and Jackson, 2011: p. xvi).

In order to have healthy communities, we must design environments conducive to healthy behaviors. These include building infrastructure for safe active transit, such as walking and biking. Zoning for mixed-use land use with dense housing units, good connectivity, and a mix of shops and green space can increase physical activity (Dannenburg, Frumkin, and Jackson, 2011: p. 36-37). Building environments which encourage mingling and social interaction can promote social support and improved mental health (Dannenburg, Frumkin, and Jackson, 2011: p. 109). Integrating parks and green space into the environment can reduce inattention and mental fatigue (Dannenburg, Frumkin, and Jackson, 2011: p. 110). Healthy environments can be constructed, and it is crucial that Madison consider public health in future city planning and design.

Key Determinants: The built environment has played a large role in creating many of the health problems faced by Madison citizens. Many portions of the city lack safe routes for residents to travel via walking or biking, as portions of the city are very car-centric. This has negative effects on the health of individuals, as it decreases physical activity. Increasing and improving pedestrian and bike access will ultimately improve opportunities for daily physical activity, promoting a healthier city.

In addition, Madison is home to many historic buildings, which add to the charm of the city. However, many of these buildings have not been updated to meet new standards, and pose health risks for those living and working in these spaces. It is worthwhile to invest money in updating these buildings to ensure they meet current codes. Madison is also in the midst of a housing boom, due to an influx of jobs within the city. This presents the opportunity to encourage the development of high density and mixed-use housing in urban areas, which encourage physical activity and less reliance on driving.

Finally, another problem within Madison is food insecurity. Food deserts are disproportionately found in areas of the city characterized as low-income and have a high proportion of minorities. This is often due to poor zoning in these areas, which do not promote retail and grocery development, forcing residents to rely on high-calorie foods opposed to healthier options (Tarasuk, 2005: p. 302). It is important to focus on making changes in these areas to provide healthy and affordable options to individuals living here.

Analysis of Intervention:

Goal 1: The purpose of Goal 1 is to "improve transportation planning and systems to provide better access for community's needs" (Madison Sustainability Plan, 2011: p. 19). There is particular emphasis on public and active transit, with goals of improving bike and pedestrian

infrastructure, fostering transit-oriented development, and strengthening current "complete streets" policies. This goal explicitly focuses on reducing the miles travelled by vehicles in favor of alternative forms of transportation (Madison Sustainability Plan, 2011: p. 22).

These actions are likely to have many positive health impacts on the community. Neighborhoods which promote active transit modes such as busing, biking, and walking are associated with increased physical activity (Dannenburg, Frumkin, and Jackson, 2011: p. 156), which reduces the risk of many chronic illnesses (Genter et al., 2008: p. 9). Fewer vehicle miles travelled reduces air pollution, which is linked to health problems such as poor respiratory and cardiovascular health, and cancer (Dannenburg, Frumkin, and Jackson, 2011: p. 156-157). Neighborhoods with safer streets have lower mortality from vehicular accidents, and promote connectivity and social capital, which lowers chronic stress (Dannenburg, Frumkin, and Jackson, 2011: p. 159-160).

Goal 2: The purpose of Goal 2 of the planning and design section of the Madison Sustainability Plan is to foster holistic land use. Holistic development is development with a systems perspective in mind. Rather than just producing more housing units, holistic developers immerse themselves in the context of the development. Projects are planned and carried out with the specific needs of the community in mind to create livable, secure habitats that all residents to meet their vital daily social needs.

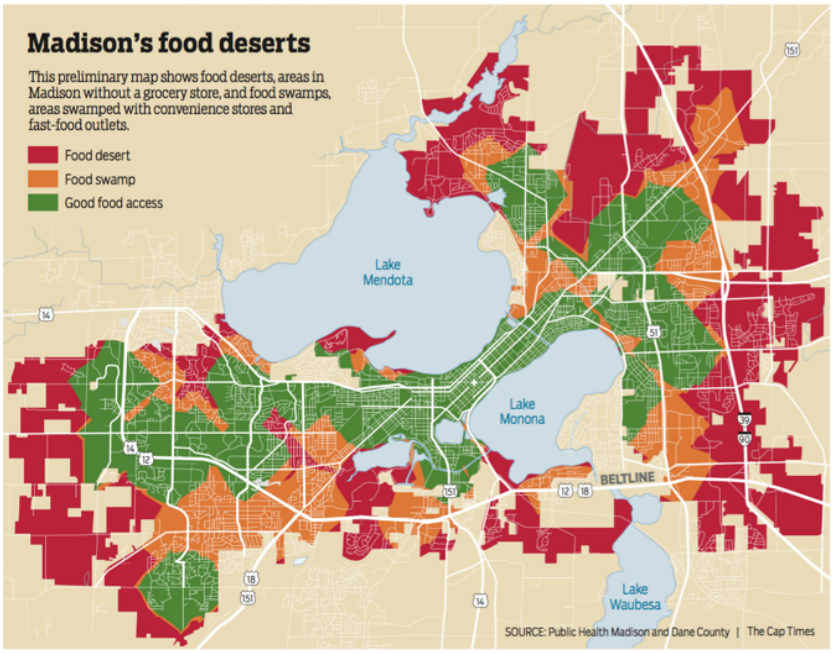
The City of Madison views holistic land use as an integral tool in planning and design that it can wield to create a healthier city, populace, and environment. Under the plan's description of the goal, holistic land use has a two-fold purpose. One is to encourage a high quality, mixed use city that is healthy for its residents and has a strong sense of place that showcases the uniqueness of Madison. The plan states that residents being able to meet daily

needs within half a mile of their respective residences— or within half a mile of public transit— would fulfill this goal.

The second aspect of the goal is to continually reassess, revalue, and if necessary reconfigure development plans for all neighborhoods. The city wants to study the conditions in healthy neighborhoods such as "livability, walkability, connectivity, density, commercial districts," and use those to help design future development plans. Another way the city plans to achieve this goal is through transparent, constant reviewing of neighborhood plans. Ideally this will involve the community as much as possible, in order to plan healthy neighborhoods that meet community needs and are also congruent with the goals of the city.

Goal 3: The purpose of Goal 3 is to "support sustainable infrastructure and buildings". In recent years, the City of Madison has begun encouraging sustainable development, recognizing that changes must be made to address major issues, such as climate change and public health. The main purpose of this goal is to provide incentives to developers who utilize these sustainable practices (Madison Sustainability Plan, 2011: p. 22). There are already buildings within Madison that demonstrate sustainable infrastructure, such as Monona Terrace and the Sequoya Branch Library. These projects meet many of the actions Goal 3 looks to achieve such as LEED silver certification, utilization of recycled glass throughout the buildings, and the use of rainwater collection to serve as a water source (City of Madison Sustainability, 2016). As this plan moves forward, it will be important to look to emulate projects such as these that successfully encompass the main goals of sustainability.

In addition to sustainable infrastructure, providing spaces that encourage physical activity and well-being are at the forefront of this plan. This goal seeks to increase these activities by building opportunities for activity within everyday life. This includes revitalizing sidewalks and bike paths to make them safer and more user friendly, and promoting the building of pocket parks (Madison Sustainability Plan, 2011: p. 22). As Madison continues to grow, it will be important to implement changes sooner rather than later, so communities can begin to reap the health benefits associated with these goals.



Goal 4: The purpose of Goal 4 in the Madison Sustainability Plan is to promote and foster local food systems. Maintaining a thriving, resilient local food system is vital to achieving meaningful sustainability. Strong local food systems help not only with food security, but also improve the local economy (Feenstra, 1997). Those without reliable access to healthy foods face health problems such as obesity, cardiovascular disease, diabetes, and a lack of general well-being. (James et al., 1997). Residents who live in an area where there is no access to fresh, healthy food are said to live in a food desert; those that live in an area where cheap, calorically dense food overshadows the more expensive, healthier options are said to live in a food swamp. The above figure illustrates that

there are many neighborhoods in Madison that are in dire need of healthier options at a lower price.

The plan desires to connect the producers of local food with local venues, support urban agriculture initiatives such as community gardens, increase the local public and private land allotted to local food production, and further develop the processing and distribution networks for local food. A strong local food system will improve the nutrition and therefore the health of the entire populace, especially those currently residing in food deserts.

Barriers and Opportunities for Implementation:

Goal 1: Funding remains a significant barrier to implementation for Goal 1. In Madison, 27% of the metro's total operating costs must be covered by local funds, which are limited by Madison's city budget (2035 Regional Transportation 2012: p. 124). It is likely that meaningful expansion of the bus transit system will require the creation of a regional transit governance system financed by new local taxes (2035 Regional Transportation 2012: p. 124-125). Funding for off-street bike paths is more optimistic, as predicted funding for these projects appears adequate for prioritized projects through 2035 (2035 Regional Transportation 2012: p. 129-130). Funding for further bike and pedestrian projects is less predictable and depends on future federal, state, and local budgets (2035 Regional Transportation 2012: p. 122).

In addition, the rapid growth of Madison will place increased stress on the already taxed public transit system, and increase the number of pedestrian, car, and bike commuters (2035 Regional Transportation 2012: p. ii). By 2035, Madison's population is expected to increase by 25% to 291,000 (2035 Regional Transportation 2012: p. ii). Along with this growth has come increased bus ridership; in 2015, Madison Metro Transit tallied over 15.2 million rides, an increase of 500,000 rides from 2014 (Metro Transit 2014). Since 2000, the number of bike commuters in Dane County has almost doubled, with 5.6% of workers living in the City of Madison commuting by bike (Bicycle Transportation 2015: p. 3). This growth must be taken into account when increasing active transit in Madison.

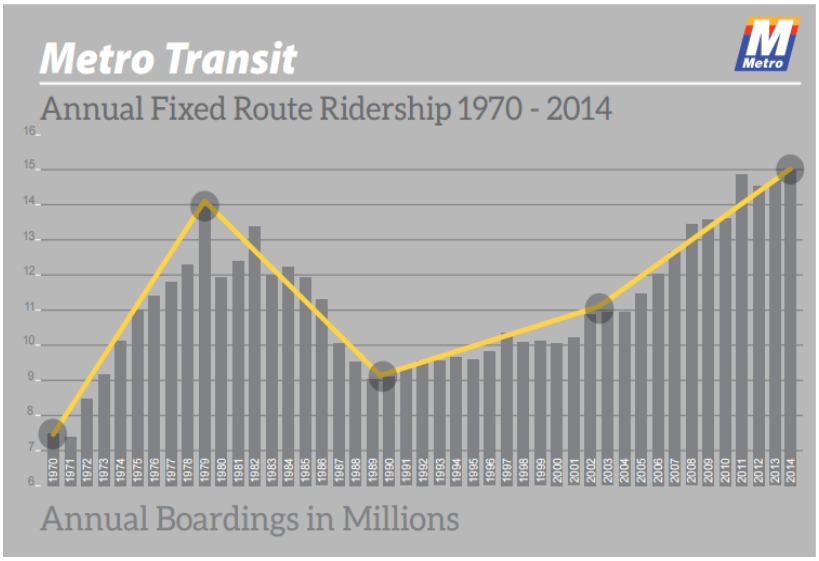


Figure 2: Increase in Yearly Madison Metro Transit Ridership (Metro Transit 2014)

Goal 2: Holistic development faces barriers because it does not have a clear definition, and takes a lot of effort on the part of the city, the developer, and the residents of the community. The single biggest barrier to true holistic development and mixed land use is that there are currently no disincentives to develop in a way that produces sprawl. Madison actually ranks near the top of all cities of its size in the nation when it comes to sprawl (Smart Growth America, 2014). However, it is easier for a developer to create a subdivision in Cross Plains, WI, than it is for them to build a block of row houses in an already existing neighborhood. Once the infrastructure is sprawl oriented, it makes it easier to continue to develop in a single-use mode.

The best way for Madison to combat this by planning new developments and neighborhoods holistically, and by making the downtown area a desirable place to live.

Goal 3: Although many initiatives suggested in Goal 3, such as requiring LEED silver certification in all public buildings or utilizing high-volume cement replacements, will yield sustainable changes, these projects come at a cost. The Madison area must determine who will incur these costs and over what time frame these changes will occur. Additional taxes may be unpopular with residents. The City of Madison must also realize that unlike laws, incentives are optional, and thus may not achieve the desired goals unless they provide real benefits to businesses and developers.

Another potential problem is finding spaces to create new housing that encourages mixed-use development and allows for pocket park creation. Madison is already densely populated, and spaces are limited to create new buildings. However, Madison is currently in the midst of rapid urban development, and there are opportunities to replace old infrastructure with new mixed-use and mixed-income housing options. City leaders must also balance development against the potential for displacement due to lack of affordable housing.

Goal 4: The most significant barriers to the fostering of the local food environment are cultural. Although it is a huge movement nationwide, local food is still seen as an alternative, not as the norm. The entire nation including producers, distributors, and consumers, are entrenched in a western food system that values monoculture, price margins, and ease (Pollan, 2013). The best way to overcome this barrier is education. Madison Metropolitan School District has more than thirty gardens at their schools, which are used for learning about food production, the environment, and to foster respect for nature in the students. There are also initiatives by non-

profits such as REAP Food Group, which supplies school children with local snacks, and brings in chefs to schools to teach cooking.

The major barrier to eliminating food deserts is economic. A food desert is not only defined by the availability of food, but by the affordability. While increasing access to community gardens can ameliorate the problem, they are not feasible on a large scale to feed entire food deserts. One way to overcome this barrier would be by creating economic incentives to supply local food at an affordable price in food deserts.

Policy Priority Setting:

Goal 1: One of the largest policy obstacles to overcome for Goal 1 is political opposition to the creation of Dane County Regional Transit Authority (DCRTA). This authority would implement an additional local sales tax, which would raise crucial funding for the implementation of a bus rapid transit system (2035 Regional Transportation 2012: p. 124). In 2009, the state legislature authorized the creation of the DCRTA, but in 2011 the state legislature dissolved this body (2035 Regional Transportation 2012: p. 124). Without an RTA, it will be exceptionally difficult to find and maintain funding for bus rapid transit or commuter rail in Madison. Rapid, efficient modes of transit provide opportunities for transit-oriented development along stops which in turn promotes the development of walkable and bikeable neighborhoods.

Goal 2: The major policy barrier to implementing more holistic land use policies in Madison are the current zoning laws that are in place, and the lengthy process required to circumnavigate them. This is especially true of older neighborhoods. The City of Madison already includes holistic planning principles in their new developments. The challenge is that older areas have already been zoned, and conditional use permits can be hard to obtain. This is especially true of larger development projects, which need the approval of multiple city committees and the other

residents of the neighborhood. The current zoning laws also prevent redevelopment to increase the density of an area.

Goal 3: Due to the changes in infrastructure and buildings proposed, there are some obvious policy obstacles to overcome. This plan calls for incentives for sustainable development, infill development, and meeting LEED silver standards for public funded construction. In order to achieve these incentives, policies will need to be created that determine what projects qualify for this benefit. While establishing policies for requirements met by LEED silver standard buildings will be easier because these policies already exist, creating minimum requirements for other development will be more difficult. Additionally, the overarching goal of providing these incentives is to persuade developers to create sustainable spaces ultimately leading to a healthier city. Incentives must be tempting enough to these developers to utilize them, otherwise they will not be taken advantage of, and no progress will be made.

Goal 4: Agriculture subsidies from the federal government serve as the main barrier to local food systems. Subsidies insulate producers of food from the market; they reward meeting the needs that the federal government prescribes, rather than the real needs of their consumers. These subsidies perpetuate the large scale industrial agriculture that shapes the nation's food system. "If these agricultural subsidies went directly to consumers to allow them to purchase food, each of America's 144 million taxpayers would be given $7.36 to spend on junk food and 11 cents with which to buy apples each year – enough to buy 19 Twinkies but less than a quarter of one Red Delicious apple apiece" (Russo, 2011). If the subsidies are not altered to incentivize the production of healthy food intended to be sold locally, then it will continue to marginalize the small and mid-scale farms that local food production depends on.

Recommendations and Communication Plan: After reading through the Madison Sustainability Plan, we have identified actions within each of the four goals that we feel highlight the main goals of the planning and design section, focusing on both holistic land use and mixed-use development. Our overarching recommendation for the City of Madison is to begin with these smaller and shorter term changes that can be easily implemented, and gradually work towards the larger and longer term goals.

Goal 1 - Actions 4, 9: Within Goal 1, we identified actions 4 and 9 as attainable areas of particular health impact. Action 4 aims to "implement further planning efforts to create efficient regional transit hubs, including developing an express bus/Bus Rapid Transit (BRT) program to decrease commute times and improve customer service" (Madison Sustainability Plan, 2011: p.19). Use of public transit is well-known to increase levels of physical activity. With Madison Metro's ridership increasing each year, there is ample reason to believe that a bus rapid transit system would be highly utilized. Furthermore, Madison has detailed plans in place to implement either a BRT or commuter rail system once funding becomes available. The city should focus on petitioning the state legislature to allow for the creation of a regional transit authority in order to move towards a more modernized transportation system.

Goal 9 aims to "Plan for, map and implement major pedestrian and bicycle facilities in new developments and within the city and region to ensure a well-integrated pedestrian/bicycle corridor network. Emphasize closing gaps and overcoming physical barriers and challenging intersections" (Madison Sustainability Plan, 2011: p.19). This is a broad action which aims to improve bike and pedestrian infrastructure as a whole. It also encompasses a number of other actions within Goal 1, including the promotion of bike infrastructure, commuter sidewalks, and complete streets design. This action would make active transit easier and more pleasant for

Madison residents, and acknowledges the need to expand infrastructure for active transit into new developments as the population grows and the city expands.

Goal 2 - Actions 1, 4: Within Goal 2, we have identified two actions in particular that we believe should be focused on to create a meaningful, positive impact in regards to the sustainability of the city of Madison. These actions are: "plan and create walkable neighborhood opportunities for Madison's increasing population. Upgrade walkability in already built out neighborhoods," and "Encourage higher density of single family housing (e.g., additional dwelling units, row houses and small single-family lots near parkland)" (Madison Sustainability Plan, 2011: p.20). Part of the reason these particular actions were suggested is that they are concrete ones that can be applied to both new developments and redevelopment of older neighborhoods. We also consider these actions to both have major environmental and public health impacts.

Sustainable cities in the future will not be car dependent, they will be walkable. By increasing the walkability of an area, whether it be by improving sidewalks, creating new paths, increasing the connectivity of existing paths, or developing services near residences, residents will see benefits as they walk more (lower obesity rates), and drive less (lower emissions). Walkable cities are also more equitable cities. It removes the financial burden of owning a car, which in many neighborhoods is still a prerequisite to leading a normal life.

The next action, increasing residential density, is a phrase that is often misunderstood by the public. Higher density housing does not necessarily mean that everyone must move into high rises; it merely means that the density should be increased. This will encourage infill development, and discourage sprawl. Sprawl is strongly associated with poor health and well-being (Frumpkin, 2002). Simply eliminating sprawl development is a strong start to building a

more sustainable city, and this is the action that does this most effectively. This action will look like: building rowhouses on small lots in existing neighborhoods, increasing the number of residences in existing buildings, or simply building smaller.

These two actions were chosen to focus on because we feel as though they will have the most concrete health benefits for the residents of the city of Madison. If the city can upgrade its walkability and density in existing neighborhoods, while concurrently applying these design principles to new developments, then Madison will be making strides toward being a truly sustainable city.

Goal 3 - Actions 7, 9: Within Goal 3, we identified two actions that we feel are attainable, and will ultimately improve the health and well-being of Madison communities. The first of these is Action 7, which looks to "create incentive programs to encourage rehabilitation of existing buildings and new infill development" (Madison Sustainability Plan, 2011: p.22). By providing incentives, such as tax breaks or additional funding for smart growth, developers will be more apt to build future communities and revitalize others with sustainability and health at the forefront of these plans. Since Madison is currently experiencing a housing boom, and an influx in new development, it is important to implement these changes as soon as possible, so that new development reflects these sustainable goals.

The second action is Action 9 which looks at promoting pocket parks in neighborhood communities (Madison Sustainability Plan, 2011: p. 22). Pocket parks are an easy way to incorporate more green space and increased opportunity for both physical activity and social capital within a community (Cohen, et. al., 2014: p.25). Previous research has demonstrated that despite the inability for vigorous activity within pocket parks due to their size, there are still many health benefits to be gained. Pocket parks encourage individuals to walk to these parks,

and partake in mild to moderate physical activity, effectively serving as a "catalyst for physical activity" (Cohen, et. al, 2014: p.25). Additionally, pocket parks serve an important role in "strengthening social ties", and promoting social capital as neighbors meet and socialize within these parks (Cohen, et. al, 2014: p.25). Due to the smaller size of pocket parks in comparison to larger scale parks, they are more cost effective, and the project time frame is also much shorter, allowing health benefits to be felt sooner.

Goal 4 - Actions 2, 10: In order to foster and encourage Madison's local food system, we recommend two specific actions to be focused on. These actions are: "Identify and develop strategies to eliminate "food deserts" (i.e., areas of the city that are distant from food stores)," and "Work with local farmers and other stakeholders to create processing and distribution systems for their goods, and connect institutional buyers to these systems." These two actions together will increase the equity of the local food environment while at the same time increasing the capacity of it. As access to healthy, local food increases, there will be real and quantifiable public health benefits.

Although there is access to locally grown food in the Madison area, it is not equitable access. If Madison increases the production of its local food system without addressing the fact that there are food deserts in the city, then it will only be a very shallow improvement, and not a truly sustainable one at that.

Action 10 will work to increase the capacity of the local food system by helping farmers to distribute their food. Connecting small to midsized farms with the buyers creates a local market for farmers to sell in. Without creating the market for them, it is more challenging for them to reach the consumer. The most efficient way to do this thus far has been to use non-profit groups. These groups, such as REAP Food Group (Formerly Dane County Research, Education,

Action and Policy on Food Group) act as the middlemen between farmers and coalitions of farmers, and institutions. They also have programs aimed at local food education such as bringing local, healthy snacks to elementary schools. By increasing the ability of farmers to reach consumers, it will be possible to create a local food system where locally grown food is equitably available year round; this will have a dramatic positive impact on the health of the population and the local economy.

Evaluation and Next Steps:

Goal 1 - Action 4, 9: Progress indicators for action 4 include legislative approval of a Regional Transit Authority (RTA) and actual construction of a bus rapid transit (BRT) system. Additional indicators for use of public transit include mode of transportation to work, travel time to work, and % of urbanized areas and population served by transit (2035 Regional Transportation 2012: p. 146). Data for type of mode of transit and travel time to work can be obtained through the American Community Survey, which collects information yearly (Bicycle Transportation 2015: p. 53). Further information can be obtained through surveys and evaluation conducted by Madison Metro Transit.

Progress indicators for action 9 include miles of bike lanes and multi-use paths, number of bike and pedestrian commuters, and total bicycle and pedestrian crashes and fatalities (2035 Regional Transportation 2012: p. 146). Data on miles of bike lanes and multi-use paths can be obtained through evaluations conducted by Madison Traffic Engineering. The number of bike and pedestrian fatalities can be obtained through the Wisconsin Department of Transportation. Further data on usage of multi-use paths can be obtained through the UW Madison Transportation Services Study, bike counters on paths, and with the help of volunteer human counters (Bicycle Transportation 2015: p. 53).

Goal 2 - Actions 1, 4: Holistic land use is a broad term, so it is a challenge to accurately measure the degree to which Madison is progressing in regards to this goal. To simplify matters, we recommend that an operational definition of holistic development is adopted. This definition should focus on the availability of employment, recreation, healthcare and other vital needs, healthy food, public transit, and education, within walking distance of a given residence. Geographic information systems could be used to assess and score each block of Madison. An important aspect of this measure is that it should be publicized. Every resident should be able to easily learn about the quality of their neighborhood environment to encourage more community participation in the neighborhood planning process. True holistic planning recognizes that urban communities are complex systems, and this awareness of environment is a feature of the system.

In order to determine whether higher density development is occurring, the density of each neighborhood should be measured as a baseline, and it should be retaken periodically. This will help to determine how the density of each neighborhood is evolving with time, and how that density responds to different policies and actions taken by Madison. Madison should also be aware of the age of all of the neighborhood plans, so as not to let them become dated.

Goal 3 - Actions 7, 9: Incentive programs for sustainable development should be consistently monitored to ensure that companies are partaking in the program. If it appears that these incentive programs are not being utilized, it may be worthwhile for the City of Madison to look into providing better incentives or moving to implement laws that assist in creating sustainable buildings. In Massachusetts, one incentive for smart growth development required meeting certain goals in order to keep the funds, such as ensuring that 20 percent of the new housing development here was affordable (Ingram, Carbonell, Hong & Flint, 2009: p. 7-8).

There are also methods to study the impact of pocket parks on health. Baseline surveys should be conducted to measure the amount of physical activity that individuals report and their social connectedness to those living near them. After the creation of these spaces, the System of Observing Play and Recreation in Communities (SOPARC) evaluation can be utilized. This approach utilizes direct observation to assess park usage, characteristics, and physical activity levels of park users (McKenzie & Cohen, 2006: p. 2). Data obtained from SOPARC can be used in conjunction with data detailing the prevalence of diseases, such as high blood pressure or obesity, which are often linked to inactivity. SOPARC data can be utilized to compare social gathering rates to mental health statistics of the neighborhood.

Goal 4 - Actions 2, 10: This health impact assessment recommends a two pronged approach to monitor and evaluate the progress made in fostering the local food system of Madison, specifically the elimination of food deserts. Focus should be placed on the community nutrition environment and the consumer nutrition environment. The community nutrition environment consists of the type, location, and number of stores, as well as the availability of different varieties of food at each site. The community environment takes a more global perspective of what people are buying and why (Kelly, 2011). A further crude measure to assess local food production includes measuring and monitoring the gross production of local food that is meant for consumption.

In order to quantify the community and consumer nutrition environments, we recommend that a version of the Freedman Store Audit (Freedman, 2009). The audit takes takes a census of all food outlets within walking distance of a given location. The type of outlet and the types of food sold are recorded. Surveys are conducted of local diets and perceptions of the local food environment. Baseline measures are taken and repeated periodically. Geographic information

systems should be used to map food outlets. In this way it will be possible for Madison to comprehensively assess progress in fostering local food and eliminating food deserts.

