Roadside Vegetation Study

Department of Geographical and Sustainability Sciences

The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

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Prairie by Pavement:
A Proposal for Roadside Vegetation
Along Highway 6 in Iowa City

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Introduction

Critical to any urban area is its roadway infrastructure. Designed to facilitate the circulation of people and goods within an urban landscape, roadways also have a number of secondary effects, including increased surface run-off, exacerbated soil erosion, and fragmented urban ecosystems. However, integrative roadside management techniques that use native grasses and wildflowers in place of turf grass and other conventional roadside vegetation can mitigate some of these deleterious effects. In addition to the ecological benefits, these techniques can help curb maintenance costs by reducing the need for mowing and chemical applications.

The purpose of this report is to examine the suitability of a portion of Highway 6 in Iowa City for alternate roadside vegetation that utilizes prairie grasses and wildflowers. It outlines criteria to consider in choosing locations for prairie plantings, identifies three such areas along Highway 6 and discuss how a planting regime might be tailored to the conditions at each site, offers suggestions for structuring a prairie test plot, and highlights potential benefits including reduced long term maintenance needs and costs.

Background

Driving along Iowa's highways, Interstates, and county roads, it is not uncommon to see the tall grasses and rustic wildflowers of a prairie landscape lining the right-of-ways. Because of Iowa's natural heritage, a driver could mistake these prairie strips for remnants of the original landscape – but, in fact, they have been deliberately planted there as part of the Integrated Roadside Vegetation Management (IRVM) of the Iowa Department of Transportation (IowaDOT). Established in the mid-1970's, this program has replaced conventional turf with native vegetation in more than 50,000 roadside acres (IowaDOT, n.d.). These plants provide a number of ecosystem services, including improved water infiltration, low-maintenance weed and erosion control, enhanced wildlife habitat, and increased biodiversity (IowaDOT, n.d.). Importantly, native vegetation along roadsides also has proven to be an effective measure to control the spread of invasive plants, as vehicles travelling along the roads also transport seeds and plant fragments, facilitating the spread of invasives. The presence of robust, established native vegetation can prevent this transported plant matter from taking root. (Lucey, 2010).

For the most part, IRVM programs have concentrated on rural stretches of roadway, raising an important question: Could native grasses and wildflowers also be planted along urban highways? Within Iowa City, two highways bisect the urban area. Both are owned by IowaDOT, but the roadside verges are managed and maintained through agreements between IowaDOT and the city or the University of Iowa, depending on the portion of the road (Hall, personal interview, 2015; Gritsch, personal interview, 2015).

This has prompted city staff members responsible for maintaining these areas to explore the possibility of implementing the IRVM program or a similar alternate vegetation regime along the urban portions of these highways.

As a result, alternate roadside vegetation regimes have been taken up by two recent research initiatives within Iowa City. Undertaken by students in the University of Iowa's School of Urban and Regional Planning, the research has yielded favorable results. In both cases, potentially suitable sites were identified. A study completed in May 2015 examined three areas adjacent to highways in Iowa City: two near the eastern city limits, and one at the intersection of Highway 1 and Highway 6 in the south. For each site, the study proposed design alternatives and subsequent maintenance requirements. A second study currently underway builds on the first study by extending analysis to two additional sites along Highway 6.

This report adds to the work done in the previous studies by examining a final portion of Highway 6 from the intersection with Highway 1 to the intersection with Hawkins Drive near the city boundary with Coralville (see Figure 1 to the right). It offers additional locations that may be suitable for prairie plantings, with special consideration given to the urban context in which such plantings would occur and ways plans may need to be adapted accordingly.

Figure 1: Investigation area on Highway 6 (*source: Google Maps)*

Methods

The research for this report began with preliminary site visits, in which the study area was divided into half-mile sections and assigned to teams of two and three group members, who then walked both sides of the road in their section to perform visual inspections. Preliminary sites were identified to examine further, and a rubric was developed to bring uniformity to the evaluation of each site's suitability (see Appendix A for a sample rubric).