Conclusion: In sum, the Planning and Development sustainability goals recommend promoting active transit and more efficient public transit, zoning for high-density and mixed-use neighborhoods close to amenities, incentivizing sustainable "green" infrastructure, and prioritizing local farmers while improving local food systems. Taken together, these changes will promote a healthier population through increased physical activity and healthier diets. In addition, such changes will promote economic growth and put Madison on the map as a progressive, pleasant city in which to live. Madison has a unique opportunity to design for health and sustainability, and should capitalize on this for the benefit of future generations

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Health Impact Assessment

City of Madison Sustainability Plan - Transportation

PHS740 Spring 2016

Ana Dyreson, Austin Gerdes, Josh Wolf, Tin Nwe Oo

1. Executive Summary

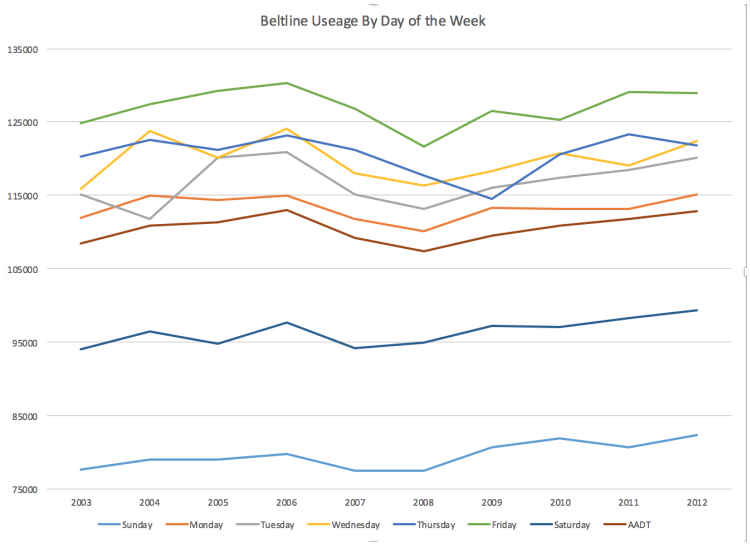
This Health Impact Assessment seeks to address changes and improvements to the City of Madison sustainable transportation infrastructure. Faced with increasing mortality and morbidity due to ever increasing levels of obesity, and lack of physical exercise, we chose to examine the impacts of investing in new and maintaining current levels of bicycle infrastructure in the city. Public transit usage decreases traffic congestion, reducing air pollution, and provides connectivity between neighborhoods leading to increased mobility for residents who may not have access to a personal vehicle. In this paper we identify problems associated with high personal vehicle use, and low active mobility. Local data comparing Madison to national leaders in the areas of health and transportation are analyzed. We present recommendations for the City Planning Commission to increase levels of bus and bicycle ridership in the city through the examination of the demographics that stand to benefit the most from incremental changes to both bike infrastructure and the Madison Metro Transit system. The health impacts of increasing bus ridership and increased numbers of bicycle commuters are assessed. Current barriers to sustainable transit are discussed and a communication plan for local residents is outlined.

2. Statement of Problem

The United States of America is a country that is heavily dependent upon automobiles for commuting transportation. According to a U.S. Census survey, as of 2013, 85.8% of workers still rely on automobiles for commuting, and only 9.4% of all workers carpooled to some extent. This is true in Dane county as well, as according to the Madison Transportation Board 64% of Madison residents and 73% of Dane county residents drove to work alone.

A society's dependence on the traditional automobile has several negative consequences on public health, both directly and indirectly. Directly speaking, any time that is spent driving is sedentary, which is less beneficial for one's health than more sustainable forms of commuting, such as walking or biking. One study (Gordon-Larsen et al.) found that "Active commuting was positively associated with fitness in men and women and inversely associated with body mass, obesity, triglycerides, blood pressure and insulin in men. Active commuting should be investigated as a modality for maintaining or improving health." Also, a massive study from Sweden indicates that commuting was correlated with sleep disturbances and elevated stress levels [Hansson et al].

Traditional commuting also leads to air pollution. The average commuter who gets 22 MPG and drives a 30 mile round trip to work daily is responsible for emitting 4.3 metric tons of carbon yearly, according to a 2003 US-DOT report. Considering the US population in 2003 of 290.1 million people, 4.6 metric tons of carbons multiplied by ~94% of US citizens that were employed, and then multiplied by ~76% (percent of US commuters who commuted alone in 2003), yields that in 2003 single passenger commuters accounted for approximately 973,622,016 metric tons of carbon. Given that according to the EPA in total the US emitted 6,000,000,000 metric tons of CO_2 in 2003, one can assert that commuters who drove alone in 2003 accounted for nearly *one sixth* of US carbon emissions. The percentages of US workforce that drive and drive alone have nearly plateaued and remained the same since 2003. Figure 1 shows the trend of Beltline Highway users in Madison, WI from 2003-2012 sorted by day of the week. This data matches this national trend.



3. Identification of Stakeholders (Ana)

Several groups of engaged stakeholders have promoted sustainable transportation or used it in the past including the Wisconsin Bike Federation and the many local Madison riders (5.2% of Madison residents commute by bike according to 2009-2011 data from the MPO, #11 overall according to the League of American Bicyclists). The City of Madison (including Madison Metro) is also an important stakeholder along with the municipalities where Madison Metro also serves and which either import workers to Madison or provide jobs for City of Madison residents. The two most clearly connected and significant municipalities are Middleton and Fitchburg. The most important stakeholders may be those most difficult to reach: residents who do not current use alternative transportation. In the health impact analysis we break down the stakeholder groups by neighborhood and by race where possible.

4. Magnitude of Problem

Distance to bus stop, density of bus stops, and number of transport modes were positively associated with being an active commuter and with meeting recommendations of physical activity (Djurhuus, 2014). Those commuting by transit accumulated more moderate-intensity physical activity (approximately 5 to 10 minutes) and walked more to services and destinations near home and near the workplace than transit non-users (Lachapelle, 2011). Active transportation (walking and cycling) provides many health benefits including preventing obesity and chronic medical disease such as diabetes mellitus and heart disease. Commuting by transit can be less stressful than driving, particularly in bad weather or during rush hour.

In addition to these health benefits, transits and access to active transport improve access to medical services and healthy food that are particularly important for low-income persons, seniors, and persons with disabilities while reducing social isolation and promoting community cohesion. Transit access also decreases social economic disparity by providing access to employment and education. Typical households spend 20% of their total household budget on transportation. American Automobile Association (2010) figures showed transportation by car alone is six times more expensive than transportation by bus. Public transit and active transport reduce the financial burden of transportation and reduces cars on the road. Transit and active transport oriented development and street design slow traffic and reduce crash rates. Riding a bus is 170 times safer than auto travel according to National Safety Council data. In addition, fewer cars mean less air pollution, and air pollution associated respiratory illnesses (See figure 2 below showing four visions with different levels of health risks and benefits depending on type of transportation infrastructure).

Figure 2: Four visions representing four different possibilities for urban transport. Visualizations are of a 'typical' Victorian terraced street, created by the School of Computing at the University of East Anglia.

Although the overall transit score (1-10) of the Madison municipality is 7.3 (very good jobs accessible enabling many people to take transits to work), less than 10% of commuters use public

transportation. Only 11% of workers residing within half mile of transit commute by walking and 6% of workers commute by bicycle (AllTransit, 2016). This car dependency leads to spending more time, energy, and money on transportation in Madison. The Housing and Transportation Affordability Index is one indicator of urban sustainability through location efficiency. Only 9% of of Madison neighborhoods are rated as efficient neighborhoods. There are 1.6 autos and 19,000 Annual Vehicle Miles Traveled per household. Only 6% of workers are transit riders and auto use produces 7.55 Tonnes annual GHG per household (HTA Index, 2016).

The transportation choices that communities and individuals utilize have important impacts on health through active living, air quality, and traffic crashes. Choices for commuting to work include walking, biking, taking public transit, car-pooling and driving alone. 73 % of the workforce drives alone to work in Dane County compared to 71% in top U.S. performers. Among those who commute to work by car, truck, or van alone, 23% percent drive longer than 30 minutes to work each day compared to 15% in the top U.S. performing city. The relationship between elevated air pollution and adverse health outcomes (respiratory and cardiovascular problems) has been well documented. Average daily density of fine particulate matter (PM2.5) in Dane County is 12 compared to 9.5 micrograms per cubic meter in top U.S. performers (County Health Rankings, 2016).

There is strong evidence that residing in a food desert is correlated with a high prevalence of overweight, obesity, and premature death. The Food Environmental index in Dane County is 8 compared to top US performers rated at 8.3. Inactivity causes 11% of premature mortality in the U.S. In Dane County, 95 % of individuals live reasonably close to a location for physical activity compared to 91% in top U.S. performers. Of adults aged 20 and over in Dane County, 15% report no leisure-time physical activity compared to 20% in top U.S. performers. In Dane County 20% of the adult population reports a body mass index greater than or equal to 30 kg/m2 compared to 25% in top U.S. performers (County Health Rankings, 2016).

Poor family support, minimal contact with others, and limited involvement in community life are associated with increased morbidity and early mortality. A 2001 study found health risk associated with social isolation is similar to the risk of cigarette smoking. In addition, individuals with a strong network (living in areas with high levels of social trust) are more likely to make healthy lifestyle choices and rate their health status higher. There are 12.8 social associations per 10,000 population in Dane County compared to 22.1 in top U.S. performers (County Health Rankings, 2016).

5. Problem Mapping

In looking at transportation deficits in the City of Madison, a number of causations emerge for the lack of personal use of public transportation infrastructure. We have selected the expansion of Madison Metro bus service and the creation and ongoing maintenance of bicycle infrastructure throughout the city as our areas of focus. These areas were selected for their ability to maximize the amount of citizen demographics that would be reached through improvements. There are multiple determinants that hinder people's usage of both public transportation and bicycle infrastructure. A number of common complaints include: people cannot find time to exercise during their busy days; people lack proximity to a bus route that will take them to places they want to go; people are unable to meet their basic needs, such as groceries, jobs, entertainment, within a reasonable biking distance; people do not feel safe utilizing bicycle infrastructure; people lack access to a bike; people are uncomfortable with the stigmatization of riding the bus. These and other factors contribute to people's reluctance to utilize the Madison Metro bus system or bicycle infrastructure.

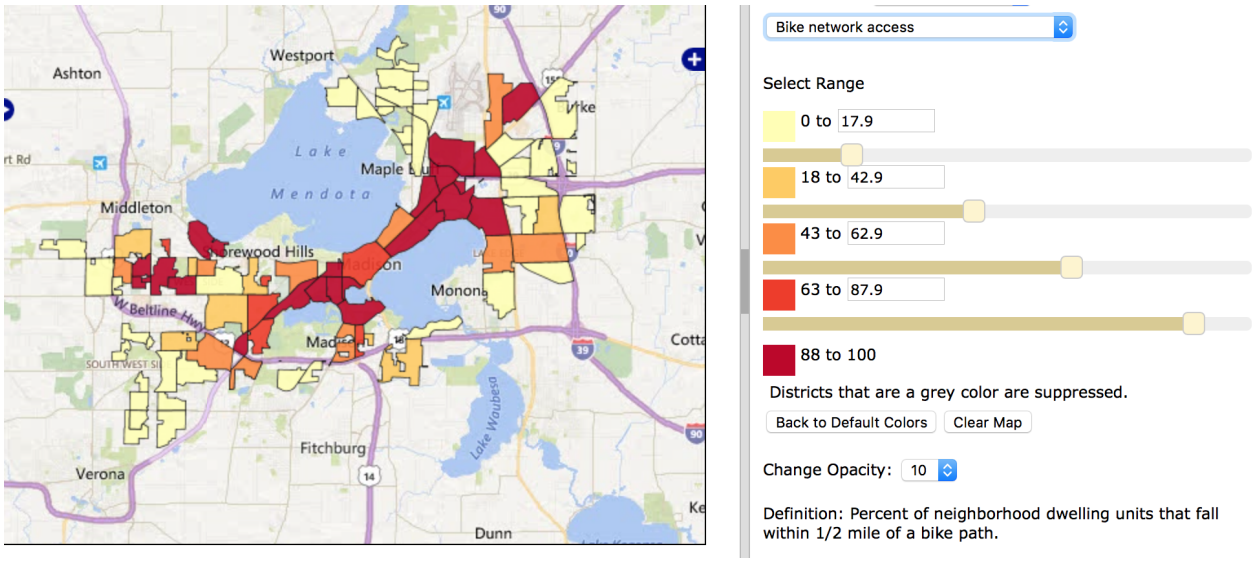
6. Analysis of Intervention Strategies

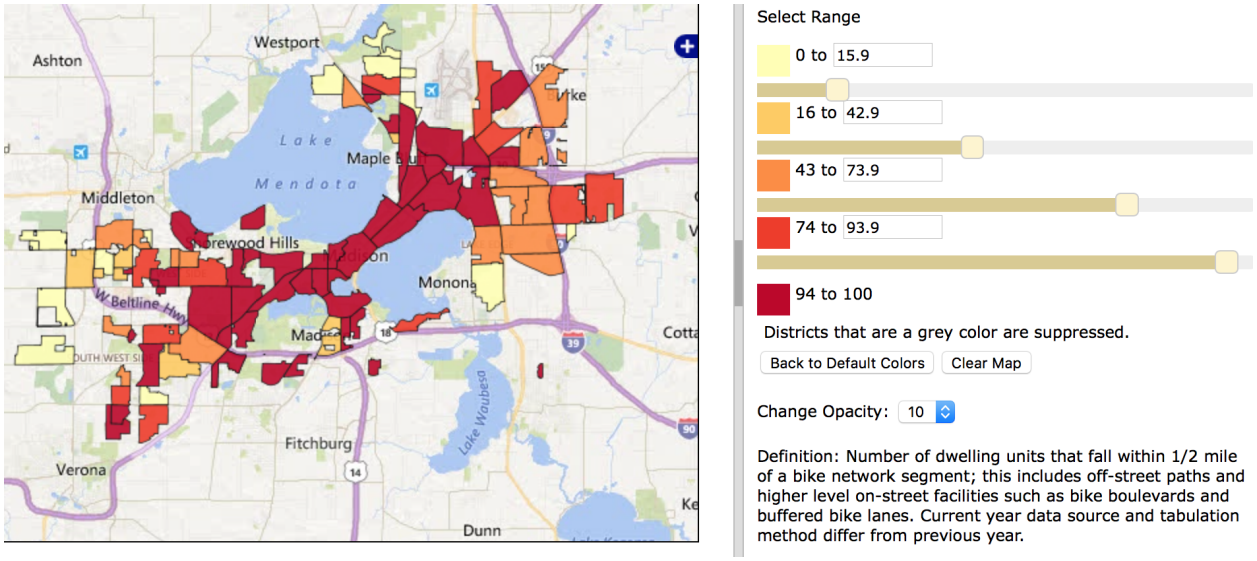
There are many potential and viable solutions to decrease reliance on cars in Madison as shown in the Concept Map created in narrowing the scope for this assessment.

This section describes the intervention strategies and health impacts from increasing ridership on Madison Metro (a result of expanded Madison Metro system) and from increasing bike commuters in Madison (from improving existing bike network).

Opportunities for the City to increase bike ridership

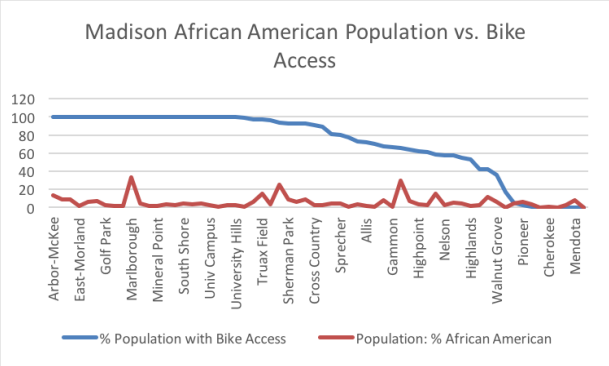
In 2014, 7,323 of Madison's 245,674 residents, or 5.3%, were bike commuters. (The League of American Bicyclists). That percentage was 3.2% in 2000, and 5.2% in 2011 (Madison Area Transportation Board). While this percentage is greater than that of many other US cities, and increasing over time, there is certainly still room for improvement in the number of cyclist commuters in Madison. To break those numbers down a little bit more, one can look at a map of Madison's bike network access by neighborhood, put together by the Applied Population Lab, comparing first 2008 and then 2014.

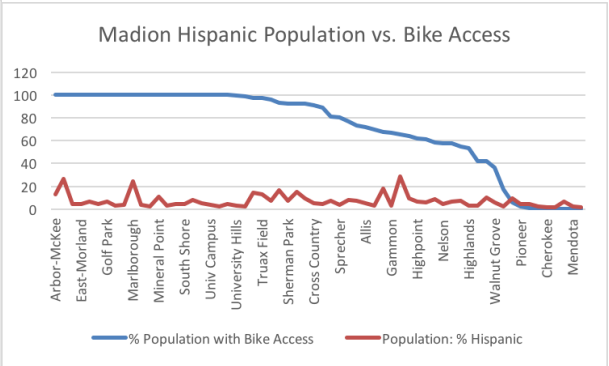


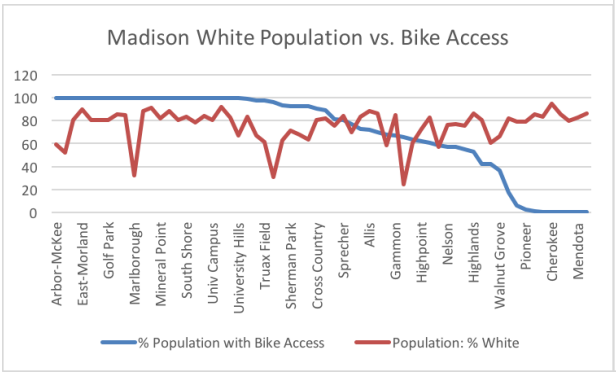


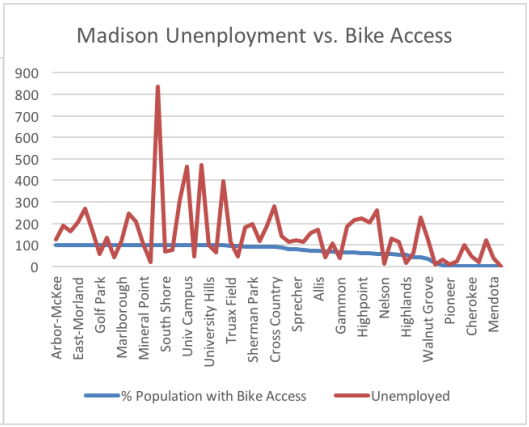
Figures 3 and 4.

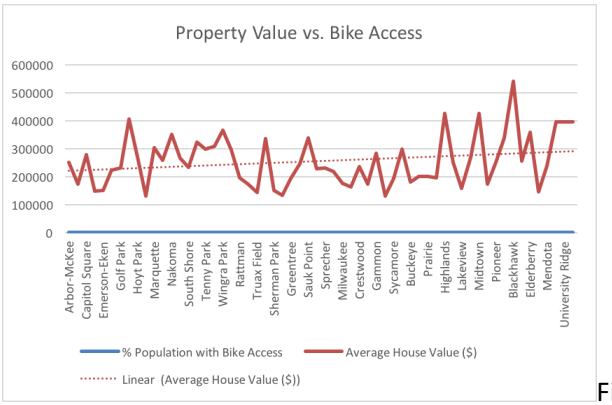
The study looked at the number of units in a neighborhood that "fall within ½ mile of a bike network segment; this includes off-street paths and higher level on street facilities such as bike boulevards and buffered bike lanes." By looking at these images, it becomes clear that Madison has been doing a good job of expanding bike infrastructure. However, by looking at the percentage of each neighborhood with access to bike lanes, it becomes clear that while residents of the isthmus have pretty good access to some sort of biking infrastructure, those in the outskirts of Madison and even surrounding suburbs still do not. Looking into the demographical area of this notion:











Figures 5-9.

In all of these graphs, the blue line represents the percent of a residences in a neighborhood with access to biking infrastructure within ½ mile of that residence. For each graph, this blue curve follows the exact same curve despite looking different in relation to the different axis. First, looking at race, there does not appear to be a correlation between being White, African American, or Hispanic and one's access to bike infrastructure in Madison. Next, there does not appear to be a strong correlation to unemployment and bike access. There is a very slight increase in property value as access to biking infrastructure decreases. These breakdowns demonstrate that there is not a clear trend in Madison between access to biking infrastructure and any given demographic. However, the charts do tell us consistently that there are certain neighborhoods that could really use additional biking infrastructure. For example, the neighborhoods of Junction, Lakeview, Walnut Grove, Midtown, Glendale, Pioneer, Cottage Grove, Blackhawk, Cherokee, Elderberry, Gompers, and Mendota all have less than 50% of the

total residences without access to safe cycling infrastructure. Considering that one survey found that over one third of people who wanted to ride their bike more were dissatisfied with existing bike infrastructure, it is vital to provide all neighborhoods in Madison with ample bike infrastructure, and those neighborhoods should be targeted.

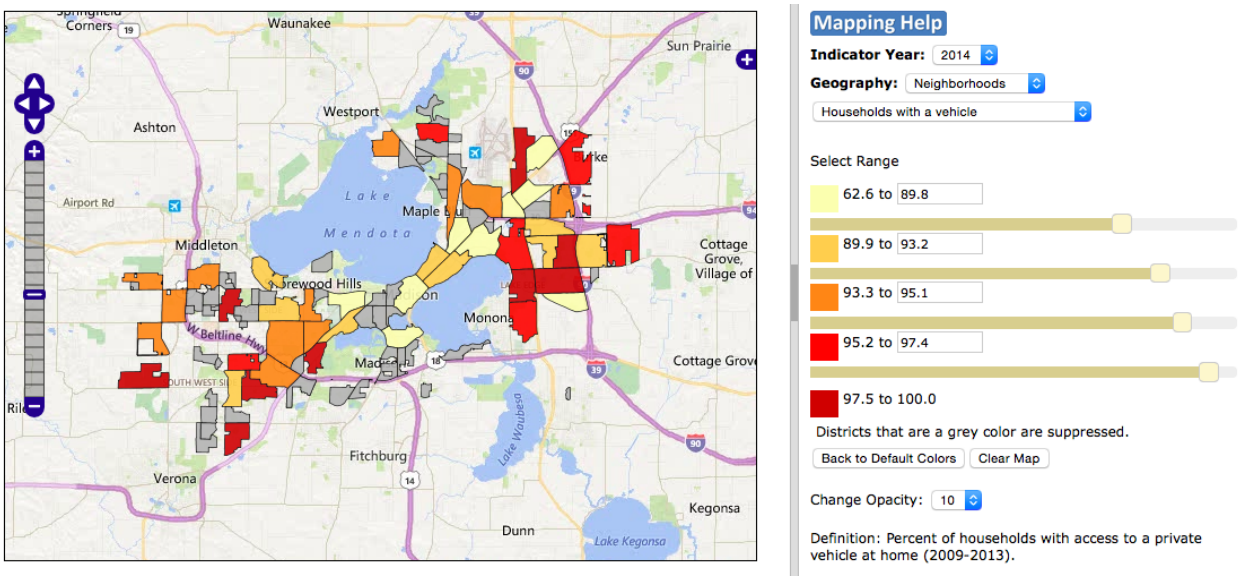
Opportunities for the City to increase bus ridership

We have reviewed the Regional Values & Priorities Survey and the 2015 Metro Transit Onboard Survey to determine the root causes of problem and current controversies or limitations to increase bus ridership. The 2013-2017 Transit Development Plan for the Madison Urban Area mentioned potential solutions to problem. Madison Metro's fixed-route transit service is grouped into four categories: core routes (2,4, and 6 - high frequency routes connecting transfer point), peripheral routes (13 and 32 – connect neighborhoods), commuter routes (38 and 75 weekdays peak-period service from residential areas to education/employment centers), and circular routes (10 and 80 – shorter routes within major activity centers or between an activity center and a nearby residential area). Metro has four major transfer points to decentralize the system that reduce travel times in outer Madison neighborhoods by providing cross-town service and eliminating many transfers at the Capitol Square (Madison Area Transportation Planning Board, 2013).

In Regional Values & Priorities Survey on prioritizing importance and performance on transportation, public transit has medium performance and importance priority. High capacity transit has low performance and medium importance priority. More than 80% of responders agree in expanding (adding high capacity) public transits and creating express bus network (Madison Area Transportation Planning Board, 2016). The Neighborhood indicators show neighborhoods at Madison CBD have higher transit stop access and bike network access, but neighborhoods located at outer

Madison have more households with a vehicle (Figure 10). AllTransit metrics show percentage of workers residing within half mile of transits commuting by cycling and walking are higher in downtown Madison compared to outskirt neighborhoods of Madison (Figure 11).

Figure 10 Neighborhood indicators by households with a vehicle and transit stop access



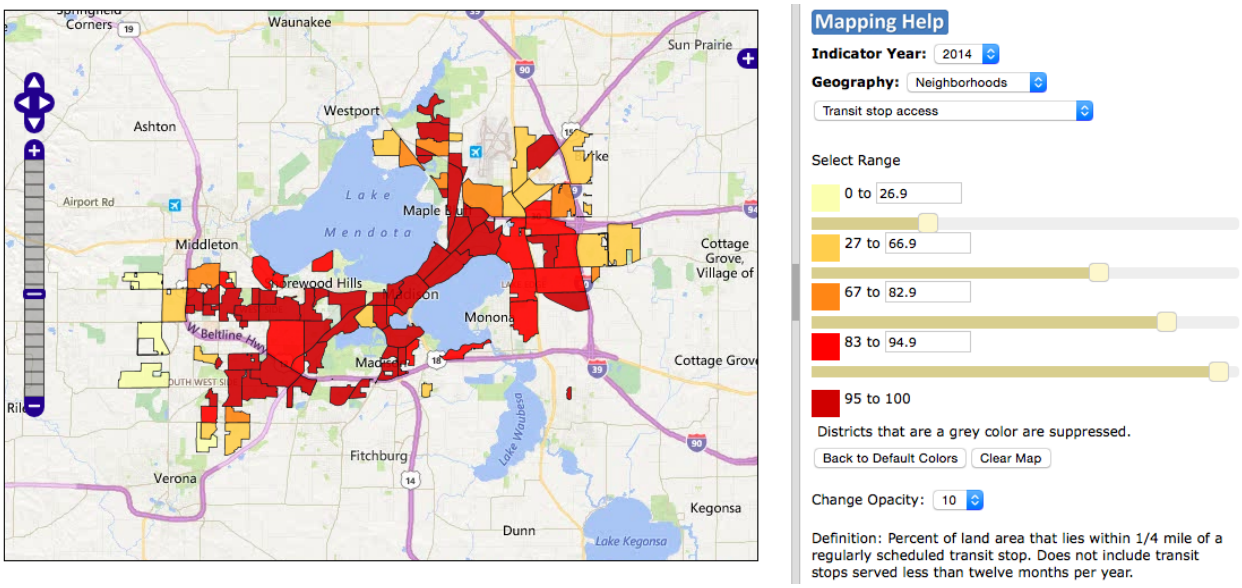
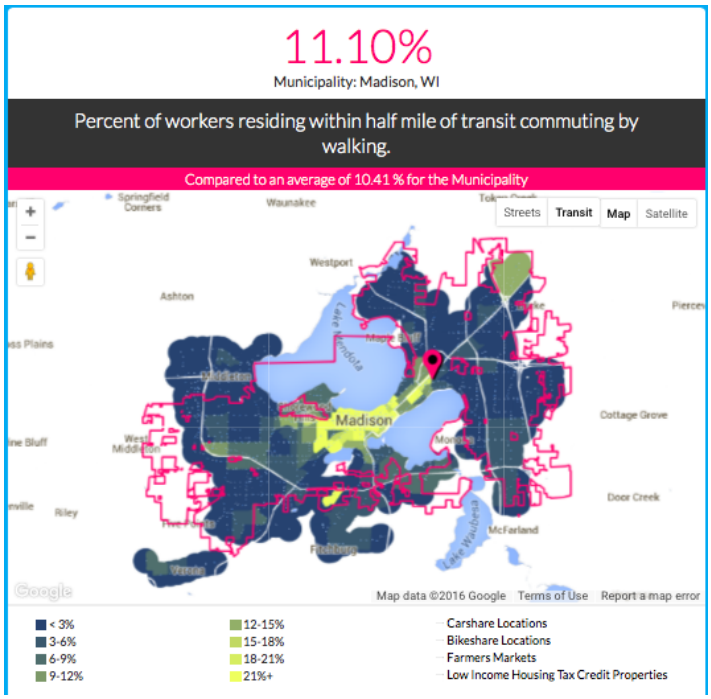


Figure 11 AllTransit: Transit Metrics: Workers who commuted by cycling and walking and live within ½ mile of transit



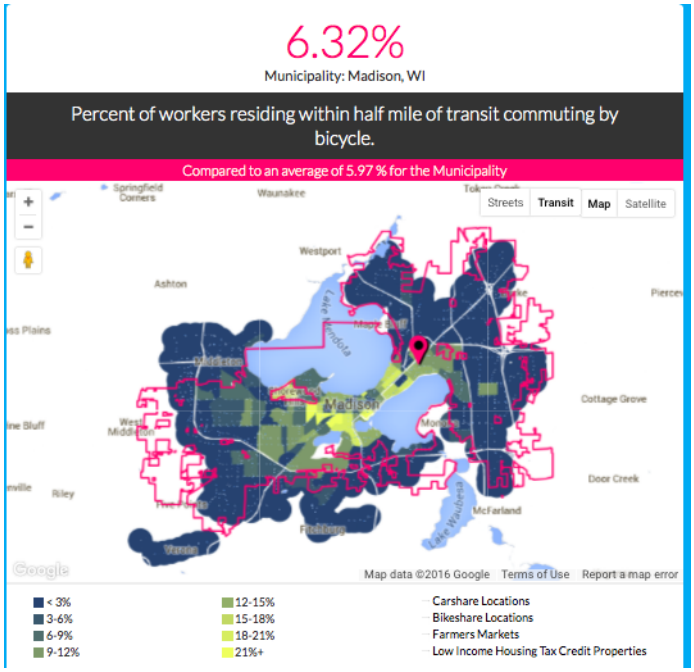


Figure 12 and 13.

The 2015 Metro Transit Onboard Survey showed the trip purpose for transit riders is dominated by trips to or from work. Transit access is primarily by walking (less than 2 blocks). The majority of riders do not transfer in order to complete their trip. However, minorities are much more likely than white riders to transfer. This may be due to the location of their neighborhoods in outside of the four transfer points. The dominant fare type used was the unlimited ride pass from the UW or another college or provided by an employer such as the City of Madison, UW, Dane County, or Meriter Hospital. The wide range of incomes can be seen throughout the Metro system, but concentrations exist. For instance, the majority of riders on Route 75 have household incomes of $75,000 or more while about 80% of Route 18 riders have household incomes of less than $35,000. In the same survey, 80% of males indicated that safety at transfer points is good or very good compared to 67% of females (Madison Area Transportation Planning Board, 2015).

The 2013-2017 Transit Development Plan for the Madison Urban Area provides a framework to guide transit system development considering many factors which have an impact on transit service design and usage, including residential and business development, socioeconomic characteristics of the population, changes in travel and living patterns, service trends and performance, and capital and operating costs and revenues. The Madison Area Transportation Planning Board found the following deficiencies in current Madison Transit:

- Need to expand metro transits
- Need more reliable transit service that is convenient, comfortable, and affordable
- Need more safety and security of transit passengers, operators, and facilities
- Need to maximize connections to other transportation modes, including intercity rail and bus lines

- Need transportation that is accessible
- Need services that increase access to jobs
- Need land use and development that maximizes the safety and efficiency of the transportation system

To improve these deficiencies, the Fixed Route Transit Service Planning/Design guidelines could be adjusted by route alignment (½ miles between transit corridors); service frequency; service span (service hours); bus stop spacing (1/8 to ¼ miles); bus stop location and amenities. To improve existing service, the service frequency and span should be adjusted to meet minimum service level for the route category or corridor. The travel time could be improved by reducing bus stop spacing, wait time, or in-vehicle travel time. The transit reliability could be achieved by reducing late buses (On-time Performance -15 minutes or less) or missed connections. The overcrowding could be prevented by shifting resources from underutilized to overcrowded service. The service could increase coverage (measured by productivity -15 boarding per hour) by adding new service to outlying communities or peripheral residential areas. The mobility in areas with concentrations of low-income and transit dependent populations could be increased by improving service in underserved peripheral neighborhoods with low auto ownership. The high-traffic-volume-roadways congestion could be prevented by increased transit use (Madison Area Transportation Planning Board, 2013).

The goals of City of Madison Transportation Master Plan are developing Madison as a walkable, bike-able, livable city; strengthening new and existing neighborhoods; and emphasizing transportation choices and mode connectivity. To achieve these goals, Madison transit should

- Improve the utility of existing transit service by improving the directness and frequency of routes where appropriate – include new service, route extensions, frequency improvements, express service, and route changes.

- Extend service to areas that are currently unserved by transit, including new commuter express service – service to Madison CBD (central business district/downtown), UW Campus areas, employment areas in suburban communities during the conventional weekday commuting hours.
- Adopt a bus stop consolidation program to remove or relocate excessive bus stops in central Madison to provides faster, more reliable services and reduce fuel use, emissions, and maintenance cost; but need to engage the public to minimize the impacts to transit users with limited mobility.

Health impacts due to increased physical activity: biking

The majority of people in the developed world do not meet the weekly recommendations for physical activity. The WHO (2007) estimates that 60-80% of individuals worldwide do not reach levels of physical activity that would allow them to induce health benefits. More and more peer reviewed studies are finding that exercise leads to improved health (Haskell et al. 2007). An increase in physical activity such as bicycling to work for a short distance on a daily or weekly basis can increase life expectancy, even accounting for the increased risks associated with this activity. All healthy adults should have moderate-intense aerobic physical activity for a minimum of 30 minutes at least 5 days per week or vigorous-intensity aerobic activity for 3 days per week according to the American College of Sports Medicine (*ibid*). A study conducted in Finland found significantly reduced risk for active commuters such as walkers and cyclists versus non-active commuters. The increased life expectancy for those participating in active commuting was 3-14 months. This greatly outweighs the estimated life lost due to addition of hazards including the increased exposure to air pollution (0.8-40 days) and traffic accidents (5-9 days). This results in an improvement of increased life years nine times that of life years lost with the largest improvements being seen in inactive people who shift their lifestyle to a more active one

(Hartog et al. 2011). Cycling in the Netherlands amounts to an increase in a half year of life expectancy per adult, resulting in a reduction of 6500 deaths per year, netting €19 billion in total economic health benefits per year (Hartog, Schepers, and Kamphuis, 2015). Maitland (2012) completed two randomized control studies of cycling commuters. The study found improvements in cardiorespiratory fitness and an inverse relationship with cardiovascular disease. Nurses who cycled or walked briskly for 30 minutes per day were shown to have significant weight loss. Bopp, Kaczynski, and Campbell (2013) found that those with greater perceived health benefits to biking were more likely to be bicycle commuters, and those reporting metabolic disease, overweight or obese status were less likely to be bike commuters. Taken together, these studies show that increased exercise can provide a number of health benefits, both in terms of decreased morbidity and increase in life years. Edwards and Mason (2014) show that due to its decreased risk of diseases such as cardiovascular disease, ischemic stroke, and colon cancer, none of which are primary causes of death of young people, increased health benefits from bicycle commuting begin later in life. Bicycle benefits are longer-term by nature, yet risks to biking are immediate, however the positive effects on life expectancy eclipse the negative (Edwards and Mason, 2014).

Table 4.
Effects of bicycle commuting on the 2009 U.S. life table.

	Change in life years due to:			
Age	Life years lived at baseline	Excess bicycling mortality	Health benefits from 45	Health benefits 20–44
0–1	0.994	0.000	0.000	0.000
1–4	3.971	0.000	0.000	0.000
5–9	4.960	0.000	0.000	0.000
10–14	4.957	0.000	0.000	0.000
15–19	4.950	0.000	0.000	0.000
20–24	4.932	− 0.001	0.000	0.003
25–29	4.909	− 0.002	0.000	0.009
30–34	4.883	− 0.003	0.000	0.016
35–39	4.853	− 0.005	0.000	0.025
40–44	4.810	− 0.006	0.000	0.037
45–49	4.746	− 0.009	0.010	0.044
50–54	4.648	− 0.011	0.037	0.043
55–59	4.509	− 0.014	0.075	0.042
60–64	4.319	− 0.017	0.125	0.041
65–69	4.051	− 0.017	0.150	0.039
70–74	3.681	− 0.016	0.136	0.035
75–79	3.167	− 0.014	0.117	0.030
80–84	2.487	− 0.011	0.092	0.024
85–89	1.658	− 0.007	0.061	0.016
90–94	0.828	− 0.004	0.031	0.008
95–99	0.264	− 0.001	0.010	0.003
100–104	0.046	0.000	0.002	0.000
105–109	0.004	0.000	0.000	0.000
110 +	0.000	0.000	0.000	0.000
Sum	78.628	− 0.137	0.847	0.415

Notes: Statistics are for both sexes combined. As described in the text, we assume a 6-mile (10 km) round-trip commute, 5 days per week for 50 weeks. Person years lived in the baseline are provided by the Human Mortality Database (2013). Excess bicycling mortality is depicted in Table 3. The health benefits of cycling are a 28% reduction in the all-cause mortality rate, and a relative risk factor of 0.72 as per Andersen et al. (2000). We apply the relative risk starting at age 45 in the third column. In the fourth column, we present the additional life years lived had the relative risk been applied starting at age 20 concomitant with bicycling.

Figure 9

The benefits to biking in Madison were estimated for this HIA using the HEAT tool (WHO). The League of American Cyclists analyses census data to determine the number of cyclists. Based on estimates of number of miles per commute (7.2 km), days cycled (124), mortality rate (390 per 100,000), all consistent with those of Grabow et al., the HEAT tool can provide estimates of the health impacts of increased cycling in Madison. The protective benefit of the level of cycling is about 7%. The Table below shows the health benefits now and for increasing levels of commuting. A range of avoided deaths are provided because representing the uncertainty in the mortality rate from 277-503.

Figure 15: Impacts of bike commuting rates in Madison due to increased physical activity.

% of workers commuting by bike (2010 baseline)	# Bike Commuters	Avoided deaths per year
5.3% (baseline)	7323	1-3
10.6% (double)	14646	3-6
20% (goal)	27633	6-10

The health impacts due to increased walking when using transit services were not quantified, but will have additional benefits.

Health impacts due to increased air quality: biking or busing

Cars produce primary pollutants that lead to ozone and PM2.5 pollutants which have health risks. Decreasing pollution from automobiles has quantifiable health impacts: research worldwide has shown the potential benefits of alternative transportation. A survey of the literature in Xia et al. (2013) pointed to examples of alternative transportation studies in London and Delhi. Estimates of avoided

premature deaths were 122,000 in the year 2030. A study of air quality improvements in Mexico City from the transportation and electricity generation sectors showed the potential to save 100 lives annually. In the US, the latest CAFE standards for overall fuel efficiency of cars in the is expected to avoid several hundred deaths in the year 2030 (this standard impacts model year vehicles 2017-2025). In addition, 3,500 asthma incidents in children and 14,000 lost work days for adults will be avoided in 2030 (EPA Regulatory Impact Assessment). But benefits vary by region and depend on baseline air quality, vehicle fleet, and other local factors. Xia et al. (2013) state that though a number of air pollutants are impacted by the transportation sector, a majority of the health impacts can be captured by looking at just PM2.5 or PM10 pollutants.

To estimate the health benefits of improved air quality in Madison, we can use results from a study of the impact of reduce vehicle travel in the Midwest by eliminating short car trips. (Grabow et al, 2012). In this study all car trips less than 8 km were eliminated in the major cities. This reduced the residential vehicle use by 20%. Though the original work considered both air quality and exercise benefits, here only the air quality benefits are applied. In Madison, the air quality impacts are mostly local (not influenced by nearby cities) and so the benefits in the full Midwest study for the city of Madison also stand on their own (personal communication, Maggie Grabow). The Table below summarizes a few of the health impacts quantified for the Madison area. (The analysis actually used a Metro area of 561,505 instead of the city population of 228,775 (US Census, 2008) but most of the short trips would be concentrated in the urban and suburban areas, so the health estimates are reasonable for the City of Madison alone).

Figure 16: Health impacts of eliminating 20% of residential vehicle travel in Madison

Indicator	**Mortality**	**Respiratory problems**
PM2.5 -0.02	1	565
	Mortality	**Acute respiratory**
Ozone ppm -0.12	<1	135

Reducing residential vehicle travel by 20% gives a reasonable order of magnitude for what could be accomplished by improving ridership and number of bicycle commuters in Madison. The Sustainability Plan includes goals of 20% trips by bike and 20% trips by bus by 2020. (We note that "vehicle use" from the study and "number of trips" are not the same metric, so the results do not translate directly, but are informative.)

7. Barriers and Opportunities for Implementation and Practice

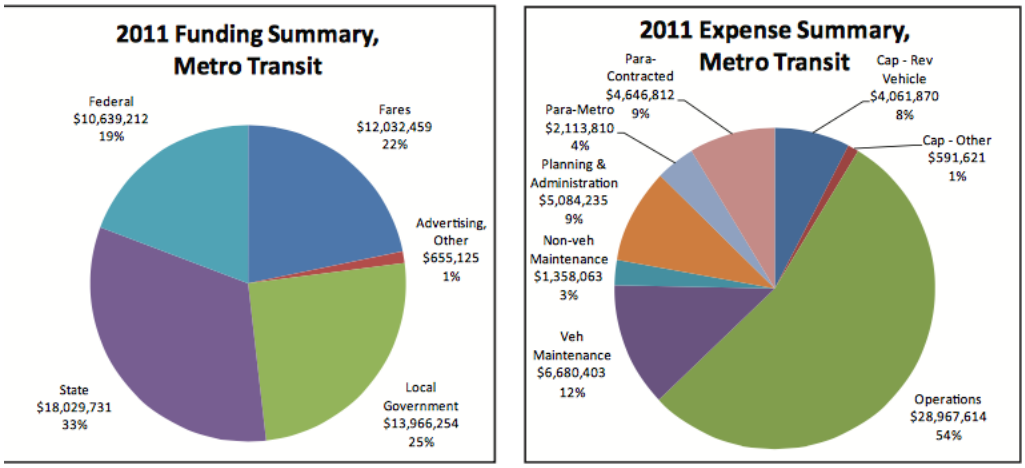
What are the barriers to implementation? What steps are necessary for successful

Barriers to increasing bus

According to the 2013-2017 Transit Development Plan for the Madison Urban Area, Metro Transit's ridership increased 30% between 2005 and 2011, while annual service hours increased only 5%. Metro's bus storage and maintenance facility on East Washington Avenue has reached its capacity and expanding the bus fleet to provide additional service is impossible without expanding storage space. Another challenge is the need to provide new service or faster service to growing peripheral employment centers and neighborhoods and suburban communities. Funding is a major challenge, given the lack of a dedicated funding source for transit and the state covering the share of operating

costs. Recent transit ridership levels in the Madison area have been growing faster than transit service levels, resulting in overcrowding. Expansion of services is becoming a top priority however it is currently limited by the fleet size, Metro Transit's maintenance facility, and the current funding structure (Madison Area Transportation Planning Board, 2013).

Figure 17: 2011 Metro Transit Funding and Expense Summary



Metro transit collected $11.7 million in fares in 2011, covering 28% of its operating budget. State operating assistance funding constitutes the largest share of Metro's overall budget (more than ¼) although the percentage has been declining since the mid-1990s. The remaining ¾ of budget contributes by local government (City of Madison), fares, and federal capital grants (less than ¼ each). More than half of Metro's budget is spent on transit operations. Average transportation cost is 19% of household income (Annual transportation cost is $11,000 per household).

In addition to affordability barrier, some people could be uncomfortable with the stigmatization of riding the bus. Some people who depend on public transport could likely be underrepresented. The other factors that might influence on bus ridership are long waiting time in cold weather that is not convenient and comfortable, and long travel time. Like most transit systems, travel times to point around Madison are generally longer (1.5-2.5 times) by auto. A dedicated funding source for transit and

the state covering the share of operating costs would be important step to improve Metro Transits. The investment to improve transit (less waiting time and travel time; convenient, safe and comfortable bus riding experiences) is a necessary step to improve transit ridership.

Barriers to increasing bike ridership

In Regional Values & Priorities Survey on prioritizing importance and performance on transportation, biking and walking infrastructure has high performance and low importance score. Land available for bike lanes is limited. Some felt bike lanes taking up space for cars on already congested streets were of concern. Public opinion on high performance of bike infrastructure and low priority in road sharing for biking would be an obstacle to invest on bike infrastructure. Cold weather and safety concern for bike riders also limits biking. The limited seasonal window makes it difficult to maintain bike infrastructure. The public education on road sharing and investment on bike infrastructure to improve are necessary steps to overcome safety barriers and increase public interest in biking. Since 1969, the percentage of children walking or biking to school has decreased dramatically, from 40% down to just 13% in 2001 (Mcdonald, 2007). A study conducted in in Louisiana investigating student's barriers to biking to school, safety was a main concern in the parent's decision making process. The study noted barriers to ridership on an infrastructure level including obstructions, incomplete sidewalks, lack of connectivity of bike routes, lack of crosswalks, and lack of bike racks (Gustat, et al, 2015). Piatkowski, Bronson, and Marshall (2015) found in a study of Bike to Work Day riders, the most significant barriers to more frequent commuter riding were "convenience and climate" and "costs and concerns". The convenience and climate category is comprised of factors concerning the convenience of cycling in comparison to other modes of transportation, weather, terrain and commute time. The cost and

concerns factor includes bicycle cost, challenge of bringing a bike on transit, adequate bike storage, and concerns regarding theft and vandalism.

9. **Recommendations and Communication Plan**

The health impacts of the two City goals considered in this impact assessment were found to be positive and well documented. We recommend that both of the policies be pursued, but we find that the social justice setting should be considered in implementing them both. Every Madison resident can benefit from increased air quality and those with low physical activity levels can benefit from improved access to non-car transportation. However, the air quality is generally good in Madison according to City Department Public Health Madison & Dane County. And physical activity as a whole in Dane county is high: only 15% of county residents report no leisure-time physical activity compared to 20% in the other best cities in the US. Since average cycling and health indicators are good, the stakeholders to benefit the most from sustainable transportation in Madison are those on the fringes who don't have good access.

Recommendations for bus transit

Madison Metro data shows that minorities are more likely than white riders to transfer during the bus trip, making a longer and less efficient trip. While most riders do not transfer, black riders are three times more likely to than white riders. Madison Metro notes that diverse neighborhoods are on the peripheral of Madison (though not the west side) and away from transfer points. Black riders have longer trips and longer travel times than white.

Expanding the Metro system should be done with a focus on providing fast service in an equitable manner through the city. This does not change the expected air quality related health impacts

but would provide a greater impact health impact for the minority populations by increasing their physical activity level for those who do not currently ride (walking to the bus, health benefits not quantified) and by decreasing their time spend in transit for those who do currently ride the bus. A decrease in commute time relates to improved mental health and potentially improved access to jobs and income (not quantified in this report).

Recommendations for cycling

In terms of equity in biking access, the Bicyclists League of America showed that minority populations are some of the fastest growing cycling groups nationwide (League of American Bicyclists, 2013). So willingness to ride isn't the issue, but yet they also showed that the cycling infrastructure is not equitably distributed nationwide. Compared to white men, minority groups more often say they would like to bike more but that they don't feel safe. Low income groups also feel less safe biking. In Madison, analysis of the data does not show that this trend is also true in Madison, but we recommend that as bike networks are increased, the City continues to consider the social justice factor to ensure equitable access.

Expanding and maintaining the bike infrastructure should be done in a way that supports safe biking routes throughout the city. Neighborhoods with currently low ridership should be invested in.

Communication Plan

The communication plan for improving biking and busing infrastructure in Madison should incorporate the stakeholders identified at the outset:

- Wisconsin Bike Federation
- Madison Metro

- Current bus riders
- Current cyclists
- City leaders

To reach those who don't use bike or bus for commuting, a communication plan should target neighborhoods with low ridership. In addition, the known health impacts of alternative transportation should be communicated. A positive campaign could include messaging such as:

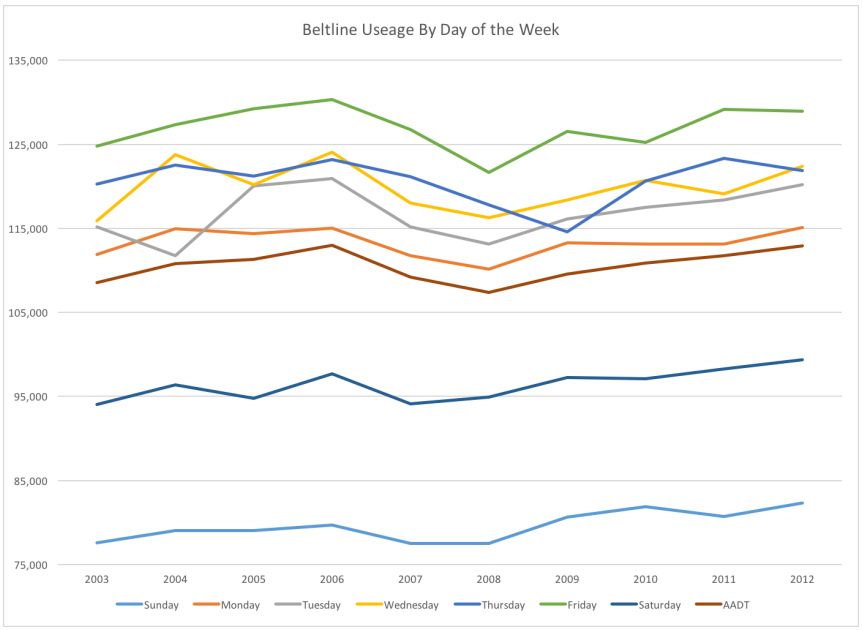
- Madison is a great place to ride bikes, let's make it a great place for *everyone* to ride bikes.
- Madison Metro is improving transit times to and from your neighborhood.
- We all benefit from cleaner air when you ride the bus.
- You can live longer if you start biking to work tomorrow.

10. Evaluation

There are several ways to evaluate the health impact of improving transit access and improving the amount of bike riders in Madison. Firstly, the most direct way to measure these metrics would be through direct rider counts. For increasing Madison Metro transit accessibility, you can analyze trends in rider counts by seeing if routes that serve minorities increases. Furthermore, surveys and further studies could tell you metrics such as what groups of riders have the longest commutes, what groups of riders are making the most transfers, what groups are waiting the longest for their bus, etc.

As for bicycle riders, the most direct way to analyze the data would be to analyze trends in rider counts, such as the counting stations on Monroe street or John Nolen Drive. Surveys and further studies could tell you what percentage of bike riders are commuting every day via bike, what percentage are satisfied with the current cycling infrastructure, what percentage feel safe biking on Madison roads, where the ones who don't feel comfortable are experiencing problems etc.

Less directly, another good measure may be to analyze car trends in Dane county. Several major roads in and around Madison keep numbers on how many cars utilize them. For example, the graph below is an example of beltline usage per day of the week, over the last decade. As you can see, usage of this popular highway has stayed pretty consistent over the last decade or so, if not increasing slightly. Once more and more people start utilizing public transit and biking, we could expect to see this graph start to plateau and decrease on roads around Madison. Granted, other factors like population growth aren't taken into consideration with this graph, one could ideally see a decrease in car ridership or commuting figures if the implementation of our recommendations is successful.



Lastly, one could analyze several public health factors in Dane County to see if our recommendations were successful. Assuming that the percentage of the public commuting by bicycle increased, we would expect to see metrics such as obesity, cardiovascular disease, and diabetes prevalence decrease, while metrics like mental health and overall physical fitness increase. This would be the evaluation that would be the most challenging to quantify, considering there are so many confounding factors (such as a new hit diet, nicer weather that allows more people to be outside, etc.), however we do believe that our recommendations would have a positive impact upon public health. We may not be able to say the betterment of some of those metrics would be a direct causation, but certainly a correlation.

11. Conclusion

Of the many goals in the Transportation section of Madison's Sustainability plan, we focused on increasing and improving the Madison Metro bus system and building and maintaining bike infrastructure. Both of these goals help move the populus away from car dependence. A health assessment found a wealth of related health impacts, and noted that the air pollution impacts (due to decreased car use) and physical activity benefits (due to biking and walking to transit) were the most direct impacts that can be quantified. Several lives can be saved per year by getting bike transit to 10% ridership from 5%. In addition, a few lives can be saved due to decreased air pollution if both goals are successful. Importantly we found that access to bus and bike transit needs to be equitably distributed to account for the possible inequities in bike transit, and, in Madison, the known inequities in bus transit.

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Relationship between commuting and health outcomes in a cross-sectional population survey in southern Sweden

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Carbon and Energy

A Health Impact Assessment

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5/10/2016

Produced for Population Health Sciences 740 Professors Jonathan Patz and Jason Vargo

I. Executive Summary

As the Madison Sustainability Plan illustrates, "climate change is one of the greatest challenges of our time. Greenhouse gas (GHG) emissions come from a variety of sources and have an impact on the overall quality of life not only within the Madison region, but also the world. Electrical power generation and motor vehicle use are two significant sources of GHG that need to be addressed. Madison embraces sustainable approaches to fuel our economy and community, achieving an 80% carbon reduction by 2050. Our City government and staff set examples of reduced energy use and emissions for businesses and individuals to emulate." If accomplished, each of the six goals highlighted under the Carbon and Energy section of the Madison Sustainability Plan have the potential to impact human health, either positively or negatively, though likely a net positive effect. Each goal builds on the others, thus we recommend pursuing all six goals in a holistic effort to reduce emissions in the City of Madison.

II. Screening

In this section, we outline why carbon and energy are important to the sustainability of Madison, and provide a justification for conducting a health impact assessment.

A. Statement of Problem

The specific problem of the Carbon and Energy section of the Madison Sustainability Plan is essentially "how can the City of Madison lower its carbon footprint, and also influence the general public of Madison to lower its own carbon footprint?" The difficulties in answering that question are found in existing infrastructure, power purchase contracts, and the laws of private property. As a broad summary, the problem of carbon and energy that the city of Madison faces is this: the City government, and the vast majority of the city residents, are net carbon producers in day to day practice, in terms of direct energy consumption and transport, in ways which directly

and specifically affect the health and wellbeing of the residents of the city, and the entire world in general.

B. Justification for a Health Impact Assessment

The goals specified in the Madison Sustainability Plan are aimed at addressing the concerns of climate change by minimizing Madison greenhouse gas emissions. As the city of Madison alludes to in the above statement extracted from their Sustainability Plan, there are substantial environmental, economic, and health benefits to be recognized through emission reduction strategies. Most notably, we are concerned with the health impacts associated with fossil fuel dependence for energy. Greenhouse gas emissions and the resulting climate change can cause or worsen a wide range of human health impacts including, but not limited to: mental illness, cardiovascular disease, respiratory illnesses such as asthma and lung cancer, food insecurity, heat stroke, neurological diseases, and direct mortality events from more intense weather events like hurricanes (National Institute of Environmental Health Sciences 2010) Moreover, aside from the emission of greenhouse gases, energy production also emits several other pollutants, such as sulfur dioxide, nitrogen oxide, particulate matter, and ozone that adversely affect human health primarily through cardiovascular and respiratory disease. As a result of the health impacts associated with energy consumption and production, an analysis of how the goals under the Carbon and Energy section in the Madison Sustainability Plan affect human health is important to explore through a health impact assessment.

III. Scoping

In this section, we will assess the magnitude of the problem, identify potential stakeholders, and outline key determinants of health.

A. Magnitude of Problem

The magnitude of the problem is significant, for three reasons. First, alternatives to carbon based power are significantly more expensive upfront than standard coal or natural gas derived electricity, and is not as suitable for base load electricity, of which the most carbon-intensive energy sources provide. Second, much of the existing infrastructure and transport technology was simply not designed with energy efficiency in mind as a primary goal, meaning that much more energy is used than necessary, requiring expensive retrofits. Third, because efficiency was not a primary design consideration in the majority of existing infrastructure and technology, the use of cheaper, more readily available fossil fuel derived energy is an easy, cheap path to to take, and potentially costly to transition away from. These three large problems apply to both the city government and the general population.