The preliminary sites were visited a second time, and each was evaluated in terms of vegetative cover, current maintenance regime, slope, indicators of soil erosion, soil conditions, root depth of current vegetation, area, litter, pollutants, presence of curb cuts and existing utilities. Accompanying photos were taken to document findings. Three elementary root depth samples were taken at each site at approximately equal intervals along a diagonal transect using a garden trowel and ruler. As can be seen in Table 1, the average root depth was found to be 8 cm. (The root depth of prairie plants, in comparison, can range from 60 to 450 cm long) (Conservation Research Institute, n.d.).

Based on these assessments, the potential sites were narrowed to three locations, shown individually in Appendix B. The sites were further evaluated using GIS data on slope and soil types. Ownership for each parcel was determined by using the Johnson County plat map. Right-of-way information was found from the IowaDOT regulations, and traffic counts for the adjacent roads were obtained from IowaDOT. Maintenance responsibility was determined through interviews.

Table 1: Root depth samples

Location/Sample	Root Depth
Site A / 1	7.5 cm
Site A / 2	7.5 cm
Site A / 3	9.5 cm
Site B / 1	3 cm
Site B / 2	4 cm
Site B / 3	7 cm
Site C / 1	7.5 cm
Site C / 2	9 cm
Site C / 3	12 cm
Site D / 1	11.5 cm
Site D / 2	12 cm
Site D / 3	7 cm
Site E / 1	7 cm
Site E / 2	7 cm
Site E / 3	8 cm
Average root depth: 7.96	

Results

Following the data collection and site selection, a SWOT (Strengths, Weaknesses, Opportunities, & Threats) analysis was used to identify the strengths and weaknesses of each site in terms of suitability for establishing prairie plants as well as the opportunities to realize benefits from the plants and threats that might undermine successful implementation. To refine planting recommendations for our selected sites, soil characteristics were identified utilizing information available from the USDA Natural Resource Conservation Service “Web Soil Survey” tool. Out of many variables, we chose to focus on the slope and type of each soil within our selected site, as well as soil moisture levels, limitations in terms of plantings, and what main hazards threaten this soil type. These considerations not only help to select the right seed mixes but enable evaluation of the benefits alternative plantings could bring to the soil on site.

Site 1: Myrtle Hill

Myrtle Hill represents the largest of the three selected sites (see Appendix B, Figure 1, for a detailed map). It is located at the intersection of Myrtle Avenue and Riverside Drive. Due to its size, this site presents an opportunity for multi-stage planting. Because sloped areas require a higher amount of material during initial seeding (Smith, 2010), level areas located at the western and eastern edges of the

site (the top and bottom of the hill, respectively). Prairie here would not present a challenge to motorist visibility, and preparing the site would not be as difficult as it would be on the sloping portion of the site. The silt-loam soil at Myrtle Hill is well suited for prairie plantings, and does not present the soil compaction issues the other two selected sites exhibit. Erosion, however, is a concern at this site due to the 22 percent grade present along the northern edge, though this phenomenon suggests a greater need for control and drainage. The flatter areas located at the top and bottom of the hill are less prone to erosion and drain well.

A key advantage of planting prairie vegetation at the top of this hill is that the plants function as a bulwark against runoff from the parking area at the top rushing down the hill towards Riverside Drive. Planting at this site also would reduce the amount of time and money spent on maintenance in the long-term, and the hill's use as a recreation area makes it an excellent location to increase public awareness of benefits associated with prairies through signage posted alongside the prairie plot.

Consideration should also be given to some of the more challenging conditions on site, however. None are prohibitive for a prairie planting, but they should be factored into any implementation plans. The slope of this site will require additional seeding to ensure the prairie species take hold, for example, and the pervasiveness of creeping Charlie (*Glechoma hederacea*), a fast-spreading weed, could present challenges in establishing prairies. Maintenance regimes such as prescribed burning may be more difficult due to the site's proximity to a residential neighborhoods and Riverside Drive. There are also a number of mature trees on site (see Table 2) that would need to be incorporated into any design plans. The general public may also complain about an unkempt appearance, especially since the site is very visible and people tend to be most comfortable with manicured turf grass. The portion along Riverside Drive is also exposed to heavy automobile traffic – a 2014 traffic count recorded 24,000 average daily vehicles (IowaDOT).

Table 2: Myrtle Hill Tree Inventory

Myrtle Hill Trees	Quantity
Ash tree	1
Bur oak	2
Shagbark hickory	3
White oak	6
Eastern cottonwood	1
Kentucky coffee-tree	3
American linden	4
Northern catalpa	2
Sycamore	5
Silver maple	1
Pin oak	1
Crab apple	2

By beginning with a prairie plot at the top of the hill, some of these challenges may be overcome. Gravity would assist in spreading the prairie slowly down the hill, reducing some of the expense and difficulty of planting the slope manually. Also by beginning at the top of the hill, land managers could allow for passing motorists to become acclimated to seeing prairie on this site, such

that when a second portion is planted at the bottom it would more likely be perceived as a positive extension of the prairie rather than an area left untended.

Site 2: Riverside Parking Area

The smallest of the selected sites, this parking area is located a tenth of a mile north of Myrtle Hill along Riverside Drive (See Appendix B, Figure 2) and is a strip of land that separates Riverside Drive from a parking area next to the Iowa River. This site features level ground. Prairie planting here could reduce the amount of runoff pollution entering the Iowa River from Riverside Drive and the parking lot. The soil at this site is also highly eroded; tree roots were exposed throughout the site and pebbly surface soil was observed, indicating a near total loss of top soil on site. Thus, even small improvements could produce large returns, including an eventual reversal of soil loss. Additionally, the large proportion of ash trees at this site (see Table 3) will likely be removed in the near future. Having any healthy vegetation at this site would markedly improve the aesthetics, and the site location makes for easy access for implementation and maintenance of prairie vegetation.

Table 3: Riverside Parking Area Tree Inventory

Riverside Parking Area Trees	Quantity
Ash tree	13
Redbud	10
Kentucky coffee-tree	1

However, the narrow size of the plot coupled with severe degradation of the soil are potential hurdles in establishing prairie at this site. High pedestrian and automotive traffic will make this site hostile to any plantings occurring here. The 2014 traffic count for this portions of Riverside Drive also recorded 24,000 average daily vehicles for this site (IowaDOT). Moreover, the highway on the western side of the plot and parking area on the eastern side mean the area is subject to twice the exposure to salt and other road maintenance activities. There may also be concerns regarding visibility for cars entering or leaving the parking lot from a busy road, so the height of any grasses planted here is an important consideration.

The challenges should not be thought of as a barrier to alternate vegetation, though, but an opportunity to employ prairie plants for the benefit of the area. A grass seed mix that produces shorter prairie grasses can provide many of the ecosystem services of tall grass prairie, such as improved water filtration and reduced erosion. A short grass prairie mix already employed by the University of Iowa that includes buffalo grass (*Buchloe dactyloids*), sideoats gramma (*Bouteloua curtipendula)*, blue gramma

(*Bouteloua gracilis),* and prairie dropseed (*Sporaboulis heterolepis*) could be planted at this site to reap some of the benefits of prairie plants without reducing visibility for motorists.