However, addressing these challenges is imperative to a sustainable, healthy future. The goals outlined in the Carbon and Energy section of the Madison Sustainability Plan can help address these issues.

B. Identification of Stakeholders

The Carbon and Energy section of the Madison Sustainability Plan is unique in the fact that the impacts are to extend beyond the immediate Madison region. Due to the nature of energy and the emission of carbon dioxide, the stakeholders in this case, defined narrowly, are the City government, local business owners, and city residents. More broadly defined, the stakeholders may also include the power utilities of Wisconsin, and stepping back even farther, may include the whole state, the United States, and even the world.

As with most adverse health outcomes, individuals with existing health issues, pregnant women, the elderly, and children are most at susceptible to the ill effects of pollutant emissions

(Sacramento Metropolitan Air Quality Management District 2016). That being said, reducing emissions can benefit the citizens of Madison's health immediately, but also will have lasting health benefits for global citizens in the future. In addition to health benefits, reducing emissions by pursuing clean-energy alternatives can have significant environmental, economic, and energy security benefits by reducing pollutants and climate change, saving money, and decreasing reliance on energy imports from abroad.

C. Key Determinants

Relying on energy derived from the burning of fossil fuels affects humans in several ways. Not only does the emission of criteria air pollutants affect individuals in the immediate region directly, but the emission of carbon and other greenhouse gases will affect individuals in the future indirectly through the effects of global climate change such as increased habitation of disease-carrying insects, prolonged droughts, and more intense heat waves.

The key health determinants to be assessed through this goal include measuring the emission levels of air pollutants associated with air pollution and climate change: volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM2.5 and PM10), sulfur dioxide (SO2), carbon monoxide (CO), and other greenhouse gases. Together, these pollutants primarily affect human health through increased cardiovascular and respiratory illnesses and can even lead to premature mortality (Sacramento Metropolitan Air Quality Management District. 2016). The primary health benefits associated with reducing emissions will likely be recognized through these reducing these pollutants.

IV. Assessment

We assess how each of the goals in the Carbon and Energy section of the Madison Sustainability Plan could impact human health. First, we outline the strategies and policy

alternatives with goal-specific targets. Next, we analyze how the policy intervention will impact human health. Then, we discuss potential barriers to implementing the outlined strategies.

A. Strategies/Policy Alternatives

In order to assess how the Carbon and Energy goals impact human health through emission reduction strategies, we will systematically analyze the following goals and respective targets:

Goal 1: Influence reductions in transportation related carbon impacts

Target: Reduce car miles traveled and increase low-carbon fuel use so that Madison achieves 10% emissions reduction every 5 years to get to a goal of 40% by 2030.)

Goal 2: Systematically upgrade existing buildings, equipment and infrastructure

Target: Reduce overall energy consumption by 50% by 2030 (kWh and Therms per square foot or equivalent unit of measure) in the public and private sectors (using 2008 baseline data).

Goal 3: Improve new buildings and developments

Target: New buildings and developments to meet zero net energy standards by 2030. Have City set example for zero net energy by retrofitting or building a facility that demonstrates techniques and concept of zero net energy by 2015.

Goal 4: Engage the public in energy efficiency and climate change programs

Target: Work to have 20% (currently 40,000 people based on 2010 population of Madison's population) actively participating in energy efficiency and climate change programs by 2030. Mobilize marketing, programs, measurement and targets through educational programs and community partnerships so that by 2030, 60% of Madison's population is aware that community members are being encouraged to engage in energy efficiency and climate change programs, such as Mpower Madison.

Goal 5: Obtain 25% of electricity, heating, and transportation energy from clean energy sources by 2025

Target: No additional target specified for Goal 5 beyond the target identified in the goal.

Goal 6: Report carbon footprint to the public

Target: Develop a comprehensive Carbon Footprint Report for the City of Madison that highlights greenhouse gases and air pollutants emitted and provide report to the public every two years.

B. Analysis of Intervention

We now analyze each of the six goals outlined in the Carbon and Energy section of the Madison Sustainability Plan with respect to human health impacts. Special attention is given to actions we feel are especially pertinent.

Goal 1: Influence reductions in transportation related carbon impacts

The first carbon and energy goal in the Madison Sustainability Plan targets the transportation sector, which is responsible for 23% of Wisconsin's end use energy consumption (U.S. Energy Information Administration 2016). Specifically, the Madison Sustainability Committee would like to "reduce car miles traveled and increase low-carbon fuel use so that Madison achieves 10% emissions reduction every 5 years to get a goal of 40% by 2030."

We identified three interrelated primary actions to focus our health impact assessment on within the broader goal: Actions 2) Encourage and promote the use of electrical vehicles and the creation of electrical vehicle infrastructure; 7) Develop and promote incentives for alternative fuel vehicles, such as "preferred parking" and graduated parking rates based on fuel efficiency/emissions, and; 12) Create a City Fleet Transition Plan to incorporate low or no-carbon/efficient fuel supply options, including biogas, CNG, plug-in hybrids and electric car charging (including on-versus off-peak) and other fuels. Replacing a conventional vehicle with an

electric vehicle can reduce emissions of volatile organic compounds by 99.7%, nitrogen oxide by 76.1%, particulate matter by 65%, sulfur dioxide by 96%, and carbon monoxide by 99.8%. We chose to focus on these actions because of their coordination with one another and we believe it will have a greater impact towards the overarching transportation target than the other actions.

Through Actions 2, 7, and 12, Madison hopes to expand the use of electric vehicles and other alternative fuels through infrastructure development, financial incentives, and a City Fleet Transition Plan in an ultimate goal to reduce transportation-related emissions by 40% by 2030.

Although it is possible to generate a robust electric vehicle network without financial incentives, a recent study suggests that incentives are driving alternative vehicle sales (Morris 2014). According to the report by the International Council on Clean Transportation, the states providing the largest incentive packages are often the states that experience the highest alternative vehicle adoption rates. Conversely, states with little to no incentives often have the lowest adoption rates. An important note is that this report examines all incentives, not just financial incentives. Naturally, some incentives prove more effective than others. Namely, subsidies, carpool lane access, and emission testing exemptions tend to be the most effective while public charging stations are the most cost-effective. Developing a large incentive package will further entice alternative vehicle sales through decreasing the cost and increasing the value of ownership. Focusing these incentives on cost-effective strategies will help maximize the benefits produced.

According to the Wisconsin Department of Transportation (2014), about 5 billion vehicle miles traveled occur annually in Dane County. Information could not be found for solely the city of Madison. A 40% reduction of this amount would result in approximately 3 billion vehicle miles traveled, or a reduction of 2 billion miles annually. The National Research Council (2010) published a report titled “Hidden Costs of Energy” that attempted to place a monetary value on the

non-climate change damage of a vehicle mile traveled using the federally produced life-cycle analysis tool titled GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) tool.

Using the standard United States fleet mix, the benefits of reducing 2 billion vehicle miles traveled *each year* could produce up to $84.5 million, or 4.3 cents per mile, in mortality, morbidity, and environmental benefits from emission reductions, of which about 90% of total benefits are health benefits. Assuming a $43/ton carbon price (Environmental Protection Agency (2015) Clean Power Plan, assuming a 3% discount rate), $46.5 million of this is from climate benefits, whereas the remaining $38 million are from reductions in criteria pollutant emissions. This analysis is strictly back-of-the envelope because it is using non-Madison-specific estimates of vehicle miles traveled, and fleet composition. Our estimate is reasonable, though: The 2015 Madison Measures report estimates the avoided costs of a 40% reduction greenhouse gases (from 2012 levels) from transportation would be about $15.2 million assuming a $43/ton carbon price. This is about one third of the value we estimated for Dane County as a whole, which is reasonable given that Madison's population comprises just under half of Dane County's population. Regardless, the message remains: for each vehicle mile reduced, significant health benefits can be achieved through decreased mortality events, respiratory illness, and cardiovascular disease, in addition to other health outcomes.

Goal 2: Systematically upgrade existing buildings, equipment and infrastructure.

Goal 2 of the Carbon and Energy section aims to "reduce overall energy consumption by 50% of 2008 levels by 2030 in the public and private sectors." With the appropriate funds, the city could retrofit commission city buildings and obtain LEED certification for its buildings. However, due to tax levy limits imposed by the state legislature, Madison may not have the funds to fully

implement all 23 actions laid out in this goal. Thus, we focused on action 7 in the public sector section and action 8 in the public sector section. Action 7 looks to take advantage of retro-commissioning existing city buildings for energy efficiency improvement. Retroactive commissioning buildings is shown to lead to a 10-15% energy use reduction (Mills 2010). While energy reduction may appear to be productive to reducing carbon emissions, the city should make sure that this reduction would either maintain or increase the amount of renewable energy generation. This would ensure a reduction in harmful emissions from power plants similar to those listed in Goal 1.

Action 8 dealt with utilizing LEED certification to reduce energy consumption and ultimately a reduction in harmful emissions. According to available data, a handful of city buildings such as library branches have sought LEED certification setting an appropriate example for the private sector to follow. LEED certified buildings are known to positively impact employee health outcomes such as the addition of 38 productivity work hours per employee over the course of the year (Singh 2010). Madison could track this effect through longitudinal data such as employee health surveys. Overall the city has made significant improvements to reduce its energy consumption by 9.1 % in 2013 (American Council for an Energy Efficient Economy 2015)

Goal 3: Improve new buildings and developments.

Goal 3 strives to "create a target for new buildings and developments to meet zero net energy standards by 2030. Have city set example for zero net energy by retrofitting or building a facility that demonstrates techniques and concept of zero net energy by 2015." The actions in this goal relate to establishing energy standards for new buildings being built throughout the city. While most of the actions are relatively broad, there are many indirect health outcomes connected to the 9 actions. Actions 3, 7, and 8 have the most measureable health outcomes. Action 3 deals

with LEED certification. Action 7 deals more with the interaction of natural infrastructure in the built environment to minimize urban heat islands, optimize carbon sequestration and promote water retention, while action 8 deals with onsite energy generation like rooftop photovoltaic solar cells.

Action 3, similar to action 8 in goal 2, relies on employee health improvements. There's a fair amount to unpack in action 7, we focused on the urban heat island effect. The US Green Building Council lists about 100 buildings either seeking LEED certification or having received it (U.S. Green Building Council 2016). Similar to Goal 2, the city and private sector business will have to set up a system of employee health evaluation. The current removal of ash trees as a result of the emerald ash borer could greatly affect the urban heat islands throughout the city. Currently, there are approximately 8500 ash trees slated to be cut down and replaced. Many of these are established trees on public right of ways and in city parks (Klein 2014). Urban heat island effects require the deployment of temperature sensors throughout the city but especially in currently identified high risk areas such as the isthmus.

The amount of energy generated from distributed sources will be an excellent measure of success in action 8, ideally reducing harmful emissions. MGE currently lists 350 sources of distributed energy sources throughout their service area which includes communities outside of the city (Madison Gas and Electric 2014). The exact amount of energy generation offsetting energy from carbon sources would have to be requested from MGE. While utilizing distributed energy sources would significantly aid in reducing dependency on fossil fuels, it may be hard to coordinate relative to large scale energy production.

Goal 4: Engage the public in energy efficiency and climate change programs.

Engaging the public in energy efficiency and climate change programs essentially serves two basic purposes. The first reason is to educate the public about climate change in general and linking that education to the reason for a Madison city sustainability plan. The second reason follows the first, and that is to cultivate public support for the sustainability plan, both in terms of the actions the city will take, and, critically, for the financial expenditures the city will make. The plan has two broad, measurable goals it is trying to achieve:

1. "Work to have 20% (currently 40,000 people based on 2010 population of Madison's population) actively participating in energy efficiency and climate change programs by 2030."
2. "Mobilize marketing, programs, measurement and targets through educational programs and community partnerships so that by 2030, 60% of Madison's population is aware that community members are being encouraged to engage in energy efficiency and climate change programs, such as Mpower Madison"

Neither of these two goals directly relates to improving public health, in the sense that achieving either of the two goals through implementation of any of the proposed 12 actions will not, by itself, result in a direct health outcome in the Madison city population, nor will it result in emissions reductions, cleaner streets, energy innovation, or sustainable practice. What achieving either of the two goals will do, however, is ensure that a majority of the population is able to hear the City's message, and that every individual will have both personal information, and examples to follow. When such goal setting is communicated effectively, it often results is a more positive response, and in more support. (Das, et al, 2008) This broadening and deepening of public information and awareness regarding the City's Sustainability plan and ongoing efforts may very

well result in individuals businesses changing behavior to a more sustainable model. Sustainable models of food production and energy production have positive impacts on public health. (McMichael, et al, 2007) Because of this, the specific actions of Goal 4 are worth evaluating in a Health Impact Assessment framework.

Action 4 states "Create and implement an energy consumption feedback system (secure database) between local utilities and the City of Madison Assessor's Office to allow consumers to compare their energy consumption with other consumers in Madison based on building data (size, age, construction materials, etc.)" From the perspective of public health, most improvements in health outcomes require individuals to modify their personal behavior, either because it is in their own interest, or because they want the benefit the modified behavior gives them (Elder, J.P et al, 1999). Convincing people that they need to change in their own interest usually requires real information that is relevant to the particular individual, not abstract terms (Katz, 1997). Successfully implementing the database will allow people to access energy and emissions data for themselves and others, but it will not force them to do anything, nor will it necessarily convince them that it is important that they modify behavior. That's where action number 7 comes in.

Action number 7 – "Create rotating 5-year marketing campaign partnerships with media groups that spread the message on energy conservation and carbon reduction "– is the persuasion element of the sustainability plan. Action number 7 at its core is a marketing plan, and marketing can effectively convince people they want something they didn't know they wanted. "Media groups" should encompass the total range of communications platforms that the people of the city interact with – television, radio, internet (email, Facebook, twitter, and other social media platforms) signs, billboards, and physical mailings. By utilizing all available means of

communication to make sure as many people as possible hear the messages relevant to the Sustainability Plan, the city will be able to reach as many people as possible across all demographics in the city.

It seems unlikely that these messages will affect public health in and of themselves. But what may affect public opinion as a whole is a persuasive message received by an individual, combined with that individual's ability to act on that particular message (a message like "Carpool whenever possible to reduce energy", or "Join the City in reducing Energy Use by 10% in January!"). The messages will need to contain relevant information about the actions that are being taken, i.e. database comparison, knowledge of upcoming specific action days to join, increased knowledge about the impact of emissions on public health and where energy comes from, and seeing other people doing innovative work to help reduce emissions impacts (Actions 1,2,3 and 7)

In combination, Actions 4 and 7 may have the effect of causing local emissions from both electricity production and transportation to be reduced as people less electricity, turn down thermostats, use more public transit, and walk or bike more, with quantifiable health benefits.

Actions 4 and 7 do have some risks, which cannot be quantified at this time. There is virtually no perceivable or predictable impact on public health as a result of either of the stated goals, or the proposed actions, because there is no message that has been crafted and communicated to the public yet. There does not seem to be any impact on public health from creating the database or beginning media campaigning initiatives, unless the expense of either diverts funds from budgetary areas that impact public health in a direct way, as would be the case if funds for providing homeless people with shelter, or funds providing local food assistance, were diverted. Finally, the specific marketing and messaging of the initiatives is so central to predicting

any impacts at all that saying that a particular messaging goal or action would impact public health in any way is futile.

On balance, it seems intuitively consistent that a program of information dissemination and education with appropriate messaging would result in a better educated, more energy and emissions conscious public, with corresponding benefits to public health. But the Goal 4 goal descriptions and actions in and of themselves do not have the kind of impact that allow us to quantify and kind of impact at this time.

Goal 5: Obtain 25% of electricity, heating, and transportation energy from clean energy sources by 2025.

The fifth carbon and energy goal in the Madison Sustainability Plan attempts to increase clean energy attainment across a variety of sectors. All of the actions within Goal 5 revolve around the central goal of increasing energy from clean sources. Implemented individually, each will make a small impact, but together, they can transform Madison's energy consumption mix to become more environmentally and economically friendly in addition to recognizing several substantial cardiovascular and respiratory health benefits. Most of these actions revolve around expanding purchases from clean power sources, developing or improving clean energy production, and providing incentives to encourage clean energy growth in Madison.

The Public Service Commission of Wisconsin already requires the consideration of renewable sources and nuclear energy before fossil fuel energy respectively, but developing additional policies to help spur the expansion of clean energy sources could accelerate this transition. Examples of some general policy actions include expanding purchases of external clean energy, developing additional internal renewable energy systems to generate clean energy within Madison, and working with local utilities, policymakers, and businesses to explore opportunities

to cut and reuse resources. Together, these general policies and others will help Madison transition towards clean energy for electricity, heating, and transportation.

Relying on the work from the National Research Council (2010), replacing a general kilowatt-hour with the Wisconsin electricity generation mix, a kilowatt-hour of clean energy can save about 8 cents per kilowatt-hour. About half (4.5 cents per kilowatt-hour) of these benefits are recognized immediately through reducing air pollutants like sulfur dioxide, nitrogen oxide, and particulate matter that are known to increase cardiovascular and respiratory disease. The rest of these benefits are from reducing greenhouse gas emissions which affect climate change, of which the future health effects are indirect such as increased prevalence of vector-borne diseases and mental illness. Given that the City of Madison purchased approximately 32.7 million kilowatt-hours from non-renewable sources in 2013, there remains significant room for improvement. Since about 23% of electricity generated is already renewable, but a much less percentage is clean for transportation, there are likely more substantial benefits to be recognized in "greening" the transportation and heating sectors. At any rate, there are notable health benefits of transitioning to clean energy as the electricity example above demonstrated.

However, in 2014, the City of Madison reduced their target percentage of renewable energy consumption down from the 2013 level of 23.4% to 1.4% in 2014 – a 94% reduction – justified in the 2015 Madison Measures Report in order to "reduce the amount of green power the City purchases. Instead, the City has invested capital funding into implementing the Sustainability Plan which will increase the funding available for building renewable energy facilities and implementing programs to reduce energy." While we believe funding for the Sustainability Plan is important, it appears that decreasing the amount of renewable energy consumed is in direct conflict with Goal 5 of the Sustainability Plan. This decision, if the amount displaced is not

replaced through internal renewable energy systems, will likely produce some of the significant adverse health effects associated with criteria air pollutants, and even climate change, mentioned previously. So the way in which the city defines the goals and incorporates them into future planning will potentially have a large impact on public health in the City of Madison, but the impact could be a net benefit or a net loss for residents.

While there appears to be a concentrated effort to increase the amount of kilowatt-hours generated by the City of Madison, the amount barely scratches the surface of the amount of clean electricity proposed to be cut. Madison has almost doubled their renewable power generator capacity since 2012 (71.35 kilowatts to 134.75 kilowatts); however, assuming an extremely generous 30% capacity factor, the amount of electricity these systems could maximally produce is about 350,000 kwh and the target to cut is more than 10 million kilowatt-hours of renewable electricity. If Madison is serious about the Carbon and Energy section, namely Goal 5, of the Sustainability Plan, they should explore alternative options for funding and reinstate the purchase of clean electricity for consumption because the target cuts will result in detrimental health effects for Madisonians.

Goal 6: Report carbon footprint to the public.

To achieve Goal 6, the city proposes 6 actions (See Appendix Goal Six) that work together to create a Carbon Footprint that assess emissions from Madison city operations (Action 1) and emissions from all businesses and residents in Madison (Action 2), and assess them according to a baseline, and outline a climate action plan with benchmarks and targets for future years (Action 3). Action 4 (hiring an energy manager) gives a central person of responsibility and accountability. But it is Action 5 (publicizing the plan and incorporating goals into future planning, budget and outreach activities) and Action 6 (creating Carbon Footprint measurement and take CO2 into

account when determining city projects) that have the largest potential impact on public health. For this reason, this assessment focuses on actions five and six of Goal 6.

Action five states that the "City will publicize the plan and incorporate the goals (presumably the carbon targets created by action 3) into future planning, budget and outreach activities."

Action 6 states that the city will "Create Carbon Footprint measures and take CO2 into account when determining City Projects. Create an internal carbon pricing system for the City. Determine a price per ton of CO2. Add the cost of CO2 to project costs when assessing options. Use internal carbon pricing when determining infrastructure improvement costs. Research, as methodology evolves, internal carbon pricing in calculating building costs such as energy efficiency, energy sources and CO2 cost of construction material production and delivery."

The City has undertaken this action, in cooperation with the Lafollette School of Public Affairs at the University of Wisconsin. The most recent report, for the year of 2012, published in 2014, indicates that overall emissions are rising sharply, though there have been reductions in the residential and transportation sectors of energy consumption. (Anderson, Et al, 2014)

Table 1: CO_2e Totals by Inventory Year and Sector

	2010 CO_2e (Metric Tons)	2012 CO_2e (Metric Tons)	Difference	Percent change
Commercial	1,574,096	2,157,848	+583,752	+37.1
Residential	859,582	823,390	-36,192	-4.4
Industrial	373,254	623,245	+249,991	+67.0
Transportation	1,073,720	822,705	-251,015	+23.4
Waste	73,641	81,290	+7,649	+10.4

Though the city has created a CO2 inventory report for the years of 2010 and 2012, it does not appear that it is being used by the public as a general rule, or that there are any efforts to reduce

emissions in the commercial or industrial sectors. This suggests that whatever public messaging has occurred regarding the Carbon inventory report, it is ineffective at best, in terms of changing overall emissions behavior.

One modification that might make a difference to the public is to tie carbon emissions information to the energy consumption database proposed in Goal 4. If individuals could look at their energy consumption report in realtime and see both the amount of energy consumed, and the corresponding amount of emissions emitted, it might be a more direct connection that allows individuals and companies to actually see the full impact of their energy consumption.

In terms of Goal 6, the risk assessment for both Actions 5 and 6 are similar, so we address them together. In the case of Action 5, the risks to public health appear tied to two factors that work together: how aggressive the city is in setting emissions reductions targets, and the means by which the targets are pursued. If the City is able to devise ways of reducing overall emissions, especially in transportation, through means that do not put a financial burden on lower income residents, there will likely be a net gain in public health. In the case of Action 6, the risks to public health are directly tied to the amount of money the city will spend reducing CO2 emissions in building efficiency due to the calculated social cost of carbon.

In both cases, the risks are principally related to the amount of money that will be diverted from people who need financial help, either through increased taxes, higher energy costs, or reduced assistance programs. The more financially well off people of the City will have the ability to either pay more, or to move outside of the City to escape the higher costs. If an exodus of a tax base occurred, and wealthier Madisonians moved out of the City into to the communities surrounding Madison, it would put more strain on the City and force more costs onto people less able to afford them. But even if such an exodus doesn't occur, the question of what the impact on

low income and assistance needing individuals and families will need to be calculated and prepared for. Any increase in the costs of energy, or increases in tax levels, reduces effective income, and income is closely correlated with both mental and physical health outcomes (Ettner, 1996)

C. Barriers to Implementation

The six goals deployed by the city of Madison to achieve their 80% carbon emission reduction by 2050 each have their own obstacles to implementation as well as some obstacles that are present for all goals. Due to the economics of each action, some will be easier to implement on a shorter term basis which could result in more immediate outcomes. Some goals will require less upfront cost than others. Incentive-based policies are relatively inexpensive from Madison's perspective. Although upgrading existing infrastructure may require significant resources in the near-term, it is often the most cost-effective way to reduce emissions. Goals that also affect co-pollutants will likely have greater immediate health impacts than solely carbon-oriented goals.

One general difficulty is the reliance on changing citizen behavior. This indirect approach to carbon emission reduction largely hinges on consumer response to public incentives and programs which is difficult to predict. Moreover, most of these policies are regulatory in nature, and will likely face some political opposition. However, Madison is notably environmentally-conscious and liberal, which suggests that the majority of citizens might support additional regulation for the sake of environmental, health, and economic benefits. Another complication may arise insofar as Madison is a city within larger political jurisdictions at the county, state, and federal level. Some policies may cause friction with existing policies at these higher levels.

One advantage of the cumulative set of goals is the deployment of dozens of small-scale changes that have the potential to make a significant cumulative impact. Focusing on implementing several smaller pieces of the puzzle will make the transition to a sustainable future

more politically feasible. The scale needed to effectively implement long term energy solutions is large and could take multiple city administrations to execute.

V. Reporting

As the city works to accomplish the aforementioned targets in the 6 goals, communicating success will be vital. Goals 4 and 6 deal most directly with developing strategies for engaging the public. Without this communication, public support for carbon and energy reductions could wane. Most of the goals involve a long time horizon. Therefore, accurately reporting various benchmarks showing progress towards eventually completion is necessary.

VI. Monitoring/Evaluation

The success of our recommendations can be evaluated based on how many and how much of each goal is met. Each goal contains several actions that lay the foundation for accomplishing each goal. Success can be measured by how many actions within each goal are attained. Some of these actions are qualitative in nature, so relating each qualitative goal to a quantitative measure will be helpful in analyzing the success of the city moving forward. Moreover, some goals have specific quantitative targets and can be assessed based on whether or not these targets are met. Qualitative goals should be coupled with quantitative benchmarks to achieve.

VII. Recommendations

It is not only important to create policy actions that reduces energy emissions (Goals 1, 2, 3, and 5), but it is also critical to communicate the rationale for these decisions to community members. Moreover, energy efficiency improvements (Goals 2 and 4), are generally more cost-effective than new infrastructure development (Goals 1, 3 and 5). However, expanding clean energy infrastructure and developing additional incentives (Goals 1 and 5) is crucial for the long-term sustainability of the city. As a result, we recommend to pursue all six goals highlighted in the

carbon and energy report. We believe that each plays a critical, unique role in helping Madison achieve a more carbon-friendly energy environment. Each goal builds on the others, and together they produce a vision for a holistic approach to creating an increasingly sustainable city. Moving forward, we recommend that the City of Madison:

1) Influence reductions in transportation related carbon impacts

2) Systematically upgrade existing buildings, equipment, and infrastructure

3) Improve new buildings and developments

4) Engage the public in energy efficiency and climate change programs

5) Obtain 25% of electricity, heating, and transportation energy from clean energy sources by 2025

6) Report carbon footprint to the public, tied to individual energy consumption comparison database.

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Wieseckel

Executive Summary

This report conducts a health impact assessment of the Economic Development section of the Madison Sustainability Plan. While Madison has long been a leader in environmental initiatives, the City of Madison believes that there is much more that can be done to improve on its environmental, economic, and social goals through increased sustainability efforts. Assessing health impacts of economic development, particularly local food access, is essential to determining whether or not these plans will help the City of Madison meet its goals. The stakeholders in any new sustainability policies include the citizens of Madison, the businesses and their respective leaders within the city, local farmers who may be called upon to provide healthy produce to residents, and the City of Madison itself. Government officials believe there are still major issues to be addressed in any future policy, especially in regards to disenfranchised members of the Madison community and the health of all residents.

The City of Madison hopes to reach its goals of encouraging sustainable business practices, increasing the market for green products and services, and promoting the consumption of local foods through the development of a diverse economy. This is expected to be done by allowing easier access to subsidies for green and renewable development and increasing the consumption of local foods. This approach will, in turn, improve the health of Madison residents through a reduction of air pollution and its associated health impacts as well as providing avenues for healthier diets with increased consumption of fruits and vegetables in lieu of starches and meats.

To this end, we recommend that city officials find and develop metrics to measure local food production and consumption, increase this consumption in disenfranchised communities, increase support for public market and packaging facility efforts, define what the city means by

the use of the word “sustainable,” identify specific goals and benchmarks within the sustainability plan, and develop an outreach approach for the communication of this plan to the public.