Site 3: Hawkins Drive

Located at the westernmost end of the study area, Hawkins Drive is an institutional road of the University of Iowa that connects to Highway 6 and is currently under construction (See Appendix B, Figure 3). As a result, a narrow, crescent shaped area between the portion of the road and an adjacent oak savannah has been devegetated. (For this reason, no tree inventory was taken; the site is currently bare ground.) The presents an excellent opportunity to establish alternate vegetation, as the area will need to be replanted once construction ends. In addition, this site is relatively level, and the northern end is subject to flooding, a phenomenon prairie can help to mitigate. Access for maintenance is easy via maintenance routes that pass through the woods from Carver Arena, and the chance of prairie plants being trampled by pedestrian traffic is low. Prairie species at this site could act as a buffer between the road and the oak savannah behind the suggested site.

Weaknesses of the site include heavily compacted soil, and the area is subject to litter from passing arena traffic as well as the construction crew. Artefacts will likely be present in the soil following the cessation of construction activity. Hawkins Drive is a busy road, and the resulting maintenance regime could present a harsh environment for roadside prairie species. The 2014 traffic count cited earlier recorded 9,900 average daily vehicles along this road (IowaDOT). Invasive species such as garlic mustard (*Alliaria petiolate*), peppergrass (*Lepidium latifolium*), and yellow rocket (*Barbarea vulgaris*) are common at this site, and the species may infiltrate the initial planting site as has been observed at the nearby prairie remnant along Mormon Trek trail. For this reason, careful site design and preparation will be key to the success of any prairie plants established here.

Discussion

Ecosystem benefits

Prior to European settlement, Iowa's landscape was predominantly tallgrass prairie (Samson and Knopf, 1994). However, more than a century of urban habitation and land development in Iowa City have altered landscape conditions within the city. Not only has most of the prairie been eliminated (with the exception of the aforementioned prairie remnant along Mormon Trek Trail), soil and hydrological conditions have been altered as soil has been removed or eroded and new soil and seeds imported. Furthermore, large portions of the city soils have been sealed with impervious surfaces, which decrease water infiltration and increase runoff. Likewise, ice removal on roadways utilizing salt has resulted in

roadside soils with higher saline concentrations. As a result, true prairie restoration may not be successful along roads as the conditions are no longer fully analogous with those in which the original prairie flourished. For this reason, the three sites identified in this study are better suited for reconciliation efforts, defined as improvements to a landscape that do not return an area to a pre-disturbed condition but which nonetheless allow for better ecological function as well as continued human use (Francis and Chadwick, 2013).

Utilizing native prairie plants in an urban setting can improve the quality of life and increase resilience within cities. As Table 4 notes, the plants provide a number of ecological services. Many of these benefits are the result of the natural biological functioning of the plants themselves. For example, the mitigation of urban heat island effects by prairie plants results from the evapotranspiration process in which air is cooled as water released by the plants absorbs heat (Gómez-Baggethun, et. al., 2013). Likewise, the plants' respiration process helps purify air by assimilating common pollutants from atmosphere (Gómez-Baggethun, et. al., 2013). This, in turn, benefits human health, as recent studies have shown air pollution such as airborne particulate matter and ozone increases respiratory and cardiovascular diseases (Brunekreef and Holgate, 2002). Furthermore, urban prairie can contribute to global climate regulation by acting as a sink of CO_2. As part of the photosynthesis process, urban prairie plants store atmospheric carbon dioxide as biomass (Gómez-Baggethun, et. al., 2013).

Table 4: **Benefits to Urban Areas from Prairie Plantings**

Benefits of Prairie Plants in Urban Areas	Ecological Benefits	Urban Heat Islands Mitigation
		Noise Reduction
		Air Purification
		Runoff Mitigation
		Global Climate Regulation
		Habitat for Biodiversity
	Social Benefits	Aesthetic Benefits
		Ecological Awareness

Similarly, the structure of the leaves and stems of the vegetative species in prairie ecosystems is able reduce runoff by intercepting water (Villareal and Bengtsson, 2005). One acre of leaf surface of prairie grass can hold 50 tons of water droplets, reducing runoff by allowing water to evaporate back into the air or slowly drip onto the soil (Henderson 2010). Prairie plants also make the soil "spongier" through producing more organic matter in the upper soil layer, which increases the capacity of those soils to hold and filter storm water. Additionally, the fibrous roots of prairie plants are outstanding at retaining soil and preventing erosion. The unique extensive root systems of prairie can penetrate 6 to 8 feet deep down to the soil (Henderson 2010).