Problem Statement

Madison, Wisconsin has a reputation as one of the most progressive cities in the country. Thus, it should come as no surprise that many within the city limits seek to create a more sustainable city for future residents. To this end, Madison has already made many great strides. Through its emphasis on environmental and economic performance, Madison has eclipsed many of its peers environmentally and has been ranked in the "Top 25 Green Cities" list by *Forbes* magazine. The Brookings Institute also ranked Madison as one of the economically strongest 20 metro areas in the nation.

Despite these great achievements, the City of Madison believes that there is much more that can be done to improve on its environmental, economic, and social goals through increased sustainability efforts. Any future efforts at sustainability improvement should attempt to address all three goals as well as consider how these future decisions support each other to minimize negative health impacts on the city's long-term quality of life. Madison envisions strengthening its economy overall "engaging entrepreneurs, growing the workforce, developing spaces and a built environment that support and encourage a regenerative green economic climate while reinforcing the expansion of existing businesses and encouraging the development of new green business" (Madison Sustainability Plan, 2011; pg. 40) Through this vision and the measures that may come as a means to bring about this future, the City of Madison hopes that health within the community will increase while it "provides for growth and development of a strong environmentally and socially responsible community" (Madison Sustainability Plan, 2011; pg. 40).

There are seven goals of varying specificity that Madison has declared to be a part of their sustainable economic development:

1. Encourage sustainable business practices
2. Share resources
3. Increase the market for green products/services
4. Foster initiatives that promote sustainable economic development
5. Create a sustainability index tool
6. Promote consumption of local foods
7. Support a diversified economy

These goals, which would improve the health of Madison residents, could in turn facilitate a healthier economy. According to a letter from Polsky et al. (2010) from Fairleigh Dickenson University, "Successful corporations need a healthy society. Education, health care, and equal opportunity are essential to a productive workforce; as are safe products and working conditions. Efficient utilization of land, water, energy, and other natural resources makes business more productive. Ultimately, a healthy society creates expanding demand for business, as more human needs are met and aspirations grow."

Health Impact Assessment Framework

Throughout this report, we utilize the framework of Health Impact Assessment (HIA) to evaluate the potential health impacts of these economic development policies. The National Research Council Committee on Health Impact Assessment (2011) defines HIA as "an approach to assessing the risk factors, diseases, and equity issues that create poor health outcomes in the USA" (Ross, 2014; pg. 4). Health Impact Assessment is a tool that can be used to inform decision-makers about the health consequences of their policies. It typically is used to evaluate

policies that do not already have health as their primary focus (Ross, 2014). Thus, it is an appropriate framework to evaluate the Madison Sustainability Plan, which is not directly a health-oriented policy.

Identification of Stakeholders

The primary stakeholders of any government action are the citizens, as there would be no city or government without them. Many Madison residents tend to be in favor of more sustainable avenues for business. Seeing as a large portion of the residents are students, who tend to be more liberally minded, there is a historically blue voting record for the county (Sherwood, 2008). While the existence of student residents is conducive to more sustainable economic policies, there are many permanent non-student residents as well. However, the existence of many food cooperatives and community events provides evidence for the like-mindedness of the entire community.

Another major group of stakeholders of any new government action are the businesses within the city. Indeed, it is impossible to have an economy without business. Businesses are the direct target of goals one, three, and seven, and will need to work with the city government to come to any sort of action to address what is perceived to be a problem of sustainability. Many of the actions described within Madison's sustainability plan require the development of a purchasing consortium, of which many business leaders will need to be attendees to ensure its success. To develop an economic plan without the coordination of local business is like trying to drive a car without an engine.

Local farmers are also major stakeholders in economic decision-making, especially in regards to sustainability. Farming is the cornerstone of every economy, as everyone must eat.

Consumption of local foods reduces the toll on the environment through the reduction of fossil fuels used for their transportation. In turn, there would be less need for pesticides and preservatives, further minimizing the environmental impact of food production. One of the most popular social functions during the growing season in Madison is the weekly farmers market, which promotes a greater consumption of fresh fruits and vegetables in the community, stimulating a positive health impact.

Finally, the city of Madison as a whole is a stakeholder in sustainable economic practices. Madison is growing at an enormous rate, and may continue to do so if it is perceived as a sustainability poster-child for economic growth. As such, its reputation is on the line. If sustainable practices do not allow for the continuation of its growth, the credibility of its advocates, officials, and the city itself may suffer.

Magnitude of the Problem

While Madison has been recognized as a leading city for green development and sustainability, there is plenty of room to improve; if the status quo is maintained, little improvement will be made in the development of cleaner, more sustainable business practices. While some residents have access to sustainable products in the city, many do not. Food deserts, in particular, are an issue for low-income residents, who are disproportionately affected. Unsustainable business practices and production can have direct health impacts through the consumption of cheap, processed food. Indirectly, the purchase of products with a large environmental production, or that have been transported large distances, can also have adverse effects on residents' health based on the dose, mix, and time of exposure of certain air and water pollutants.

Food produced and consumed in a local context can have direct, positive health impacts. According to Morland et al (2002), proximity to a supermarket has a strong relationship with an increased incidence of fruit and vegetable consumption, especially for minority populations. The health benefits of consuming fruits and vegetables are myriad, including reducing the risk of cancer, heart disease, stroke, cataracts, pulmonary disease, diverticulosis, and possibly even hypertension (Duyn and Pivonka, 2000). This is a health issue, but it is also an equity issue; the two are inseparably intertwined. By increasing access to local food, the Madison Sustainability Plan would have positive impacts on both equity and health.

Air pollution is an indirect consequence of consuming non-local food. As the distance to transport food increases, so does air pollution from fossil fuels, because more fuel must be burned to transport that food to its final destination. Air pollution alone can have severe effects on the respiratory system through nose and throat irritation, shortness of breath, lung inflammation, respiratory infection, asthma, and even lung cancer (Bernstein, 2004). There can also be impacts on the human nervous system with the inhalation or ingestion of heavy metals such as lead, mercury, and arsenic. These effects may materialize as episodes of fatigue, hand tremors, and slurred speech with prolonged exposure (Ewan, 1996; Ratnaike 2003). With incomplete combustion of certain energy sources, increased concentrations of carbon monoxide can lead to a decreased capacity of one's blood to carry oxygen. This lack of oxygen can lead to problems with the brain and heart, causing a lack of concentration, confusion, and slowed reflexes in the populace (Badman, 1996). Thus, policies that increase local food consumption can reduce air pollution, having a positive effect for these health outcomes.

However, one study found that the consumption of locally grown produce may, in fact, be associated with a decrease in environmental and public health. Edwards-Jones (2010) found

that when non-native or off-season foods are produced locally, they can have a larger carbon footprint than non-locally produced food because they require greenhouses. This is certainly an issue for Wisconsin; however, Edwards-Jones assumes an extreme scenario where all food is generated locally, which is not the goal of the Madison Sustainability Plan. Still, it is an issue to consider, and policymakers should take caution not to incentivize unsustainable local food practices such as excessive use of greenhouses.

Moreover, Edwards-Jones (2010) found that local foods are not always the most nutritionally beneficial; while they are often better because fruits and vegetables typically contain the highest nutrition levels just after being picked, nutritional content can also vary based on factors such as sunlight exposure, soil, and weather. Some climates may be better suited to growing certain plants than others. Thus, it is important for policymakers to encourage local farmers to produce fruits and vegetables that grow well in Wisconsin and find ways to deliver them to the consumer quickly.

This juxtaposition highlights the fact that the City of Madison faces a challenge in developing meaningful policy to promote the health of its residents. While it is clear that the consumption of more fruits and vegetables instead of grains and meat is beneficial for health, the environmental impact of where that produce comes from is still a topic of debate. Madison has a unique opportunity to investigate and measure these conflicting ideas moving forward.

Key Determinants

Local Economy

As the second largest city in Wisconsin, Madison has an estimated population of 245,691 as of 2014, a 5.4% increase from 2010. With a median household income of $53,958 and an

unemployment rate of only 3.7%, Madison is an economic hub of growth and job creation in Wisconsin. While healthcare, agriculture, and manufacturing remain the biggest sectors in Madison's economy, efforts between the University of Wisconsin-Madison and the City of Madison have sought to grow small businesses and encourage new startups in the technology and biotechnology industries.

The University of Wisconsin-Madison (UW-Madison) is one of the major players in both the local and state economies. Accounting for an estimated $15 billion in annual state revenue, UW-Madison provides 193,310 jobs across the state (Bump, 2015). In the local economy, UW-Madison and the University Alumni Research Foundation (WARF) play a critical role in the creation and growth of small business development in the area. With programs through the university like the Small Business Development Center, which provides free consulting and low-cost entrepreneurial education, and the University Research Park, which provides low cost office space for small businesses, UW-Madison has created an estimated 311 startups. Ranking 4th for research expenditures among universities at $1.12 billion annually (Bump, 2015), UW-Madison also works with the WARF to transition academic research into small business start-ups in the hopes that one of these small businesses will become the next EPIC systems.

In any discussion about the local Madison economy, EPIC systems cannot be left out. A regional economic super-power, EPIC was started in Madison in 1979. Now located in Verona, EPIC generated 1.77 billion in revenue in 2014 and employs an estimated 9,000 people (Moe, 2015), the majority of which live in the Madison area. As a growing company, EPIC is expected to continue to add jobs in the next few years.

Access to Local Foods

Home to the largest producer-only farmers market in the United States, Madison is committed to purchasing and growing local produce. The Dane County Farmers' Market consists of around 150-170 individual producers during the spring and summer months and around 50-100 during the winter (Dane County Farmers' Market, 2016). Additionally, several other markets on the east and west sides of Madison provide access to local foods.

Dane County is also a major agricultural center for Wisconsin. Approximately 66%, or 504,420 acres, of Dane County's land is used for farming, generating $15.9 million in sales. The majority of these farms, 84.1%, are family owned, with another 8.2% being owned by family partnerships. This has created $2.9 million of local food sales from roadside stands, farmers' markets, auctions, and pick-your-own operations among 256 separate farms (Dane County Agriculture, 2014).

Community gardens have also become popular within the last few years among Madison residents. There are approximately 60 community gardens in Dane County, with at least 50 of those being located in Madison. A study in 2013 of 26 of these gardens demonstrated that nearly half of the families who owned plots in these gardens, 48%, were at or below the poverty level. Additionally, in the 26 farms, the report found that over 701 families representing 2,137 people maintained plots and put in an estimated 5,000 hours of work into garden upkeep, operations, and administration (Madison and Dane Public Health Department, 2014).

Sustainability Information and Resources

As a growing urban environment, Madison has made some efforts to encourage sustainable and environmentally friendly business practices. The efforts have been primarily focused on creating sustainable public buildings through solar panels and recycling initiatives.

However, some Madison programs like Green Madison partner with local businesses to improve education and awareness on sustainable business practices and how to reduce energy consumption. Other programs like MPower Business seek to create and fund sustainability projects which businesses can voluntarily sign-up for and participate in. Historically, MPower has been a successful way to reduce carbon emissions, previously reducing carbon emissions by 26,540 tons annually (City of Madison, 2016).

The City of Madison has also made an effort to provide public transit systems. Madison Metro had record ridership numbers in 2014, 15.2 million rides (Madison Metro, 2015). The transit system also caters directly to EPIC, which is one of the area's largest employers.

Policy Interventions

Subsidies for Sustainable Practices

Tax breaks and incentives for sustainable practices have largely been overlooked by the City of Madison as a method of encouraging sustainability. There are a few programs at the local level which can provide assistance. One example is the MPower Plan, which has been able to reduce carbon emissions for businesses citywide. Other tax breaks are more geared towards households, like the Lead Service Replacement Program, which provides a rebate covering half the cost of replacement for lead service lines. The City of Madison also provides financial assistance to clean up brownfields (abandoned and possibly-contaminated industrial sites) to businesses looking to invest in the area.

Madison has also proposed significant policy interventions to reduce CO_2 emissions and transition to solar energy. One proposal from 2014 sought to create a "$4 million plan to provide a site for construction materials recycling, study the feasibility of "capping" the landfill with

solar collectors, and test technology that could allow the county to capture carbon dioxide produced by landfill operations." (Rickertt, 2014). This project was eventually passed with substantial cuts in budget; what started out as a $4 million plan will debut at just under $400,000 in July of 2016. Another now defunct program, MadiSun, provided solar panels at a reduced rate for communities in Madison. This program, which ended in April of 2012, was attempted to be revived in 2014. However, it was met with significant opposition by outside interest groups, which we will discuss later.

For most residents or businesses that use tax breaks and incentives to create sustainable practices, the funding comes from either the state or federal level. One of the more significant programs at the state level is the Wisconsin Home Energy Assistance Program (WHEAP), which is the Wisconsin version of the Federal Low Income Home Energy-Assistance Program (LIHEAP). WHEAP provides funding to low-income families to help with weathering homes and is used by approximately 230,000 Wisconsin households annually.

Local Food Consumption

Since local food consumption is currently not studied or quantified, the first step to increasing consumption is to measure the amount currently consumed. The biggest problem facing the measurement efforts is that there are multiple methods by which local food can be purchased or consumed; anywhere from the farmers' markets to community grown gardens could be a source for local food. This makes the amount of locally consumed foods very difficult to track. However, in 2014, the State of Vermont passed a Farm to Plate Initiative, and one of the first priorities was the establishment of a metric to measure the amount of locally produced food. Vermont ended up using a system similar to the USDA's measurement, which relies solely on the food sold directly to consumers and does not provide measurements for the amount of locally

consumed food through community or urban gardening (Conner et al., 2013). Madison would also need to define what is considered local food or produce. The current federal definition of "local food" is food grown within a radius of up to 400 miles, which would mean that food could come from as far away as Kansas or Missouri and still be considered local.

Once local food consumption is able to be measured, increasing local food consumption could be done in a variety of ways. One goal of the Sustainability Plan was to increase local food consumption in schools and nursing homes. Programs through the USDA like the Farm to School Grant program, which provides funds to schools to establish school gardens and educate children about nutrition, are available and some are already implemented in Wisconsin (REAP, 2015).

Increasing local food consumption at nursing homes might be more difficult, due to the fact that they are privatized. If these programs could be encouraged through tax breaks or publically available funding, they could have a measurable effect on long term care and health of residents. Malnutrition and weight-loss are common illnesses in long-term care residents.

Another proposal that would increase access to local food is the Madison Public Market. The plan, finalized in 2015, would include not only local produce but also local goods and craft services. The permanent location for the District has not yet been determined; however, it would provide additional space for the sale of local goods

Implementation Barriers

Special Interest and Government Interference

While Madison has made significant progress towards sustainability, there are major barriers to overcome in order to succeed in the implementation of new policy. One of these is the

vested interest in fossil fuels by area energy companies. In the case of the MadiSun, the program was blocked from renewal due in part to opposition from Madison Gas and Electric (MG&E) (Tarr, October 15, 2014). This opposition was then followed up by MG&E announcing rate cuts which critics say encourage more energy consumption.

Implementation Opportunities

Popular Support

Residents of Madison have traditionally supported environmental and sustainable programs. Considered a traditionally "liberal" city, Madison re-elected Paul Soglin, a self-proclaimed environmentalist, in a landslide with 71% of the vote (Mosiman, April 8, 2015). Support for green policies like community gardens is also high with waiting lists required to keep up with demand for plots.

Zoning

Since 2009, Madison has made an effort for zoning to allow for farmers' markets and community gardens to be easily established. Currently, farmers' markets with less than 15 stalls are able to be established in Neighborhood Mixed-Districts (NMX) without approval. Community gardens and market gardens are able to be established in any zone, although they require special approval (Mosiman, October 15, 2009).

Policy Priority Setting

In this section, we will discuss the external political factors that could either inhibit or speed along these agenda items. In essence, we will explore the political climate to determine

whether these issues will be priorities or not. There are several factors that could affect where sustainable business development lies on the City of Madison's agenda.

First, the state of the budget always has an impact on whether or not an agenda item will become a priority. Without resources, new initiatives will have a very difficult time coming to fruition. On the other hand, in times of budget surplus, the unexpected windfall can smooth the way for new projects. Unfortunately, money is tight right now for the City of Madison. Mayor Paul Soglin is projecting a $7.9 million budget shortfall in 2016 (Mosiman, 2015). This means that any money devoted to sustainable business development will have to come at the expense of other programs, which will create new reasons for people to oppose the proposal. These opponents may not openly oppose sustainable business development, but they will oppose it because of the tradeoffs it necessitates. This factor may significantly lower sustainable business development on the policy priority setting in Madison.

Second, the strength of the economy, both locally and nationally, can impact the viability of sustainable business initiatives. In times of growth, it's easier to convince businesses and the public to make sacrifices. When the economy is weak, businesses are more likely to protect the bottom line. On the positive side, the economy is growing nationally, and people are generally more optimistic about their economic prospects than they were in the direct wake of the 2008 recession. However, while this trend is occurring nationally, a recent high-profile job reduction in the Madison area may create economic uncertainty. The closing of the Oscar Meyer plant, which was announced last fall, will result in a loss of 1,000 jobs (Newman and Mosiman, 2015). The fact that such a large business is moving out of the area may help fuel opponents concerns that increased regulation could drive other businesses away from Madison.

Third, interference from state legislature could block attempts to increase regulation on local businesses. With a Republican-dominated state legislature and Scott Walker as the governor, any plan that runs afoul of conservative principles risks raising the ire of the state government, especially if the plan severely diverges from regulations in other Wisconsin cities. We have seen this happen already with two other issues. First, the state government recently passed a law severely restricting local cities from placing regulations on Airbnb (Glaze 2016). The state assembly also passed a law changing shoreline development regulations, which has undermined efforts at the local level to protect sensitive fish populations (Ferrall 2016). Thus, providing subsidies to incentivize behavior may be a better option than trying to impose new regulations on businesses. However, subsidies will also be difficult, due to the budgetary environment.

Finally, local attitudes towards green initiatives can either help or hinder proponents of the initiatives. This is an area where sustainable business development is helped significantly. Madison has a local culture that is very supportive of environmental activism and there would likely be a large amount of support for the plan. There are also many non-profit environmental advocacy groups based here in Madison. It would be fairly easy to rally them around the cause.

Recommendations

In light of these potential political barriers, we make the following recommendations for the City of Madison:

1. Find and develop metrics to measure local food production and consumption.

Madison already has an abundance of local food resources, including multiple large farmers' markets, community gardens, close proximity to agricultural hubs, and more. However,

it is difficult to quantify exactly how much local food the Madison area produces and consumes. Thus, it is important for the City of Madison to figure out a way to measure the amount of local food production that is currently happening so that they can determine areas that need improvement and set reasonable benchmarks for future production and consumption.

2. Increase local food consumption at sites like senior centers, low-income sites, child-care centers and schools.

Senior centers, low-income housing, child-care centers, and schools all could benefit from increased access to local food. Many of these places regularly serve meals to large numbers of people. Increasing the portion of local food served could bring both direct health benefits to potentially sensitive populations (children, the elderly, and low-income individuals) by giving them healthy, fresh, less processed food to eat, while also bringing the entire city indirect health benefits by lowering pollution in the air (through reduced transportation). Increasing local agricultural production could potentially have a negative effect on the local environment by increasing the amount of phosphorus runoff in the lakes, but we believe that these downsides are outweighed by the health benefits that come from local food. Moreover, increasing agricultural production locally would decrease agricultural production elsewhere, resulting in an approximately net-neutral effect on the environment.

3. Increase support for Public Market and Packaging Facility efforts.

The City of Madison has developed a plan for the creation of a public market that would help create local jobs while facilitating a "dynamic public space" which would be a mix of "food retail, wholesaling, and processing, arts/craft vending, community uses, and events" (COM). This could be an opportunity to increase local food production and consumption while also

promoting other local businesses and sustainable products. The City of Madison should also support packaging facility efforts to increase sustainability through environment-friendly packaging.

4. Define key words such as "sustainable" in the context of business.

Currently, the Madison Sustainability Plan defines terms like "sustainable" very broadly, because the plan encompasses a number of different areas. We believe that in order to achieve sustainable business development, it is necessary to define key terms like "sustainable" more specifically in the context of business. These criteria need to be clear and measurable. Otherwise, it will not be clear to the public whether or not the plan is meeting its goals.

5. Identify specific goals and benchmarks within the sustainability plan.

Similarly, specific goals and benchmarks need to be identified for sustainable business. The Madison Sustainability Plan proposes a number of ways to increase sustainable business development, but it does not give concrete numbers for what the ultimate goal should be (such as, for example, a 30% drop in carbon emissions by 2025 from Madison-area businesses). Without these benchmarks, it will be easy to tout initiatives without making reach progress.

6. Adopt a multi-faceted outreach approach for communicating this plan to the public.

We believe that a campaign to inform the public of the benefits of local food consumption, including representatives at the farmers' market handing out flyers explaining the health impact of these proposed sustainability initiatives, interviews with local news sources, and collaboration with local nonprofits to host events in support of local food will help to get the message out. However, it is important that key terms and goals are first clarified in the plan.

Evaluation and Next Steps

In lieu of a more comprehensive plan to evaluate the success of sustainable business development in Madison, we offer some initial steps to begin the process. First, health surveys should be distributed among a sample of people in Madison to determine local consumption patterns (such as number of trips to a farmer's market in a given month) before and after these initiatives are implemented. This would allow quantifiable measurements to determine if the changes proposed by the plan had any effect. Second, farmer's market growth should be measured. These metrics include total sales, number of booths at the market, etc. This would be a good indicator to see if local food consumption is increasing; as demand rises, the farmer's market will likely grow as well. Third, the amount of money currently being spent on local produce must be determined. This is a necessary first step that will allow the city to target sustainability efforts more effectively in the future on areas that are underserved by local food (or types of food that are not currently being purchased locally).

Conclusions

Based on our assessment, we have determined that the economic development portion of the Madison Sustainability Plan will have a measurable impact on the overall health of Madison. The largest impact will be due to an increased access to local food by at-risk and vulnerable populations. The plan outlines goals related to local food consumption and we feel the most important goal to accomplish first is establishing a method allowing the city to measure local food consumption. Once that is accomplished, local food consumption can be increased by providing funding for community gardens or new farmers' markets. Local food has been shown to not only decrease air pollution, but tends to be generally healthier than most processed foods.

Connecting people to their food also has been correlated with healthier eating habits and increased physical activity which improves overall health.

Additional goals of the economic development portion of the sustainability plan focused on promoting sustainable business practices and clean energy. While these can have measurable impacts on human health due reductions in air pollution and carbon emissions, the best method to implement these practices is through tax incentives and subsidies. We feel that the incentives already provided at the federal and state levels are adequate, and due to Madison's budget shortfall, additional measures at the local level should not be implemented at this time. However, Madison should actively pursue federal grants for sustainable development and continue with current ongoing education efforts.

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An Initial Health Impact Assessment

of the

Madison Sustainability Plan: Education

Photo Credit: kokuahawaiifoundation.org

University of Wisconsin-Madison

Health Impact Assessment of Global Environmental Change

Population Health Sciences 740

May 10, 2016

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Executive Summary

The Madison Sustainability Plan (MSP) aims at arming the community with the tools necessary to be a "self-reliant, peaceful community that relies on renewable, local resources and is able to adapt to changing environmental, social, and economic conditions over time. It will be a beautiful place in harmony with the environment where it thrives" (The Madison Sustainability Plan). One of the most important components of this Plan is education. This Health Impact Assessment will focus on the Madison Metropolitan School District (MMSD) and its necessity to adopt the policies of the MSP in order to increase education around sustainability and healthy living. The MSP offers five different goals, each of which has three to six of its own suggestions for how to reach its respective goal. This HIA will concentrate on three different actions from two different goals, chosen because they all have a focus on healthy food. This HIA will also inform the supporters of the Madison Sustainability Plan about the health outcomes of those three actions.

This HIA recommends:

· The MMSD should perform sustainable changes in its institutional purchasing methods through the support of already existing school-level initiatives, joining a food purchasing group, and creating school wellness committees.

· By implementing an award system, the MMSD could increase community awareness and excitement about healthy schools and healthy living.

· The MMSD has a responsibility to adapt to the changing environment surrounding students living in the world today. In order to fully adapt and prepare children and community members for the future, Education for Sustainability should be added into schools' core curriculum.

Statement of the Problem

Definition of Issue

For the purpose of our analysis we will narrow the broad issue of education as presented in the Sustainability Plan down to the education of children in the Madison Metropolitan School District. We do this because supporters of the Sustainability Plan can bring together stakeholders to advocate for changes in MMSD's sustainability education.

Currently, children enrolled in the MMSD receive inadequate sustainability education which ultimately affects their lifestyle and awareness of health issues. There is insufficient opportunity for children to gain necessary knowledge of the stewardship of resources, respect for place, and sustainable and healthy practices necessary in order to live a healthy lifestyle.

Scientific Background and Current Knowledge

The literature suggests that school garden programs can heighten students' learning abilities in different domains of social, academic, and health-related skills. School gardens also have the potential to promote the strengthening of the school environment as a setting for positive youth development. A study was conducted between seven schools in Temple, Texas that studied the science achievement of third, fourth, and fifth grade elementary students. One group of students was taught using only traditional classroom-based methods, while the other group was taught using both traditional classroom-based methods and school gardening activities. The students that participated in gardening activities received significantly higher test scores on the science achievement test compared to the students in the non-gardening group (Klemmer et al.). These results demonstrate the ability of sustainability education to effectively improve children's academic capacity.

Likewise, the farm to school strategy aims to implement healthy, sustainable habits and education at schools and preschools. The program's implementation strategies include purchasing and serving local foods, providing educational activities centered around agriculture, food, health, and nutrition, and engaging students in hands-on learning through school gardens. Some of the outcomes of the farm to school program include improved eating behaviors, increased knowledge of life skills, and greater overall academic achievement. When taking part in the farm to school program, K-12 students chose healthier cafeteria options, less unhealthy food and sodas, consumed more fruits and vegetables, reduced time spent in front of a screen, and increased physical activity. Students in early childhood and K-12 settings also demonstrated a greater willingness to try new and healthier options. Students in the farm to school program also learn valuable knowledge about local and healthy food, gardening, agriculture, and seasonality (The Benefits of Farm to School).

Goals/Objectives

According to the Madison Sustainability Plan, the goal of promoting sustainability education is to "create awareness of the environmental, economic and social principles associated with sustainability and to facilitate cultural and behavioral shifts that will lead to more sustainable living, both now and in the future" (The Madison Sustainability Plan). The goals and objectives of this HIA are centered around the health effects of the initiatives aimed at improving sustainability education and sustainable practices in the MMSD. Another goal of this HIA is to promote the implementation of Education for Sustainability as part of the MMSD core curriculum, encourage sustainable institutional purchasing, and implement an award system for MMSD schools that practice healthy education and sustainability.

Decision Process

This HIA will inform supporters of the Madison Sustainability Plan, with hopes that the they will inform other stakeholders, about the health effects of the proposed goals in the education section of the Madison Sustainability Plan.

Identification of Stakeholders

The Madison area has many stakeholders that are dedicated to promoting awareness and fostering sustainable education with outdoor learning. Such stakeholders include the *Grass Roots Outdoor Wonder Coalition (GROW)*, *the Madison Sustainable Schools Initiative,* the *Wisconsin School Garden Network (WSGN), Sustain Dane*, and the *Cities Connect Children to Nature Initiative.* However, the stakeholders with the most power to make the goals of the Madison Sustainability Plan and this HIA become realities are the supporters of the Madison

Sustainability Plan. These members have a large stake, complete with visions and goals to make sustainable education a core component of the curriculum. Their goals and actions for education surrounding sustainable practices, gardens, and stewardship make this group of stakeholders extra important. Furthermore, supporters of the Madison Sustainability Plan have the responsibility and the power to be the key mediator and communicator between the numerous stakeholders and the MMSD board. Other stakeholders include the children enrolled in the MMSD, their parents, and school administrators.