Other ecosystem services provided by prairie plants include reduced noise pollution through absorption, deviation, reflection, and refraction of sound waves (Gómez-Baggethun, et al. 2013). Prairie plants along roadsides can function as a natural buffer to block noise. Such areas also can provide increased habitat for species such as birds, bees, butterflies and small mammals that rely on prairie ecosystem. One study found out that the abundance of butterfly community increased roughly five times more on roadsides restored with native prairie vegetation in Iowa than on turf roadsides. Species richness of habitat-sensitive butterflies was also found to be twice as large on prairie roadsides than regular turf roadsides (Ries, Debinski and Wieland 2001).

For the human inhabitants of urban spaces, the aesthetic value of prairie plants entails psychological benefits such as reduced stress and increased mental health (Gómez-Baggethun, et al. 2013). Although a prairie vegetation project aimed toward landscape reconciliation rather than restoration may not include the same diversity of grasses and forbs, it can nonetheless contain a reasonably diverse mix (and represent a greater diversity than conventional turf grass) such that many of the ecosystem services can still be realized.

Planting recommendations and test plot structure

Because each of the three recommended sites have unique characteristics in terms of soil, slope, and proximity to the road, it is appropriate to administer slightly different planting and management techniques for each. However, some basic principles for site preparation prior to seeding and maintenance afterward apply broadly to all. What follows are the general recommendations for establishing a plot of native grasses that can be used for implementing a test plot at one of the sites. These recommendations also can be used at all three sites for implementation of the project as a whole, with notes made as to site-specific considerations for altered regimes where appropriate.

Site preparation

Proper site preparation is imperative for successfully re-establishing native grasses and forbs. Persistent invasive weeds must be controlled prior to any planting. This will be of particular importance at the Hawkins Drive site, given the number of invasive plants observed in the fringe areas of the adjacent woods. The most effective method of preparation is a combination of herbicide treatment and mechanical cultivation. This involves mowing down the area, then two weeks later applying a broad-spectrum herbicide such as glyphosate (Simth, 2010). Burning can be used in cases where the dead vegetation is particularly heavy. Planting can follow about a week later.

Alternately, to avoid the use of herbicides, mechanical cultivation alone can be used, though it is very labor intensive and requires tilling at a depth of 4-5” every two weeks through the course of a

season. Planting can then take place the following spring (Simth, 2010). There is a risk of erosion with this method, as the ground is left bare during the tilling period. For this reason, controlled use of herbicides strictly following the dosage and application guidelines may be the most cost and labor effective method of preparing the site.

The final step of preparation is raking the soil to even out irregularities prior to planting the seeds. A rototiller can be used for smaller sites. The soil should not be too loose or too packed. To help prevent erosion during seeding and while the new prairie is taking root, a cover crop such as wheat or oats can be sown along with the prairie plants. Rye, however, should be avoided as a cover crop, as it can suppress the growth of other plants (Simth, 2010). Alternately, the IowaDOT does allow for hydraulic seeding using wood cellulose or a bonded fiber mix as a mulching agent or pneumatic drilling using well-decomposed compost matter as erosion-control seeding methods, provided the same guidelines are followed as for other roadside seeding processes (IowaDOT, n.d.).