Magnitude of the Problem

Threat to Public Health

Students in the Madison Metropolitan School District (MMSD) are not receiving the necessary education to make healthy and sustainable decisions regarding nutrition and lifestyle. Failure of the school curriculum to arm children with the proper health behavior practices is problematic for the future of public health. Not only do 93% of children fall short of the daily recommended serving of vegetables, but 33% of children are classified as overweight or obese (MMWR, 2014) (CDC, 2015). Children who are overweight or obese are more likely to have risk factors like high blood pressure, high cholesterol, and high blood glucose levels that predispose them chronic health conditions such as stroke, heart disease and diabetes in the future (CDC, 2015). Children who are obese are more likely to suffer from psychosocial issues, such as low self-esteem and depression, too (Ogden et al., 2007). Long-term, these overweight/obese children are exponentially more likely to be obese with an exhaustive list of comorbidities. Obesity and its resultant comorbidities account for 21% of all medical spending, or $190.2 billion dollars annually (Cawley J, Meyerhoefer C, 2012). This type of health culture and practice is unsustainable.

The obesity epidemic did not occur overnight. It is a result of the nation's changing awareness and understanding of what it means to be healthy. Now, more than ever, people consume high calorie, low energy dense foods and children seem to prefer screen time over play time. The prevalence of childhood obesity has tripled over the last 40 years and parents now recognize obesity as their number one health concern over tobacco and drugs (AHA, 2014). Although poor health outcomes like obesity have numerous contributing factors, the lack of proper, school-based curriculum to address this cultural shift has contributed to this problem.

Benefits/Risks to Public Health

The benefits of EfS on public health are numerous. EfS will create more sustainability-literate children and adults. This literacy can translate into adoption of a healthier lifestyle as a result of environmentally sustainable practices such as home gardening, stewardship of natural resources, and adoption of healthier eating habits. In fact, a study conducted by Duncan et al., found that school-based gardening interventions increased the daily consumptions of fruits and vegetables while improving their attitudes surrounding the practice (2015). Success stories like this are not unique or rare. Additional studies indicate that school gardens and the associated EfS improve student health and nutrition while promoting responsible planning and management of the community and its environment (California State Education Environmental Roundtable, 2000). Some obvious risks surrounding this initiative are regarding where the required funding and resource allocation would come from. If this initiative is to be state or locally funded, would an already financially stressed education system lose funding for other programs and projects? Furthermore, there is inherent risk that there would be resistance from administrative officials, community leaders, and parents surrounding the EfS initiative.

Impacts on Human Health, Development and the Economy

Reaching children at a young age when they are impressionable and eager to learn has positive, long-term health impacts. A curriculum that emphasizes EfS can create a new standard for a healthier culture. Having the knowledge and awareness will translate into health behaviors that will reduce the risk for obesity, heart disease, and diabetes, among others. If this action/initiative can increase sustainable practices and reduce the burden of preventable, chronic diseases, then it is a major public health victory. More than 72% of hospital admissions and 1.7 million deaths are attributed to chronic diseases. Economically, those who live healthier lifestyles have increased economic productivity, improved quantity and quality of labor, and contribute more to the national GDP than those who have chronic diseases like obesity and heart disease (WHO Economic Impact, 2006).

Vulnerable Populations

At this time, all children in the MMSD are vulnerable. Until there is dedicated curriculum to teach sustainable practices and lifestyles as a core competency, each student is likely to miss out on crucial information about proper health behavior. However, children of low socioeconomic status (SES) and minority populations are the most vulnerable. On average, obesity in African-American and Hispanic-American kids is 5-11% higher than Caucasian kids of the same age (AHA, 2014). The schools these populations attend are more likely underserved with less administrative and parental support for sustainable education. It is these low SES or minority children and the adverse determinants of health they face, which contribute to their

vulnerability. Schools that are independent of MMSD jurisdiction, such as private educational institutions, may be missed, too.

Key Determinants

Causes of the Problem

Children in the MMSD do not currently receive adequate food sustainability education and access to sustainable foods. This is due to a large number of issues. The first issue is behavioral, the lack of community support and funding for these programs. The lack of funding and the lack of existing infrastructure are two causes of this gap. Without funding and infrastructure it is difficult to establish lasting systems of food education and healthy food access. Beyond these operational causes, creating a comprehensive food education system and healthy food network is difficult without support and excitement from school administrators, parents or caregivers, and the public. For healthy food education to produce the best health outcomes the continuation of education outside of the school is necessary, and currently there is not the community investment.

Controversies or Limitations

There are limitations to implementing sustainability based food education and food access programs. Opponents argue there is not adequate evidence-based examples of success of such programs. Though research has shown the correlation between implementing these programs and the reduction of obesity, the large number of determinants that feed into obesity make it difficult to attribute to the specific program.

Another limitation is the general opinion that the main focus of schools should be on traditional core curricula. In a time when many arts and music programs are being cut, and when

recesses are becoming shorter or cut from the schedule entirely, health education is also being left aside. Exacerbating this opinion is the belief many hold that obesity and other food-related health outcomes are social issues and a result of inept parents. To spend classroom time and money on these issues is thus more controversial.

Justification of Key Determinants

It is necessary to have adequate funding, infrastructure, and public engagement in order to achieve the ultimate goal of educating youth about sustainability and healthy eating/living.

Intervention Strategies: Focus on Healthy Foods

In the following section, we will discuss suggested intervention strategies that supporters of the Madison Sustainability Plan can introduce to MMSD to increase access to healthy foods and sustainable education. To create these interventions, we looked to goals in the sustainability plan that pertained to children, MMSD, and healthy eating behaviors. We believe that by targeting these goals, MMSD can see the greatest change in behavior.

Sustainable Changes in Institutional School Purchasing

Despite the deeply entrenched causes of unhealthy eating in schools, supporting purchasing local/organic food for school meal programs, and supporting local agricultural infrastructure is a feasible and important goal for MMSD to achieve. Local organizations are already doing a lot of great work to bring local and fresh foods into MMSD. REAP Food Group has a Farm to School program which has brought ‘garden bars’ containing local vegetables into

half of MMSD's elementary and middle schools, created a healthy snack program that serves 5,000 students a week healthy locally grown vegetables. In addition, they bring local chefs into classrooms and provide nutrition, sustainability, and science lessons to kids. It is important to support organizations such as REAP as they begin to bridge the gap between local foods and schools. However, there is still room for improvement, and for the city to support more institutional changes.

One potential intervention would be to support the purchasing of local or organic food for school meal programs. There are many benefits to supporting local or organic food purchasing. Supporting the local economy, increased sustainability, and perceived increased freshness and good taste are all benefits to local purchasing. Perceived barriers to implementation are habit in food purchasing, having to plan around what is in season, distribution, quality assurance and price (Knight et al 2013). Because of these barriers, these changes would have to be in tandem with establishing local agricultural infrastructure that incorporates local food into institutional purchasing. The sustainability report suggests participating in County Institutional Purchasing Groups, and supporting food committees.

Currently, Dane County has an Institutional Food Market Coalition whose goals are to, "expand market opportunities for Dane County and regional growers, increase the sales of local Wisconsin food into institutional markets, connect large volume institutional buyers with local Wisconsin product and identify and resolve obstacles to local sourcing." It would benefit MMSD to look into joining the coalition, or one similar, to bring local food into the school cafeteria.

These programs have the ability to reach a wide range of students. Studies have found that the, "adoption and implementation of healthy nutrition standards and other recommended food procurement practices in various food venues that procure, distribute, sell, and/or serve food

to employees, students, and the public have the potential to broadly reach diverse communities that are disproportionately affected by obesity and chronic disease risk (Robles et al 2013).” Institutional purchasing could improve health for all, decreasing health disparities, while at the same time supporting local agriculture.

The key actors required to implement these changes would be district-level administrators at the MMSD. The MMSD has a District-level Wellness Committee that meets annually. The committee is comprised of one or more staff from each of the schools that monitor compliance with the wellness policies. Currently, food available through the MMSD Food Service Program has to be accessible, have certain nutritional attributes, be the proper portion size, not have nuts, and be served by qualified staff. There are no policies pertaining to food sourcing, and the District Wellness Committee has the power to adjust these policies. There is however, a gap between the students’ wellness and implementation that the District Wellness Committee is not organized to address.

A way to better support the District Wellness Committee would be to add School Wellness Committees. These committees would be comprised of students, administrators, health and physical education teachers, school board members, representatives from the school food authority and parents. Having representatives from an Institutional Food Market Coalition on a School-Wellness Committee could give schools knowledge on purchasing and help to make change quicker. These committees would allow for more structured school-based changes on more than an annual basis, and they can push for school-based initiatives such as local gardens and local purchasing.

These programs are important to the future of MMSD because, “Collective local efforts in healthy food procurement can cumulatively lead to a shift in the demand for healthier foods,

thereby nudging the food supply toward a healthier norm (Robles et al 2013).” These changes could have lasting positive health outcomes for a wide range of children.

Award System for Healthy School Nutrition Policies

One intervention strategy laid forth by the Madison Sustainability Plan is not only the adoption and support of healthy school nutrition policies, but also the implementation of a system that rewards schools that adopt healthy food policies and practices. A reward system would give schools more of an incentive to practice healthier behaviors and education strategies, ideally facilitating the movement towards EfS. The U.S. Department of Education currently employs an award system to recognize schools, districts, and Institutions of Higher Education throughout the nation that successfully employ sustainable, educational, and environmentally-friendly practices. The educational institutions that are recognized by this U.S. Department of Education Green Ribbon Schools award successfully practice methods to “reduce environmental impact and costs, improve the health and wellness of schools, students, and staff, and provide environmental education, which teaches many disciplines and is especially good at effectively incorporating STEM, civic skills, and green career pathways” (U.S. Department of Education). In order to be recognized by this award, educational institutions must show progress in all three of the aforementioned “Pillars.” According to the Department of Education, these types of wellness practices create the type of environment necessary to help students achieve their full potential, “free of the health disparities that can aggravate achievement gaps” (U.S. Department of Education).

In order to be recognized by this award, state education authorities have to submit school nominees for recognition, rather than the schools, districts, or universities applying for the award themselves. Four educational institutions in Wisconsin were nominated for the 2016 award, but

unfortunately, none of those schools are in the MMSD (U.S. Department of Education). However, they do provide good examples for leaders and administrators within the MMSD to follow in the implementation of healthier sustainability education practices . Supporters of the Madison Sustainability Plan should consider the U.S. Department of Education Green Ribbon Schools award as a long-term goal for schools within the MMSD.

On a more local scale, the MMSD and other key stakeholders could look at Florida's Farm to School program as an example of a more localized award system for healthy, sustainable practices. Florida school gardens have been increasing in popularity, and their benefits to health and education are becoming more widely recognized. The Florida Farm to School program allows elementary, middle, and high schools that employ different gardening methods, like raised bed and hydroponics, to apply for the award (Grubbs). These schools demonstrate proof that EfS can benefit students and school personnel as well as the community at large. The produce grown in the Florida school gardens was consumed by students and teachers in their regular school meals, some was donated to the community, and some was taken home by students and faculty to be consumed. There are five different categories for the award, including Best New Garden, Best Revitalized Garden, Most Creative Learning Environment, Best Use of Produce, and Most Community Involvement. For the 2016 Golden Shovel Awards, 100 applications were submitted from 23 different counties, which demonstrates the success of this program in reaching and engaging many different educational institutions (Grubbs).

Supporters of the Madison Sustainability Plan and other key stakeholders should use the U.S. Department of Education Green Ribbon Schools and Florida's Farm to School Golden Shovel Awards award systems as examples when developing an award system for MMSD schools, but the MMSD award system should be catered to the needs and specialties of the

MMSD. By implementing an award to recognize MMSD schools that excel in sustainability education and practice, the health benefits could go beyond the students and faculty, reaching the community at large. Ceremonies could be held that would bring the entire community together to recognize the positive impact that EfS has on the education of its youth. These ceremonies would increase communal excitement and motivation toward healthy lifestyle practices, and would encourage the community to continue making progress, while also rewarding involved students, faculty, and community members with a unique sense of pride.

Integration of EfS into Core Curriculum

MMSD has a standard curriculum that includes teaching science, social studies, math, world language, language arts, instructional technology, arts education, and physical education/health (MMSD, 2016). While there is brief mention of nutrition and healthy lifestyles under physical education and health, the curriculum falls short in providing the necessary knowledge to practice sustainable living. The MMSD needs to move toward integrating Education for Sustainability (EfS) into the core curriculum to provide children with the tools for healthy lifestyles, which would include gardening, stewardship of resources, and sustainable practices. One can easily argue that a curriculum that incorporates education for sustainability is just as important as any of the classic curriculum standards. The fundamental skills learned in school are nothing if one is unable to live out a healthy life. The surgeon general believes that the high prevalence of childhood obesity may result in children having shorter life expectancies than their parents (AHA, 2014). MMSD has incorporated "instructional technology" as a part of their core curriculum to evolve with the technological revolution of today. Education for sustainability should be no different.

The primary intervention strategy is to integrate EfS as a core subject in the MMSD curriculum. This policy would serve a dual purpose for both children and the surrounding community at large. The curriculum would provide school children from K-12th grade the tools necessary for healthy lifestyles, which would include gardening, stewardship of resources, and sustainable practices. This fits in extremely well with the "Education" mission of the supporters of the Madison Sustainability Plan (MSP), which provides promise that this desired policy could become a realistic action. Due to supporters of the MSP's position on the importance to raise sustainability awareness, ensure youth have access to environmental stewardship programs, and support educational institutions with healthy school programming, they are the key stakeholders in supporting the integration of EfS into the curriculum. Fortunately, MMSD is already a national leader in school gardens and sustainability initiatives. Collaboration and support of this progressive style of education are evident by MMSD "Sustainable School Initiative", partnership with Grassroots Outdoor Wonder Coalition (GROW), and exclusive participation in "Cities Connect Children to Nature" initiative. Significant financial and administrative support are present, but movement toward integration of EfS into the core curriculum is missing. Each grade level would have age appropriate competencies or standards to achieve. For example, 5th grade students would be required to know the basics of how to plant, nurture, and harvest vegetables and fruits appropriately. Middle school-aged students would be expected to understand which plants grow best in Wisconsin and the nutritional benefit of each (vitamin, mineral, fiber content). Students in high school would need to independently garden their own plot at the school and successfully yield edible produce. Final say on the day-to-day curriculum and achievement standards would be left up to James Howard, the president of the MMSD Board of Education and the six other members of the board.

The second aspect of this policy intervention is its ability to increase access to fresh produce for the school and those in the community without access or means to afford it. For example, a 200 square foot garden can yield 12-14 different vegetables/fruits, providing approximately 470 pounds of produce, costing nearly $1500. If half of the 48 MMSD schools had community gardens at just 200 square feet, that would result in nearly 13,000 pound of fresh produce. Half of that poundage would be reserved for the schools to provide healthy produce for lunches or snacks. The other half would be donated to local food pantries to benefit the most vulnerable populations in the Madison community. In this way, the curriculum change to EfS would provide the lessons and practices to healthy living, while providing tangible produce to be eaten and distributed among the community.

Barriers and Opportunities for Implementation and Practice

Supporting Sustainable Institutional Purchasing

Cost and institutional momentum are two large barriers to the first alternative. To adopt local food purchasing and the integration of more fresh foods is expensive and it is not a priority currently. There would need to be a network of suppliers, an overhaul of the menu, and training kitchen staff on new procedures. Once implemented, the program would be subject to seasonal changes.

There are many opportunities in implementation and practice of sustainable institutional purchasing. As discussed in the alternative, newly implemented school-level wellness committees could help bring healthy foods into the cafeteria. Kids will be able to ask questions and learn about produce and how it is grown, and through eating sustainable education is

conferred. This is also a great opportunity to strengthen community ties and bring in community members and farmers.

Award System

Some of the barriers towards implementing an award system include the placement of responsibility on an official or group of officials to be in charge of evaluating schools and/or applications, and then deciding which schools receive awards. Another barrier could be in creating a fair system to use to judge the schools and their progress, as different schools have different access to and availability of resources.

Opportunities that would arise from the implementation of an award system are centered around increased community involvement and improved communal behavior towards living a healthy lifestyle. Motivation for schools and their constituents to improve and embrace sustainability education and healthy lifestyle choices would be driven by a tangible award through which they could acknowledge and be proud of their own accomplishments.

Implementation of EfS

Barriers to alternative two include gaining approval from the MMSD board to change the curriculum to incorporate education for sustainability. Concern over funding and budget allocation to a new/different core subject are likely. Additional barriers include providing adequate education/resources for teachers to be effective, approval for gardens and outdoor classrooms on school grounds, and curriculum management in the winter.

Opportunities of the second alternative includes the MSP supporters' ability and responsibility to serve as the key, unifying stakeholders to approach and communicate with the MMSD board about the importance for sustainable education. Additionally, the positive health

impact of EfS and consumption of more fruits and vegetables are massive. Another significant outcome is that the MMSD has the unique opportunity to elevate its progressive standard for sustainability and stewardship for the environmental resources to the most elite level nationally!

Policy Priority Setting

Policy priority setting was determined through a goals/alternative matrix. Careful deliberation and discussion of feasibility (technical, political, scientific), efficiency, equity, and health benefits/outcomes were assigned to each action. We find that each action has health benefits, and fairly high feasibility. To see the matrix with the rationale please refer to the Appendix at the end of this report.

Recommendations and Communication Plan

Our recommendation is to partner with supporters of the MSP to reach out to the MMSD with our three actions. Again, MSP supporters have the passion and the ability to best communicate and promote this vision. MSP supporters would be more than welcome to use information from our health impact assessment to present to the MMSD. As newly invested stakeholders, our group would be happy to aid the supporters of the Madison Sustainability Plan in any way possible throughout the process. Specific recommendations about the costs, benefits, and barriers come from the goals/alternative matrix.

Evaluation and Next Steps

Supporter of the Sustainability Plan should follow up on recommendations made to the MMSD to discuss implementation and prioritize next steps. In addition to the recommended actions, we suggest that MMSD measures the success of implemented actions. In the short term, MMSD should conduct pre and post-program evaluations of children's knowledge. It is also

important to measure administrative and parental satisfaction of implemented policies and resultant behavior change. In the long term, a third-party evaluation of the implemented actions should take place to examine how the program may have affected long-term health outcomes.

Both these long and short-term recommended evaluations should be a combination of qualitative and quantitative analysis conducted through interviews, surveys, and a record of indicators including hours of sustainability education, number of outdoor classrooms, gardens implemented, meals served, and awards given.

Conclusion

Madison is already one of the nation's leaders in sustainability. However, progress still needs to be made and changes must occur in order for Madison to remain in its prestigious place. Madison is a unique place in that, collectively, it has a progressive, eco-friendly attitude and a communal passion for the state and its inhabitants. These qualities give the city a distinctive opportunity to be a leader and set an example for not only for the rest of Wisconsin, but for the nation. Although this HIA addresses a part of the 'Education' portion of the Madison Sustainability Plan, there are still many other components within the MSP that should be considered as well when facilitating the move to make the MMSD a healthier environment for the whole community. A complete HIA on the 'Education' portion of the MSP is necessary in order to understand the full extent of outcomes that would arise from the proposed actions and goals.

Appendix

Goals/Alternative Matrix

Goals	#1 Sustainable Institutional Purchasing	#2 Award System	#3 Education for Sustainability
Feasibility (Technical, political, scientific)	**Medium:** Support from local producers, but may be difficult to see as a priority politically	**High:** Other Wisconsin schools/districts already participate in USED award system; Based on examples, shouldn't be difficult to create MMSD award system	**Medium:** Significant barrier to create new core curriculum, but Madison has progressive mindset, stakeholders, and funding to accomplish
Efficiency	**Low:** More costly, difficult to work around what is in season	**High:** Low cost, nearly limited to time of filling out applications only.	**Medium:** High cost to train teachers and build outdoor classrooms (initial start-up); but low maintenance in future
Equity	**High:** Reaches entirety of school population, everyday	**Low:** Not all healthy/wellness programs will be the same. Some might have more funding, access to resources, etc. that sets them ahead of others	**Medium/High:** Reaches MMSD (25,000+ students), but leaves out private schools
Health Benefits/Outcomes	**High:** Large health benefits to eating fresh produce, long-term learning	**Medium:** Health benefits of healthy practices that drive the award system are numerous. Award system outcomes include improved behavior toward	**High:** Sustainable education and outdoor learning (gardens) improve eating habits, ability to learn, adoption of healthy and sustainable lifestyles;

		healthy, sustainable lifestyles by schools & community	provides fresh produces to school and local food pantry

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Sustainable Madison Plan
Affordable Housing

PHS 740, HIA

Melinda Fenn, Carolyn Harvey, Ashton Rollings

May 10, 2016

Executive Summary

One of the visions of the Madison Sustainability Plan is to create a sustainable city through the promotion of affordable housing and equal access to social services, basic health care, and employment. As the number households continue to grow in the City of Madison, it is important to build safe and affordable housing located near public transit. Through a health impact assessment, we aim to assess the benefits and risks associated with the different goals outlined under the affordable section of the Madison Sustainability Plan. Diversifying neighborhoods and building affordable housing on sites that are currently underutilized are important goals. Through the use of Neighborhood Indicators and Section 8 vouchers, households living in affordable housing can improve their socio-economic status and gain greater stability. However, in order to achieve this, it is critical to eliminate social stigma and encourage mixed-income neighborhoods and development. Increasing the provision of public transit near affordable housing can also improve access to social services, employment, and education opportunities. The development of Bus Rapid Transit (BRT) in the City of Madison can help to achieve this goal, all while providing beneficial health outcomes. In spite of this though, limited funding is major barrier to implementing BRT. Last but not least, through the Wisconsin Housing and Economic Development Authority (WHEDA) and the Wisconsin Home Energy Assistance Program (WHEPA), owners and renters can receive assistance for home improvements and energy updates, which can encourage green technology and improve air quality. We evaluated that the lowest risk was associated with decentralizing services and diversifying neighborhoods, followed by energy efficiency and green technology. Additionally, the highest benefit was associated with BRT and decentralizing services, followed by energy efficiency and green technology. Altogether we recommend encouraging neighborhood associations to participate in developing affordable housing, the construction of BRT, providing resources for owners, renters and landlords to access funds for energy updates, as well as conducting energy audits.

Problem Statement

"It is widely accepted that the health of individuals and communities is shaped by external influences such as the environments where we live, learn, play and worship; social conditions; economic policies; and public services" (Ross 2014, p.3). Often referred to as the social determinants of health, those influences that lie outside the healthcare system, have significant impacts on health and wellness. A family's income level affects access to nutritious food, child care services, routine health checks, and affordable housing; this impacts early detection, growth and development, food security, education, safety and exposure to environmental hazards.

Dane County and the City of Madison recognize the connection between affordable housing and health, and established it among the goals for achieving the Sustainable Madison Plan. While the region's income and construction rates have consistently grown in the last 30 years, so has the cost of homes and rent. This means that seniors, people on fixed incomes and those just entering the workforce will experience difficulty finding adequate, affordable housing. Approximately one third of all households spend 30% of their income on housing: 28,469 renters and 36,057 owners, and half of those living at or below 50 percent of the average median income, spend 50% or more of their household income on housing costs (Paulson, 2015).

These "severely cost-burdened" families and households face additional challenges in their search for appropriate housing, as the availability of various types of housing is not evenly distributed throughout the county. Forty percent of all rental properties are in buildings with fewer than five rental units, and twenty-two percent are in very small buildings, having or 2-4 units. Housing needs assessments have stated, ""smaller [rental] buildings face more difficult access to financial capital, face more administrative and financial challenges, and may lack economies of scale in terms of management and tenant selection. Many suburban areas face the challenge of an aging [smaller] rental stock in need of investment and rehabilitation, and smaller buildings' reduced capital access may be problematic [for upkeep and reinvestment]" (Paulson, 2015).

As projections for Dane County predict between 2010 and 2040 there will be an additional 65,000 households, of which nearly 11,000 are projected to be at 50% or less of the AMI; the goal of the health impact assessment is to assess the health benefits and risks of the Sustainable Madison Plan identified actions to increase access to affordable housing. Six primary goals were identified: diversify neighborhoods, build affordable housing, locate transportation

near affordable housing, upgrade energy efficiency in low income housing, provide more green low income housing, and decentralize services. Key determinants in assessing health outcomes include: environment, social and economic factors, health behaviors and access to services (County Roadmaps, 2015).

Stakeholders will comprise partners in education and community outreach, landlords and renters, community groups, construction companies and tradesmen, health advocacy groups, governmental organizations, realty companies and developers, urban planners, designers, and civic leaders. Partnerships will be the foundation of a sustainable plan to improve housing and meet housing needs. Unity across counties and between municipalities will forge beneficial relationships for obtaining healthy development goals.

Neighborhood Associations and Diversity

One of the goals of the Madison Sustainability Plan is to diversify neighborhoods through implementation of new affordable housing. Locating affordable housing in neighborhoods that are have a higher socioeconomic status has many health benefits for those utilizing the housing. Economically diverse neighborhoods allow lower-income families to access better resources, including higher-quality education and transportation. Diverse neighborhoods tend to have lower levels of crime that segregated, low-income neighborhoods, and also have the potential to improve mental health outcomes (Mueller & Tighe, 2007). By placing affordable housing in high-income areas, there is the potential to build bridges between socioeconomic classes and bring greater stability to vulnerable families.

There are several potential ways to work to increase diversity throughout the city, and these methods can also increase availability of affordable housing. The health impacts of increasing diversity will be similar no matter which strategies are employed. The main difference between the strategies will be how effective they are at diversifying neighborhoods. One of the main elements of the Sustainability Plan strategy is to use the City of Madison Neighborhood Indicators program to identify neighborhoods that are ideally suited to working families and would be welcoming of affordable housing. Once these neighborhoods are on board, they would ideally work to promote affordable housing in the neighborhood and increase their diversity. The end result of a successful project would be neighborhoods and neighborhood associations that are concerned with and regularly consider affordable housing when new developments are proposed. As more affordable housing is built in these neighborhoods, the economic diversity that's created would result in greater stability for low-income families, as well as access to high-quality education, transportation and employment.

Other strategies to improve economic diversity work at a smaller scale. Section 8 vouchers can allow low-income families to access safe, sanitary housing through rental assistance, but not all landlords work with the city to provide this option. The Madison Sustainability Plan promotes the use of these vouchers evenly throughout the city. Accomplishing this goal might involve working with new landlords to accept these vouchers in neighborhoods where there is little Section 8 housing available. Similarly, the Sustainability Plan advocates for encouraging mixed-income buildings and development, likely through the use of outside subsidies and grants that would provide rental assistance to some residents of a building that otherwise rents at market rate. This last strategy in particular would allow low-income renters to rent apartments at a rate they can afford in more economically prosperous parts of the city, without the stigma associated with living in segregated low-income or public housing.

The biggest barriers to this goal will likely be getting neighborhoods and developers on board with the idea of promoting affordable housing. While some neighborhood associations already embrace the importance of affordable housing, there is still a perception of public and low-income housing as promoting violence or reducing nearby property values. While the strategies promoted by the Sustainability Plan call for working with neighborhoods that are likely to welcome the challenge of improving their housing, there are potential barriers both to finding enthusiastic neighborhoods, and for already supportive neighborhoods to be effective. Developers also need to actively work to include affordable housing in their plans by applying for grants and subsidies, and many are not likely to put in the necessary time and effort to accomplish this.

Another strategy promoted in the Sustainability Plan is to locate sites for new affordable housing that are currently underutilized or eyesores. This strategy requires cooperation from neighborhood associations and developers to locate the sites as well as build on them. Using underutilized sites has several advantages for health. Eyesore and underutilized sites could take a variety of shapes, including empty lots, abandoned buildings, or simply older buildings. The health hazards associated with underutilized sites will vary with what form they take, but could include hazardous materials involved in building old structures. Older housing can have problems with mold, lead paint, asbestos, and other health hazards. Building new structures in place of older buildings would likely improve air quality and energy efficiency, and provide a healthier place to live for low income families (Matte & Jacobs, 2000). Another benefit of building on underutilized sites is a potential increase in density in these parts of the city. By replacing old multi-unit or single family housing with large, dense structures, there is less sprawl and less need to rely on cars for transportation.

In order to effectively use these sites, cooperation will be essential between neighborhood associations, the city government, landlords and new developers. The Madison Sustainability Plan recommends that neighborhood associations identify sites that they think will benefit the most from redevelopment, and be actively involved in planning the buildings and advocating for including affordable housing. Madison developers have often chosen to locate new housing developments on sites that are outdated or unused, but these don't always include spaces for low-income renters. There are grants and subsidies available at the local, state and federal level for building affordable housing or subsidizing rents, but developers are not always aware of them, or willing to take the time to apply for them.

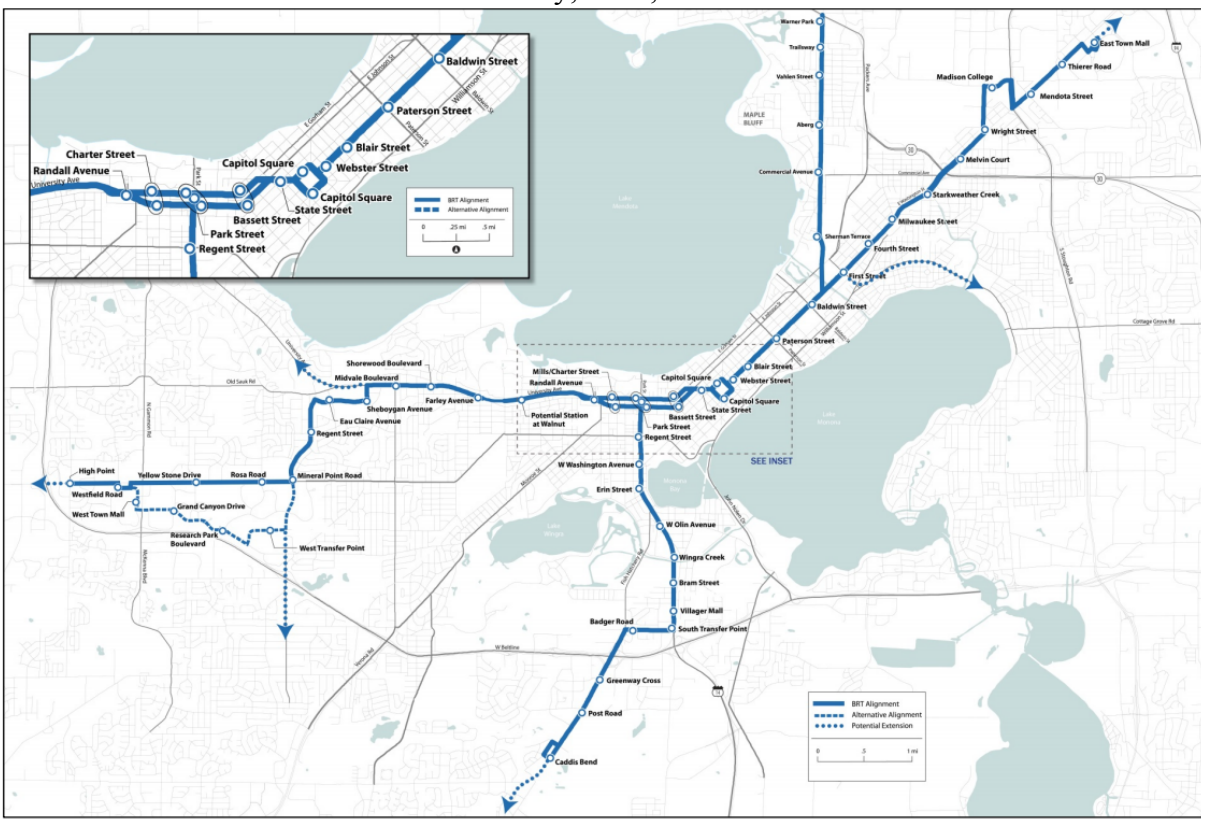
There are many potential barriers to this strategy, some of which are mostly logistical. Depending on the types of sites being targeted, there may be problems with polluted land that would have to be remediated. Other new developments might have to be rezoned if they did not formerly contain residential property. It's also possible that currently underutilized buildings are of historical value, possibly preventing them from being torn down and adding many complications to the process of rehabilitating them. While the Sustainability Plan advocates for the use of grants in creating new affordable housing, it does not recommend any specific programs. The process of seeking out and applying for grants has the potential to be difficult, and there is no guarantee that developers will receive them. If grants can be obtained, however, and the practical challenges of developing in these spaces isn't too great, they are among the best options for placing new affordable housing developments.

Transportation: Bus Rapid Transit

Another important goal of the Madison Sustainability Plan is to "ensure that all affordable housing is located within one-half mile of mass transit so that residents have access to low-cost transit to get to jobs, social services, schools and health care" (The Madison Sustainability Plan, 2011, 64). One way that many cities in the U.S. have addressed this goal is by implementing a Bus Rapid Transit (BRT) system to maximize the efficiency and access of public transportation. In our local community of Dane County, the Metropolitan Planning Organization (MPO), under the Madison Area Transportation Planning Board (TPB), has been the leading agency to propose BRT (Madison Transit Corridor Study, 2013, 3). Between 2005 and 2011, the ridership of Metro Transit in the City of Madison has increased by 30%, with only a 5% increase in the provision of services ("BRT -Frequently Asked Questions," n.d.). This has caused issues with overcrowding in buses and longer commute times. Consequently, the goal of BRT is to provide "high frequency, limited-stop bus system that is intended to provide faster service and improved reliability in urban environments" (Madison Transit Corridor Study, 2013,1). The proposed plan offers four corridors located in the north, south, east, and west of the city, all connected by the central isthmus (Madison Transit Corridor Study, 2013,1).

Figure 1: Madison BRT System- Proposed System

Source: Madison Transit Corridor Study, 2013,38



In addition, the new and higher holding capacity buses will either operate on existing street networks or fixed guideways fully dedicated to them, thereby decreasing travel time and increasing bus frequency (Madison Transit Corridor Study, 2013,31). The criteria for the arrangements of the corridors will depend on population density, employment concentration, existing transit ridership, the potential of Transit Oriented Development, and roadway suitability (Madison Transit Corridor Study, 2013,7). Through Bus Rapid Transit, the Madison Area Transportation Planning Board intends to:

- Reduce transit travel time
- Attract new riders
- Improve connections between low-income and or transit/ dependent neighborhoods and centers of employment and activity
- Provide expanded transit carrying capacity
- Improve operational efficiencies
- Provide an enhanced image for transit service
- Improve the comfort and convenience of the transit system
- Enhance opportunities for transit-oriented development (Madison Transit Corridor Study, 2013,7).

The construction of BRT in the Madison has the potential to increase access to services for people living in affordable or low-income housing. The alignment of origin routes will be

strategically built ¼ of a mile of greatly concentrated neighborhoods to serve a larger population with fewer resources (Madison Transit Corridor Study, 2013,7). Correspondingly, destination routes will be built ¼ of a mile of highly concentrated employment hubs to provide more access to services (Madison Transit Corridor Study, 2013,7). This should improve the connection between affordable housing with centers of employment and activity. Increased mobility can also offer families living in affordable housing equitable access to educational opportunities, healthy food, and medical care (Dannenberg & Sener, 2015,6).

Indirectly, higher access to employment and educational opportunities can lead to increased social mobility and income, which can greatly reduce a household's financial. Socially, transportation can influence a person's well-being by increasing social interactions as people become more mobile and have the opportunity to engage in community activities (Lee & Sener, 2016, 149). Furthermore, researchers have shown that an increased provision of transit services support a physically active lifestyle. A survey conducted in Atlanta, Georgia shows that people using the transit system generally walk more and have an easier time meeting their recommended level of physical activity compared to people that do not use the transit system (Lachapelle & Frank, 2009, S74).

Table 1: Distance walked and trips per mode by income groups and transit use, (*N*= 4,156), Metro Atlanta, 2001-2002

Table 2: Distance walked and trips per mode by income groups and transit use, SMARTRAQ (*N*=4,156), Metro Atlanta, 2001–2002

Income	*Transit users*				*Non-users of transit*			
	Less than $30,000	*$30,000–$60,000*	*$60,000 and more*	*Total (5.4%)*	*Less than $30,000*	*$30,000–$60,000*	*$60,000 and more*	*Total (94.6%)*
n (%)	52 (23.2)	92 (41.1)	80 (35.7)	224 (100)	509 (12.9)	1,471 (37.4)	1,952 (49.6)	3,932 (100)
Transit trips	1.81	1.75	1.57	1.70	—	—	—	—
Driver trips	0.71	2.09	2.66	1.97	3.63	3.60	3.73	3.63
Passenger trips	0.52	0.32	0.30	0.36	0.26	0.22	0.30	0.26
At least one walk trip (%)	59.6	60.9	56.3	58.9	11.6	9.0	8.9	9.3
Total distance walked (km per day)	1.54	1.56	2.01	1.72	0.23	0.13	0.16	0.16
No car or no license (%)	51.9	14.1	0.0	17.9	2.2	0.1	0.1	0.4
Shared car (%)	3.8	16.3	7.5	10.3	8.8	7.1	4.0	5.8
Car fully available (%)	44.2	69.6	92.5	71.9	89.0	92.8	95.9	93.8

Source: Lachapelle & Frank, 2009, S82

According to Lachapelle and Frank, "lower income individuals, minorities, rail users, and people living in higher density areas are more likely to reach the physical activity target" (2009, S75). Therefore, BRT will not only increase transit access to people living in affordable housing, but it will also help them increase their daily active transport, which can decrease their risk of

obesity, coronary heart disease, and hypertension (Lachapelle & Frank, 2009, S74). Shorter commuting time may also provide psychological benefits, such as the reduction of stress.

Finally, with the transportation sector emitting one third of all greenhouse houses contributing to climate change in the U.S., BRT provides a more sustainable option (Dannenberg & Sener, 2015, 5). Air pollutants have been a major source of lung and heart diseases, such as asthma, bronchitis, and chronic obstructive pulmonary disease (Dannenberg & Sener, 2015, 5). Buses emit 80% less carbon monoxide compared to the average car ("Why Ride the Bus?" n.d.). Additionally, the leading cause of all deaths in the U.S. among children and adults between the age of 1 and 44 is motor vehicle related injuries (Dannenberg & Sener, 2015, 4). Buses are 170 times safer that automobiles, which make transit system like BRT one of the safest method of transportation ("Why Ride the Bus?" n.d).

Although the Madison Rapid Bus Transit plan appears to provide numerous benefits to low-income and affordable housing neighborhoods, the feasibility of the project may be an issue. The Madison Area Transportation Planning Board has faced obstacles in securing funding for the project. The estimated implementation cost of BRT is between U.S. $138 million and $192 million dollars, with an annual maintenance fee of U.S. $9.8 million dollars. Many cities fund BRT though Regional Transit Authority (RTA) legislation, which allows the RTA to impose a small sales tax. In 2011, however, Governor Scott Walker repealed legislation enabling Wisconsin's RTA from imposing a sales tax to fund and run BRT. Thus, the political feasibility of BRT in Madison is also low.

Energy Efficiency and Green technology

The Wisconsin Housing and Economic Development Authority (WHEDA), though established in 1972 by State Legislation, is not a governmental agency. Today WHEDA offers small loans to owners and renters for a variety of projects including home improvements and energy updates. These programs are backed by a network of independent lenders who administer WHEDA programs (WHEDA, 2013). The organization has a long history and reports assets at 3 billion dollars. For all of these reasons, the programs offered seem to be a sound investment. Closer inspection however, finds the programs have strict eligibility guidelines regarding work history, work stability, and income level (WHEDA, 2013). These programs also have criteria for entitlement by area (Division of Housing, 2015). Due to these barriers, it is likely that those households with the greatest need would not meet the lending guidelines. Therefore, the impact of this program is likely to be low.

The Wisconsin Home Energy Assistance Program (WHEPA), much like WHEDA offers assistance to owners and renters for home improvements, energy updates and energy assistance (Wisconsin DOE, 2015). WHEPA however, has fewer eligibility restrictions, and presents fewer barriers to access. These programs would require the county to encourage use through engaging community members and offering weatherization counseling. It would also require the county to conduct energy audits. The advantage of this program is twofold. First, energy audits allow the City of Madison and Dane County to collect information that over time can be used to quantify and assess need, improvement, and possible routes for intervention. Second, due to the differences in eligibility criteria, this program is likely to have a greater health impact on those households with the greatest need.

Recommendations

The Affordable Housing section of the Madison Sustainability Plan has diverse recommendations for the best ways to improve the quantity, quality and location of housing options. Aspects of each of these sections should be considered when planning for future affordable housing. Overall, there are 4 recommendations for actions that would improve the health of Madison's low-income population.

1. Encourage neighborhood associations to participate in developing affordable housing and increasing economic diversity
2. Build Rapid Transit
3. Educate the community and provide resources for owners, renters and landlords to access funds for energy updates.
4. Conduct Energy Audits: make use of WHEPA funds.

Evaluation

The primary outcome of interest in evaluating the effect of the actions outlined above will be the number and location of housing units that are considered "affordable". These could include public housing units, units offered at below market rate rent, or those being rented by

people utilizing Section 8 vouchers. Ideally, Madison will continue to add new affordable housing options in areas that offer public services, access to transportation, and are located in high-employment and economically diverse areas.

In addition to increasing the number of units and locating them in ideal neighborhoods, another goal of the Sustainability Plan is to improve the quality of housing, particularly in terms of energy efficiency. One of our recommendations is to conduct energy audits; the number of audits conducted and the results of those audits will provide a way to evaluate how energy efficient Madison housing is.

Some of the recommended actions, such as building a rapid transit system, are difficult to evaluate in a traditional sense. If a rapid transit system is planned for, built, and utilized according to an appropriate schedule, then it likely has been successful at accomplishing its goal. Outcome measures for a transit system could include reduced commute times and increase transit ridership. Other recommendations, such as increasing neighborhood participation and willingness to promote affordable housing, would have to be evaluated in a more holistic sense. Surveying members of neighborhood associations could provide an estimate of their priorities and feelings towards affordable housing. Community education could be evaluated through measuring the number and types of community education being promoted, and estimating how many people are utilizing the education and energy improvement resources.

Due to the broad nature of the affordable housing goals for the city, it's unlikely that one type of evaluation will be successful for measuring the outcomes of all possible strategies. It's more likely that evaluation of these efforts will be somewhat fragmented as the different pieces of this strategy are implemented. Goals will also likely not be accomplished simultaneously, and

a flexible evaluation plan will allow the outcome of certain steps to be measured as they are relevant.

The immediate next steps to take by the City of Madison are those that bring affordable housing to the forefront of residents' and developers' minds. Madison is expanding rapidly, and affordable housing should be considered as new developments are brought forward for approval. The identification of available grants and subsidies is also a goal that should be accomplished sooner rather than later. Development will continue without grants; it just likely won't include affordable housing options. Since the application and award process for grants often takes months to years, it's necessary to begin this process quickly.

Conclusion

By encourage neighborhood associations to participate in developing affordable housing and increasing economic diversity, building the Bus Rapid Transit, educating the community and providing resources for owners, renters and landlords to access funds for energy updates, and conduct Energy Audits through WHEPA funds, we believe that we can achieve Madison's goal to provide affordable housing to families living below the poverty line. Through our recommendations, we are also encouraging safe and stable housing, as well as greater human mobility and increased access to education, employment and social services. Together, these factors can increase health outcome, decrease the social mobility gap in Madison, and provide the standard of living for families living in affordable housing.

In the future, identifying architectural designs that incorporate green spaces in affordable housing may provide mental health benefits to people living in the housing units. Additionally, advising the Madison Area Transportation Planning Board to implement one BRT corridor, instead of four, which connects affordable housing neighborhoods to employment hubs could help to overcome issues with funding while supporting transit dependent households. Lastly, enforcing inspections for indoor radon gas in energy efficient housing can reduce adverse health outcomes in new or updated affordable housing units.

Appendices

Policy Analysis

Policy/Program	Technical Feasibility	Economic Feasibility	Political Feasibility	Administrative Feasibility	Health Impact
WHEDA energy and improvement loan	High	High	High	High	improved air quality, decrease noise, energy savings. Most vulnerable likely not eligible. Low Impact
WHEAP Weatherization	Moderate	High	High	Moderate	new green technologies, improved air quality, decrease noise, Increase eligibility. High Impact
Bus Rapid Transit	High	Low	Low	High	Increased mobility, job opportunities, access to education, access to services. High Impact
Neighborhood Associations and Diversity	High	High	Moderate to High	High	Increase civic engagement, promote advocacy, increase social capital, promote diversity. High Impact

Health Determinants

Assessing Key Determinants					
Goal	**Benefits vs. Risk**	**Environment**	**Social and Economic**	**Health Behaviors**	**Access to Services**
Diversify Neighborhoods	Benefits Risks	++	++ -	++	+ -
Build Low Income Housing	Benefits Risks	+++ -	++ - -	++	+
Decentralize Services	Benefits Risks	+++	+++ - -	++	+++
Locate Near Transit	Benefits Risks	+++ - -	+++ -	+++ -	+++
Energy Efficiency	Benefits Risks	++ - -	+++ -	+	++
Green Technology	Benefits Risks	++ - -	+++ -	+	++
The lowest risk was associated with Decentralizing Services and Diversifying Neighborhoods, followed by Energy Efficiency and Green Technology. The highest benefit was associated with Locating Near Transit and Decentralizing Services, followed by Energy Efficiency and Green Technology.					

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A Health Impact Assessment: Art, Design and Culture of the Madison Sustainability Plan

PHS 740 Health Impact Assessment of Global Environment Change

Spring 2016

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Executive Summary:

In 2011 the Madison Sustainability Plan was released with a vision for Madison to become "a self-reliant, peaceful community that relies on renewable, local resources and is able to adapt to changing environmental, social and economic conditions over time." This plan examined goals and actions for 10 different categories that are vital for a sustainable community. While many of the sustainability goals of these categories were developed with the environment, economy and community in mind, examination of how these categories affect the health of the population and an individual were not considered. However, in order to understand the complete impact of the sustainability plan a health impact assessment for each category is essential. One category that was detailed in the Madison Sustainability Plan was Art, Design and Culture. The plan focused on creating awareness for sustainable art and incorporating this type of art in public art projects and designs. While these actions may not seem directly related to health there are a number of benefits from sustainable art in the community. Health benefits are observed in the forms of mental health and social capital of a community. Along with these benefits providing education to the public about sustainability and creating a more aesthetically pleasing

neighborhood would provide a number of other health benefits for Madison residents. These health benefits, combined with a reduction in waste make sustainable art essential for Madison. Unfortunately, lack of guidelines and knowledge among artists regarding sustainability is lacking in Madison. Also, without much funding being provided to these projects creating the number of sustainable art projects the city desires may be difficult. It is recommended that there be increase funding and support for the arts throughout Madison as well as adoption of sustainability guidelines for artists to follow in order to ensure the benefits from sustainable art are being realized throughout the community.

Madison Sustainability Plan: Art Design and Culture

In 2011, the Quality and Sustainability Steering Committee, with the input from an executive team created a sustainability plan for the city of Madison. Sustainability in the simplest terms is the maintenance of the natural environment in order to support life on earth. The focus of this plan was economic prosperity, social well-being and the environment. Through these areas of focus the committee hopes to improve the health and quality of life in the community through sustainable practices. The purpose of the plan is to create short, medium, and long-term goals that will provide a framework for citizens and policy makers to use in order to create a more sustainable Madison. The plan outlines ten specific categories in which sustainability is needed, including Arts, Design and Culture. The final sustainability plan outlines two goals to achieve sustainability in Arts, Design and Culture as well as actions that may be undertaken to achieve these goals.

Goal 1: Integrate environmental sustainability into Madison's arts program and art and design into the city's sustainability efforts

1. Encourage sustainable practices in Madison's Public Art Program.
2. Create an addendum to the Public Art Framework and Field Guide that includes guidelines for achieving sustainability in Madison's Public Art Program.

3. Research and identify best practices in sustainable art and design and encourage incorporation of such standards into public art projects.
4. Support neighborhood dance instruction for children and adults.

Goal 2: Include sustainable art in city infrastructure projects

1. Encourage development of projects that serve our community and ecosystem by maintaining high design and environmental standards, creativity and community involvement.
2. Require artist and designer participation in municipal projects over $1 million and reserve a percentage of the project budget to fund the art/design fees.

Health Impact Assessment of Madison Sustainability Plan: Arts, Design and Culture

Participation in art-related programs and installation of public art has numerous possibilities for positive health impacts on the community. Conducting an Health Impact Assessments (HIA) will allow for the examination of the goals and actions of the Art, Design and Culture section of the sustainability plan to understand how accomplishing these goals will affect the health of the Madison community. There are vulnerable populations in areas of the city that may be ignored or not receive their fair-share of funding or attention. Programs that are not culturally sensitive or interesting to certain identity groups could also lead to those groups not receiving health benefits if culturally appropriate programs that took their values into account were researched and implemented with the help of trusted community leaders. If careful consideration is not taken into account, there is a risk of further gentrification of neighborhoods and increasing the disparities that already exist so starkly in Wisconsin (Chernoff, 2015).

Importance of Sustainable Art:

In the next 100 years, climate change is predicted to have a major impact on the world. Rising temperatures, sea levels, increased frequency of drought and severe weather events have the potential to negatively impact communities throughout the world. As a result of these concerns, sustainability has been increasing in importance. Creating a relationship between the community, the population and the environment is needed in order to combat the problems the

world faces (DeVlieg, 2009). Efforts to develop a more sustainable community are varied and through programs and innovative designs centered around housing, transportation, as well as art, design and culture, to name a few, will have key results. While art design and culture may not have as big of an impact on sustainability efforts, it plays an interesting role in society and practicing sustainable art provides a number of benefits to the community. Whether it is a public mural, community art classes, or a commissioned art project each should be valued and evaluated on their basis of sustainability in order to improve neighborhoods. Artists throughout the community have the ability to address sustainability in a number of ways. Using recycled or natural materials artists are able to inspire and educate the public. Examples, such as RiverCubes (Appendix A) in Pittsburgh do this by creating art pieces from trash taken out of the river (DeVlieg, 2009). Artists often use real and symbolic meaning to create a message. By using their art in sustainable ways artists are able to create a different lens for which the public is able to view sustainability. The artist creates a connection between the art in front of them and the environment. This message and art, in general, has the ability to bring communities together. Art is able to help a community explore and understand their values. Through involvement of sustainable artists, use of green materials and education, art plays an important role in the sustainability efforts of a community (Haley & Iyer, 2009).

Key Determinants for Sustainable Art:

Art is a broad category encompassing music, painting, dance, sculpting, and more. Each of them, in their own unique way, can utilize sustainable practices and promote sustainable development through their actions. However, there are a number of problems ranging from individual artists to entire communities that are detrimental to sustainable art efforts.

Guidelines:

A number of independent organizations have created their own guidelines for what constitutes sustainable art. However, in Madison there has not been any creation or adoption of guidelines for artists to consider sustainable art practices. The Madison Art Commission (MAC) has created the Public Art Framework and Field Guide that incorporates ten principles highlighting a number of important aspects of art development in the community but unfortunately sustainability is not one of these principles. By not including a principle relating to sustainability in these guides, projects that are commissioned by the MAC may not be environmentally friendly (Madison Art Commission).

Involvement of Stakeholders:

Another problem facing the growth of sustainable art is the lack of discussion between stakeholders. The Department of Community and Economic Development and the MAC, Sustain Dane, which organizes sustainable Madison art (smART), the Quality and Sustainability Steering Committee, state legislators, private developers and local artists are just a few stakeholders that play a role in developing sustainable art in Madison. All of these stakeholders have the ability to influence the art that is created. From local artists who create green art with their own resources to state legislators, who are able to influence cultural and social policies. Involving policy makers is often overlooked but their role is important. Cultural policy may not be high on the agenda but culture has an influence on social and economic states of the community. Creating policies that influence art programs increases social involvement and public art can influence a neighborhood's development, changing the economic outlook of the neighborhood (Anttonen, et al. 2016). Another important partnership is between the MAC, a private developer and local artists. Creating collaboration between the three parties that begins early in the development process will go a long way in accomplishing the vision of the artist and the developer.

Sustainability in development is another important aspect in the Madison Sustainability Plan. By partnering these developers with artists who create innovative pieces of work using sustainable practices produces a project that is both sustainable and an art attraction. The project becomes both a destination and a local landmark (Miller, et al. n.d.). These Stakeholders play an important role and their input is invaluable toward the development and promotion sustainable art and culture. However, lack of communication and involvement has slowed development of sustainable art throughout Madison.

Funding:

Another potential obstacle for creating sustainable art throughout Madison is the funding that many projects require. Currently there are a number of methods for artists to have their projects funded but the problem is often that these funds are for project costs only and in order to maintain a thriving art community creating funds that contribute to an artist's daily living is important. In the 2013-2015 biennial state budget, $80,000 was allocated to the Municipal Art Fund, managed by the MAC, out of the $32 million the Department of Community and Economic Development Received (Walker, 2013). The MAC provides a number of grant opportunities amounting to up to $1500 or $3000 depending on the type of project. Even with these grant opportunities there are no requirements that these projects be sustainable. Besides grants there are other options for artists to get funded. In the Field Guide, the MAC outlines multiple methods, the first of which is through partnership of capital project designs. If a partnership is created, the MAC will match the construction budget 3 to 1 from the Municipal Art Fund. Other options include the support entirely from private development project budgets, private or philanthropic contributions, or sponsored artwork. Funding for arts programs is also a problem in many communities. These programs are often operated by volunteers and require

grants in order to be funded. In order to grow sustainable art throughout Madison, creating unique opportunities for artists to be funded is needed for the city of Madison (MAC Public Art Framework and Field Guide, 2004).

Knowledge:

Increasing awareness of sustainable art is another issue facing the field. While the topic has been growing among artists, creating an art community that is aware of the environment has been very challenging. In the early 2000's, the issue of sustainability generated professional discussion and by 2006 An International Symposium on Sustainability and Contemporary Art took place in Europe. By furthering the discussion about how art influences the environment, there may be a positive shift towards more sustainable art in the community (DeVlieg, 2009). Along with knowledge regarding best practices artists also need knowledge in the skills required to write grants, negotiate, network and build partnerships that are critical to design a creation that is environmentally effective and aesthetically pleasing. Hugh Pocock of the Maryland Institute College of Art describes education that students receive as tools to pursue their interests but not how to make a living. With many artists facing this issue, creating a community of sustainable artists may be difficult (Grant, 2012).

Impacts of Art on Health:

Appendix B shows how the goals and actions from Art, Design and Culture have an impact on communities and human health. Much of the impact of incorporating sustainable practices into art has impact on mental health and social capital within a community. Including environmental art, green/recycled art, participation of environmental artists and supporting neighborhood art programs into the plan the social capital of the community is expected to improve along with the mental health of the residents. Other benefits relate to improving the

image of the community and creating a more walkable neighborhood, which has beneficial impacts on cardiovascular health. Finally, including recycled art and green practices at local festivals reduces waste resulting in indirect health benefits through mediating climate change (Guetzkow, 2002).

Madison Sustainability Plan's Actions and their Impacts on Health

The goal of the HIA is to assess the health impact of three actions of the Madison Sustainability Plan: Art, Design and Culture along with an additional assessment of green festivals given Madison's abundance of festivals.

Encourage sustainable practices in Madison's Public Art Program:

Encourage sustainable practices in Madison's Public Art Program corresponds to the first action of goal one of the Art, Design and Culture sustainability plan. This action, which incorporates environmental artists in creating sustainable infrastructure, creation public projects with environmental art and utilizing environmental artists in design teams, would provide many health benefits if accomplished.

Environmental Benefits (Recycling and Awareness):

The action of encouraging sustainable practices in Madison's Public Art Program has a number of indirect health benefits through the incorporation of environmental art and green infrastructure. Environmental art often uses recycled materials to incorporate designs into the infrastructure. There are a number of health impacts by encouraging artists to use recycled materials that have been researched extensively. For example, reusing aluminum and other metals for the purposes of art projects will relate to the reductions in carbon dioxide and energy used to dispose of these materials. Also, reducing airborne metal particulate emissions is associated improved air quality (Hagelstein, 2009). While materials used in art projects may not

be large a contributor to pollution and carbon emissions, there are benefits for the art industry to understand the importance of recycling and how reusing materials can help reduce carbon emissions, which would help mediate the effects of climate change (Haley & Iyer, 2009). Understanding the effects of climate change on health is not within the scope of this HIA but actions to help offset the rate of climate change will have benefits on human health.

Appendix C shows a great art piece that exemplifies recycling is Philadelphia's "the Color of Your Voice" mural, wherein the colors actually made from trash neighborhood residents collected off the streets. Red might be a Coke can, yellow might be from a potato chip bag. The trash was also used to inscribe poetry from local poets and from Porch Light attendees who can't read or write. This is a great example of how art can be sustainable and improve the health of the city.

Mental Health Benefits:

Ecological art can work to improve mental health by serving the intellectual needs of the community. First, ecological art can offer grounds for dialogue about humans' relationship to the natural environment. The process of viewing and experiencing art made in an ecologically friendly way becomes a shared experience among community members; where the materials came from, the artists themselves, where the art was strategically placed, and what broader themes are meant to be addressed can all be discussion points (Kim, 2015). The theme of the environment also has the added benefit of permeability across age levels. Song (2012) examined several environmental art pieces constructed by a college-level classroom in Massachusetts, each one with a different intended audience. One student created a display on her campus that addressed littering among college students, whereas another student created a waterfall display that used recycled rainwater as its water source, intended to be placed in an elementary school

playground to teach children about resource conservation. Projects like the waterfall present ecological themes in a non-intrusive, playful way, thus helping to inform the next generation of environmental stewards (Song, 2012).

Second, ecologically-sound art can serve a greater purpose. Another group from the Massachusetts class created a series of habitats for an endangered species of turtle. This piece of artwork had the advantage of being aesthetically pleasing, created from natural resources like driftwood and recyclables thus reducing the carbon footprint of the project, and a home for the threatened species and an assortment of other nearby fauna, such as snails and frogs. Art as simple as this design has the added benefit of being easily digestible by all age groups, and stimulates eco-friendly ideas by putting humans in closer contact with nature (Song, 2012).

While the mental health and social benefits of ecologically-friendly art specifically remains understudied, a general inference can be drawn about its potential benefits for the human psyche. Sustainably-made-art is often publicly presented or incorporated into existing infrastructure, resulting in a wide-ranging audience in terms of viewership. For this reason, pieces of ecological art can be the basis for communal interaction and discussion, thus promoting intergroup relationships and trust within a given space. Due to the large potential viewership eco-friendly art may also present the daunting idea of environmental degradation in a more digestible way, through color and creation, which may be less anxiety-inducing in the long term for certain citizens (Kim, 2015).

Art is often an overlooked avenue to get community members involved in healthful and sustainable practices. Art can include visual art, music, dance, and other endeavors. Community-sponsored programs, such as those with MSCR and MMSD, can do more to put emphasis on sustainable practices within their programs. Programs and initiatives that are implemented must

take social justice issues into account and make efforts to make the benefits of these programs available to all, regardless of identity. Within this area of the Sustainability Plan there is much Madison can do to increase the sustainability of its numerous music and art festivals and events that take place here, especially during the warmer months.

Other cities have undertaken art initiatives to great success. Philadelphia's Porch Light Initiative is one example of this. This program brings people who have behavioral health issues (such as addiction) together for nine months to talk and to brainstorm on ideas for a mural in their neighborhood. Participants were shown on a YouTube video saying things like "I'm looking forward to coming back and keep working on this" and "I'm proud to be apart of this". The program uses parachute paper that the new artists can paint on which are then pasted on buildings like all-weather wallpaper when weather permits. This way, engagement can happen no matter the season.

Porch Light received a grant from the Robert Wood Johnson Foundation, but the Foundation asked "What's the impact?" Porch Light was lucky enough to have Yale School of Medicine agree to do a study on participants' opinions of the program, their attendance, any relapses they had. Yale also tracked program activities, comparison sites, community surveys, observed sites, pre- post- and follow up interviews. Yale found that program participants feel more connected to their community and especially felt the stigma of addiction lessen. Most of the adults they work with have addiction and mental health issues compounded by poverty; so many aspects of these residents' identities are marginalized and stigmatized. Any lessening of these mental and emotional burdens is a good thing from a health standpoint. The HIA of Art, Design and Culture does not have large impacts on physical health but health care professionals

and concerned members of society should remember WHO's definition of health; that it includes mental and social wellbeing, not merely the absence of disease or infirmity.

After two years residents who lived within a mile of a Porch Light mural had more understanding for those with mental health struggles. A survey measuring trust among neighbors also showed significant improvements post-mural installation. Individuals who painted murals at the site with most rigorous rules, guidelines, and accountability had decrease in negative behaviors with addiction and an increased adherence to treatment coupled with decreased stress.

So why have public art initiatives? There's a great need for mental health services, most people never access any, those that do usually go only once. Public art as a community-based intervention forges connections, creates healing opportunities, illuminations new ways of understanding. For example, to go back to the Philadelphia case study, a methadone clinic they put mural on was highly utilized but before hand looked like an abandoned building. Now it looks like a cared-for building and improves the mental state of those that work at and utilize the services of the clinic.

Mental health providers and clinicians also felt more positively about their worksite; felt it was effective to have painting/drawing workspace on site as they could take their clients in the room very easily. Yale also observed a site where a mural was put up by Mural Arts but without community engagement, they observed improvements in "rate of decay" except there was no reduction of stigma in the community of a certain issue like there was when a specific group was engaged. The School of Medicine survey also used neighborhood efficacy and aesthetic measures, which were standardized. Neighborhoods receiving mural installations saw improvements in both measurements. Used public transportation tokens as incentives to get people to stop and answer lengthy surveys. Philly has diversity in different neighborhoods and

also a lot of large buildings that have large visual expanses, so interventions were all different to suit different enclaves. Murals work in Philly because of these large walls they have, other communities like rural communities may have to think of other ways to incorporate art, although many of the buildings she showed in her presentation were only two stories. She also showed one story buildings and some murals installed on the ground. These could be ways that smaller communities could incorporate wall art.

Increasing Walkability in Neighborhoods

Sustainable art has the obvious benefits over traditional art because of the impact on the environment but one general area that sustainable and traditional art can impact is the walkability of a community. The increase in walkability leads to physical benefits for the community. Creating art in the community promotes neighborhood cultural diversity and reduces neighborhood crime and delinquency, both of which contribute to the walkability of a community. It has been shown that residents of neighborhoods with better walkability and more social cohesion were less likely to have hypertension as compared to neighborhoods that were perceived to be less walkable and have less social capital. These results were adjusted for socioeconomic indicators, as that is a factor that often plays a role on an individual's health. The impact of decreased hypertension has a number of other health benefits relating to cardiovascular, diabetes, and other chronic illnesses. Sustainable art will increase the attractiveness of the area, which raises attention to the community not only for its residents but also for visitors and tourists. More people will have the opportunity to walk and enjoy the art (Mujahid, et al. 2008).

Create and addendum to the Public Art Framework and Field Guide that includes guidelines for achieving sustainability in Madison's Public Art Program

As described in the key determinants, the lack of guidelines for achieving sustainability is lacking in Madison. The MAC requires artists to consider sustainability in their art but a guideline would be very useful for contracting and providing grants to future art projects. By creating a guideline for artists and the MAC to follow, health benefits will be achieved through mechanisms previously discussed (mental health, walkability, etc.). By creating guidelines for sustainable art research, to incorporate best practices, will be completed prior to guideline adoption. Through research, this guide would ensure that sustainable practices are followed so that those benefits would be achieved (Chrysalis Arts Ltd., 2010).

Support neighborhood art programs (including dance)

The presence of art in healthcare has been described as "creative activities that aim to improve individual/community health and healthcare delivery using arts based approaches that seek to enhance the healthcare environment through provision of artworks or performances (Johnson & Stanley, 2007)." Empirically, involvement in art in this way has aided in shortening length of stay in hospitals, promoting better relationship between health practitioners and patients, reducing stress and anxiety associated with illness, and alleviating drug addiction. More specifically, this type of community-based art education/therapy has been proven successful in the treatment of several mental illnesses; including depression, anxiety, and post-traumatic stress disorder (PTSD) (Johnson & Stanley, 2007).

This type of therapy can take two forms. First, active art therapy involves simply creating art for the sake of creation. This form can boost self-worth and self-confidence, as well as act as a means of communication for those otherwise voiceless (Johnson & Stanley, 2007). A community-based art education program based out of England offered a joint art workshop/support group for three populations previously identified to be at risk for developing

mental health problems: a group for single parents, a group for drug addicted or homeless people, and a group for teen mothers. Participants persisted that the group was markedly beneficial for their mental well-being, if only to serve as an informal social support network. Many participants lacked the support of a romantic partner, or feared stigmatization from the greater community due to their social circumstance, and therefore found immense comfort in the act of coming together to create each week. For one member of the homeless group, "someone out there cares whether you're dead or alive (Argyle & Bolton, 2005). Active art therapy also has physical health benefits, namely in the context of a neighborhood dance class, which can aid in reducing risk of cardiovascular disease, respiratory disease, obesity and type II diabetes among children and adults (Keogh et al, 2009; Fairclough & Stratton, 2005).

The second, passive art therapy is based on the idea of displacement: art is there to experience, to take the viewer away from the harmful or distressing feelings one experiences in the day-to-day. This form of therapy also gives the participant the opportunity to reflect on how the themes of the art apply to his or her own life (Johnson & Stanley, 2007). Consumers of a community-based art education program for adults based out of Tate Modern Contemporary Art Museum in London found that coming together to discuss pre-selected paintings with a facilitator aided in their difficulties with social isolation. Many members articulated that they previously felt the museum was "not a place" for them due to the high amount of people and the prestigious nature of the building. This perspective changed upon participation in the program; participants now felt more at ease that this was a place of comfort. Themes explored in the production of modern art can be unsettling or off-putting; to digest these themes in a group setting in the space dedicated to it was "better than experiencing it alone." Participants also noted that participation in the program had benefits in reference to their own mental health histories:

simply making it out of the house to attend the program was a big step, especially sharing personal ideas about art with strangers. This is a significant benefit of making art easily accessible outside of museums and galleries: people with mental illnesses that find therapeutic benefits to viewing and discussing art will have easier access if it is a part of their built environment. While these programs do not directly solve the mental struggles of these individuals outright, each one provides marked relief of negative symptomatology among each diverse community (McKeown et al, 2016).

Underneath the umbrella of mental health is the idea of social capital, defined as "the potential embedded in social relationships that enable residents to coordinate community action to achieve shared goals (Semenza & March, 2009)." Developing healthy social relationships and thus a network of shared norms, values, and understandings is key to the development of trust within a community. Social capital goes beyond merely psychological well-being to include the idea of social inclusion: what are the social needs of a given place, and do people have access to supportive relationships and networks that make them feel comfortable in that place? Based on this idea of access, social capital can be measured through life expectancy, education or school retention, employment, crime rates, housing affordability, and other social and environmental determinants of health. In the same light, lack of social capital can lend towards an over reliance on services such as the emergency department for routine care and therefore, increase healthcare costs (Semenza & March, 2009).

Cities across the globe have noted the role art and culture play in creation of social capital. Johnson and Stanley (2007) evaluated three Australian community art projects for their impact on social capital using the "Most Significant Change" (MSC) model, which asks participants, quite literally, the most significant change in their life that has occurred as a result

of being involved in the group. Individually, subjects felt that participation in a community-wide art project "facilitated a healthier, more supportive community, where ideas are accepted and valued." Certain participants felt the projects brought them a closer connection to something prosocial, and were thus a reason to not commit crimes. This connection to prosocial life also aided education and employment, voiced by one participant as “participation renewed [my] motivation to build a more positive life, and re-establish links to school (Johnson & Stanley, 2007).”

Another study in Memphis, TN played into the pro-sociality of art education by redeveloping a former Sears store into a community arts center. This project focused on the creation of social capital by using art to foster place attachment, defined as "an emotional connection with a familiar location." Locations that promote shared experiences and activities are good for positive place attachment, especially for young people. The creation of the arts center, which now hosts the entire spectrum of human expression including painting/craftwork, poetry slams, dance recitals, and concerts, played a pivotal role in the development of a new community in Memphis, seamlessly bridging social capital and creativity (Thomas et al, 2015).

Green Festivals

There are many health benefits from “greening” festivals and events that occur in the city of Madison. One way reducing waste and increasing recycling can help the city’s environment is reducing the festival or event’s carbon footprint. Using less material will lower shipping carbon expenditures and involve less trash ending up in a landfill, which are known for contributing methane into the atmosphere. Further down the line in the “life” of a product, once it starts breaking down (or not) in a landfill, hard metals and contaminants leeching into the groundwater

can negatively impact the ecosystem and human health (Simon et al. 2016). As many festivals and events happen in the heat and humidity of the summer, one green initiative that should become a staple at city events is a water bottle filling station. If residents know clean water will be readily and always available to them at events, they may bring reusable water bottles instead of buying throwaway plastic bottles. This could save the oil used to produce and distribute the bottles as well as the long afterlife of the bottle (Simon et al. 2016). Plastic bottles that are discarded could then end up in a waterway, a landfill, or as a breeding ground for mosquitoes. Even recycling plastic is an energy-intensive process, so a reusable bottle is a great alternative.

Barriers:

One obstacle to transmitting community-based art and dance programs to the intended population is funding on behalf of the citizens: many of the populations described above that directly benefit from the presence of a community art program do not have petty spending money for art supplies or membership fees. Participants in the Rotherham, UK community art programs, especially the homeless, were deterred from participation by the dwindling supply of free art supplies. Other participants dropped out of the program due to lack of time; a heavy workload to keep up with bills prevented them from attending meetings (Argyle & Bolton, 2005). One benefit of these programs is they are relatively inexpensive to run, depending on the salary requirements of the artist or facilitator of the meeting. These expenses could also be mitigated if materials were donated. Nevertheless, community-wide dance programs may be more expensive to run due to the need of trained instructors and rehearsal space, and would thus pose a problem of access for those members of the population, the urban poor, that may see the greatest benefits from participation.

Another issue that may limit funding of all types of community-based programs is the undervaluing of all type of arts education in public schools across the United States. A 2012 assessment from the National Center for Education Statistics saw the amount of theater and dance programs available in public schools decreased from 20% to 3% since 10 years prior. Almost 40% of public secondary schools also eliminated any type of fine arts as a requirement for graduation. This decrease was felt most severely among schools in high-poverty cities and neighborhoods (Parsad & Spiegelman, 2012). This gives further weight to the support for arts education in a community setting, especially in poor communities. The issue still remains that these communities, who may need art and culture exposure the most, do not have the means to pay for courses. If the intended goal is to support art, music, and dance programming in Madison, a solid funding source will need to be established in order to ensure the sustainability of the programs.

A common thread that ties many of the aforementioned community-based art education programs is race. Author Carolyn Chernoff (2015) notes the dangers of programs and public art installations designed and funded by predominantly white, progressive, grassroots organizations intended to bring "culture" to low income communities of color. She explains the damaging image an artist or educator can have on community programs when he or she comes into these settings with assumptions about what a particular community will like or enjoy; specifically, "when all the educators are white, presenting white ideals and perceptions to 'underprivileged colored students.'" One cited example of this mismatch in belief systems is that public murals can indicate a neighborhood is 'economically undesirable' among certain racial groups whereas in other spaces, it is just a mural (Setern & Seifert, 1998; as cited in Chernoff, 2015).This argument calls for greater racial dialogue among artists, educators, and other stakeholders before

the implementation of any programming or sustainable art structure intended to serve the psychosocial needs within ethnically diverse communities.

Recommendations:

It is recommended that encouraging sustainable practices in Madison's Public Art Program and supporting neighborhood art classes, as described in the sustainability plan be adopted by the city of Madison. Along with these actions three additional recommendations are described.

Increase support for organizations such as Sustain Dane:

Sustain Dane is a 501(c)3 non-profit serving the sustainability agenda of the greater Madison community. It has created a network of scientists, researchers, and activists who work to back other sustainability-focused policies and programs that affect those living in Madison, with the sole intent to limit further environmental degradation through limiting use of nonrenewable energy sources and "growth of civic engagement." In its short life as an organization and institution, Sustain Dane has also created partnerships with a myriad of other ecologically-minded organizations, such as Healthy Children, Healthy Planet, and the North American Eco-Municipality Network. Sustain Dane recently created a neighborhood initiative known as smART [sustainability + madison + art] directly and specifically in response to the 2011 City of Madison Sustainability goal, to "integrate environmental sustainability into Madison's art program and art and design into the city's sustainability efforts." Currently, their efforts focus on the community-wide collaborative creation of a mural, intended to generate dialogue surrounding issues of sustainability, foster community engagement, and encourage place making through providing an outlet for a large group's collective vision (sustaindane.org, n.d.). For these reasons, the Madison Art Commission is strongly urged to combine its efforts

with those of Sustain Dane and the smART initiative. Collaboration between these two organizations will be invaluable in the continued development of sustainable art within Madison, WI.

Adoption of the Public Art Sustainability Assessment:

Developed by Chrysalis Arts, the Public Art Sustainability Assessment (PASA) is a tool to used during development, creation and maintenance of public art. Developed so that public art incorporates sustainability to raise awareness for these social, economic and environmental issues. The PASA guidelines are divided into five sections, artistic practice and approach, project management, community involvement, environment and resources, site and context. Each of these five sections has detailed criteria to better judge the sustainability of a project. For example, environment and resources asks, “Can materials and resources be sourced locally and sustainably?” For a specific art project the PASA is carried out by scoring each criteria, then by adding up each score an overall sustainability score is determined. It is recommended that all five sections be adopted by the MAC and after discussion with local artists and other stakeholders, specific criteria for each section can be specified for the MAC. This recommendation would fulfill the second action of goal one and create precedent for artists to consider sustainability in their projects.

Adopt Guidelines for Green Festivals:

A 2008 Report from the Icarus Foundation based out of England provides a comprehensive, step-by-step guide to planning and implementing a "green" festival, including specifics for food services (use of biodegradable cups, domestic alcohol, donation of leftover food to charity), choice of venue to maximize walkability and minimize noise pollution, and even in event materials, such as the use of reusable tokens instead of tickets (Graci & Dodds,

2008). Another non-profit organization, A Greener Festival, incentivizes 'going green' for event planners by offering an 'A Greener Festival Award' to those groups that adhere to sustainable guidelines, with the hope that groups will make the eco-friendly switch in exchange for publicity (A Greener Festival, LTD, 2016). Some of these practices have already gained support in other European countries: the 2015 Pitchfork Music Festival in Paris relied entirely on the use of "jetons" or tokens for alcohol purchase, and required participants to purchase and re-use a plastic biodegradable cup for all beverages throughout the festival (pitchforkmusicfestival.fr, n.d.). To promote sustainability standards across all aspects of Madison culture, guidelines for enacting these festivals should be incorporated into future planning of all major events, such as Taste of Madison or the Madison Marathon.

Evaluation

In order to understand the impact on sustainable art on the health of the community, a number of measures need to be continually evaluated to ensure success of the Madison Sustainability Plan: Art, Design, and Culture. Mental health and social capital are some of the most important health benefits that are expected to be observed. While often difficult to measure, mental health and social capital will be evaluated based on surveys as well as population health data. It is recommended that the DCED, in association with the MAC utilize the Integrated Questionnaire for the Measurement of Social Capital developed by the World Bank, Washington D.C. This tool measures groups and networks; trust and solidarity; collective action and cooperation; information and communication; social cohesion and inclusion; empowerment and political action (Gootaert, et al., 2003). Conducting surveys of communities every five years, after significant involvement of the arts in the community, would allow the DCED to quantify the effect of development in the area. Measuring mental health has been investigated by

Tannenbaum, et al (2009). In the study using self-reported subthreshold mental health symptoms, self-reported full diagnostic disorders, physicians' billings for outpatient mental health visits and use of psychotropic medications to measure the mental health of a community proved to be an effective method. Using these indicators a study of mental health should be conducted every five years in a community by the DCED.

Along with these outcome measures a number of process measures should also be evaluated. The ratio of the number of grants approved for sustainable art projects over traditional art projects should greater than or equal to 0.8. To ensure this ratio a yearly audit of the PASA will be done to review the effectiveness in this tool for encouraging sustainable art. Conducting yearly reviews of involvement and satisfaction of community art projects can help program managers adapt to the communities needs. Finally measurement of recycled materials from art projects as well as festivals should be accurately measured to assess the environmental impact.

Conclusion:

Including Art, Design and Culture into the Madison Sustainability plan outlines actions that can be taken to increase the abundance of sustainable art throughout the community. By following through on these actions will provide health benefits from improved knowledge regarding sustainability, social capital, mental health and more. It is believed that this HIA will help educate and inform decision makers about the importance of sustainable art in order to make these health benefits a reality throughout Madison.

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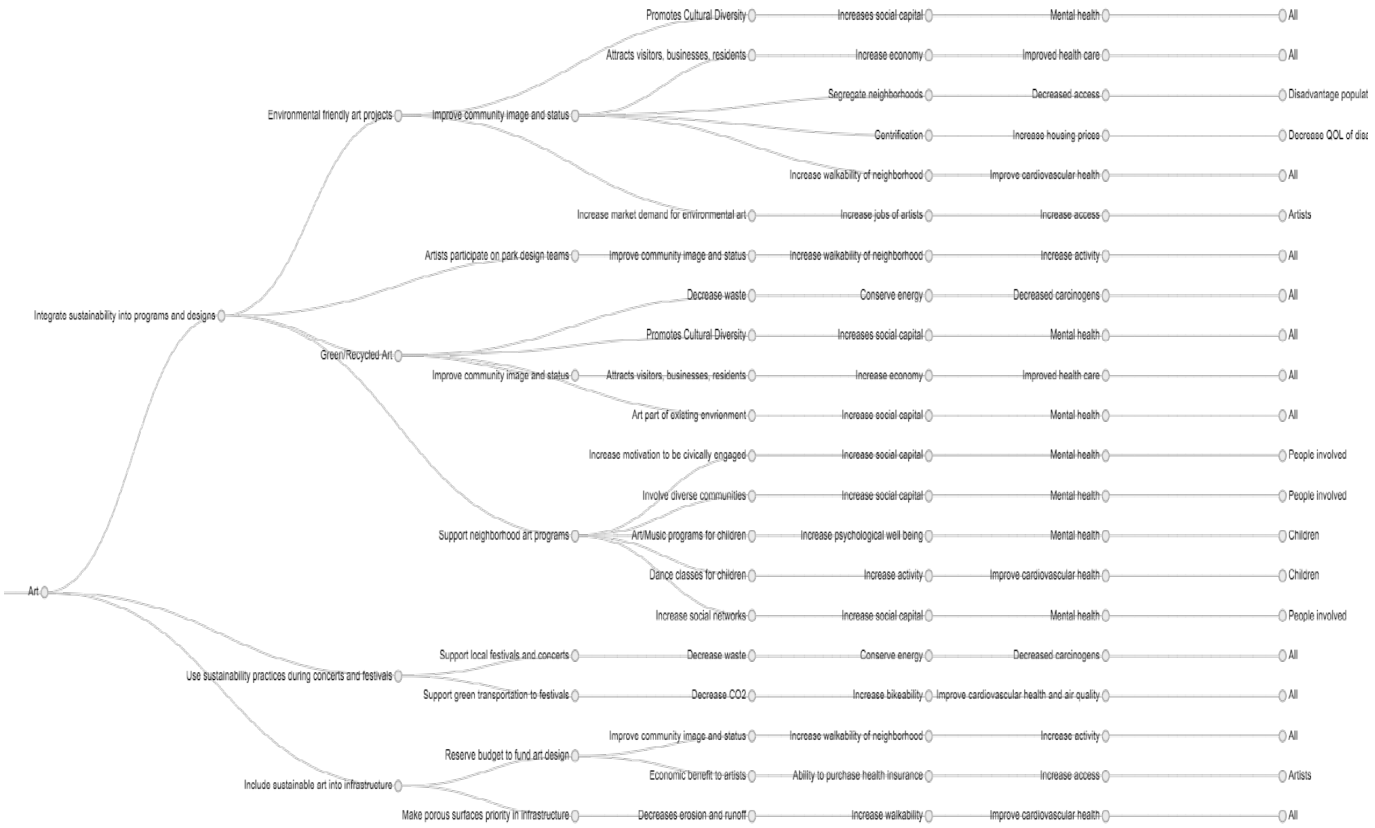
Appendix A:

River Cubes, Pittsburgh

Appendix B: Scoping Map


Art
Integrate sustainability into programs and designs
Environmental friendly art projects
Improve community image and status
Promotes Cultural Diversity
Increases social capital
Mental health
All
Attracts visitors, businesses, residents
Increase economy
Improved health care
All
Segregate neighborhoods
Decreased access
Disadvantage populat
Gentrification
Increase housing prices
Decrease QOL of disa
Increase walkability of neighborhood
Improve cardiovascular health
All
Increase market demand for environmental art
Increase jobs of artists
Increase access
Artists
Artists participate on park design teams
Improve community image and status
Increase walkability of neighborhood
Increase activity
All
Green/Recycled Art
Decrease waste
Conserve energy
Decreased carcinogens
All
Promotes Cultural Diversity
Increases social capital
Mental health
All
Improve community image and status
Attracts visitors, businesses, residents
Increase economy
Improved health care
All
Art part of existing environment
Increase social capital
Mental health
All
Support neighborhood art programs
Increase motivation to be civically engaged
Increase social capital
Mental health
People involved
Involve diverse communities
Increase social capital
Mental health
People involved
Art/Music programs for children
Increase psychological well being
Mental health
Children
Dance classes for children
Increase activity
Improve cardiovascular health
Children
Increase social networks
Increase social capital
Mental health
People involved
Use sustainability practices during concerts and festivals
Support local festivals and concerts
Decrease waste
Conserve energy
Decreased carcinogens
All
Support green transportation to festivals
Decrease CO2
Increase bikeability
Improve cardiovascular health and air quality
All
Include sustainable art into infrastructure
Reserve budget to fund art design
Improve community image and status
Increase walkability of neighborhood
Increase activity
All
Economic benefit to artists
Ability to purchase health insurance
Increase access
Artists
Make porous surfaces priority in infrastructure
Decreases erosion and runoff
Increase walkability
Improve cardiovascular health
All

Appendix C:

Philadelphia's "Color of Your Voice" art piece, made from trash collected from neighborhood