Seeding

It is essential to have a well-planned seed mix to establish a diverse, stable, and weed-resistant prairie community. The selection of appropriate plant species involves matching characteristics of individual prairie species to the site conditions where they will be planted. The strength of a prairie is in its diversity. In a naturally-occurring prairie, grasses make up 80 percent of the vegetation while forbs account for the remaining 20 percent. The grasses themselves can include between 40 and 60 species, though there are more than 300 species of prairie forbs (NPS 2016). Although it may not be possible to replicate such a high degree of species diversity in a roadside planting, a mix of at least six grasses, three sedges, and 25 forbs is generally regarded as a species-diverse seed mix for prairie restoration (Smith et. al., 2010). Although there are a greater number of forb species than grasses in such a seed mix, they generally make up a small percentage of the total seeds approximating the proportions in a naturally-occurring prairie.

To increase the likelihood of success, seed mixes should contain grasses, sedges and forbs. These should also be a mix of annual, biennial, and perennial species. The perennials will eventually dominate the prairie as the plot reaches maturity, but in the initial period the annual and biennial species, which are quicker to establish, will help with weed control. Planting at the correct density will also help prevent weeds from overwhelming the prairie plot. A minimum of 40 seeds per square foot is recommended for level areas, while 60 to 80 seeds per square foot is recommended for slopes of 33.5 percent or greater to compensate for losses due to erosion (Smith et. al., 2010).

Prairie plant seeds are available from a number of reputable sources, both individually and in pre-configured mixes. This includes an IowaDOT-established mix of seeds available through both United Seeds in Nebraska and Shooting Star Native Seeds in Minnesota (see Appendix C for an index of three seed mixes available through Shooting Star, including prices and seeding rates for comparison). Prices for seed mixes will vary from month to month based on availability of seeds and rate of demand (Shooting Star, phone interview, 2015; United Seeds, phone interview, 2015). Additionally, the Iowa Natural Resources Conservation Service provides an online seed mixes calculator for the public to roughly estimate the cost of seed mix as well as a list of prairie seeds species native to Iowa is also available to the public.

The other important consideration in selecting seeds are their compatibility with the soil moisture and composition in the planting area. Although site-specific soil testing was outside the scope of this study, the basic soil type for all three areas was determined to be silt loam, which is classified as mesic (that is, moderately moist) in terms of soil moisture category (USDA NRCS Soil Report). GIS mapping also showed the slope in the three sites to range from 1 to 25 percent (Soil Report). All three sites receive adequate exposure to sunlight.

Given these conditions, a basic prairie mix such as that offered by Shooting Star Native Seeds serves as a good template for a seed mix for the recommended sites in this study. It contains six grass species and 18 forb species, and is designed to flourish in mesic soil with full to partial sun exposure (Shooting Start Native Seeds, 2016). However, it produces plants that can grow from 2 to 8 feet tall, which makes it unsuitable for roadside planting. The site located at the top of Myrtle Hill is the strongest candidate for a mix containing a similarly wide range of grasses and forbs, as it is subject to the least exposure to traffic and entails the fewest visibility concerns. In contrast, a mix such as the one approved by the IowaDOT might be the best candidate for the Hawkins Drive site, as the species have been selected to withstand roadside conditions and to be short enough not to interfere with motorists' field of vision. A highly-tolerant short grass mix would be the best fit for the Riverside Parking Area.

Maintenance

In general, the first three years of planting can be considered the first phase of establishing a prairie plot. This is a critical time period for successfully planting prairie. Although in subsequent years mowing may not be required, during the first year the plot will require some mowing to help with weed control. Ideally, mowing should keep plants to six inches tall through use of a flail mower (Kilde, 2000). This decreases the chance of smothering young prairie that has not yet fully established itself. For the

same reason, mowing should not be undertaken when the ground is wet. Clippings should be raked and removed from the site, and mowing should be done no more than three times in the first year.

Monitoring of sites should be done frequently to prevent invasive or otherwise unwanted plants from establishing in the prairie. However, manual pulling of weeds should be avoided, as it could damage prairie seedlings (Diboll, n.d.). Instead, cover crops such as oats can be used to prevent establishment of unwanted weeds, and, if necessary, spot-application of herbicides can be used sparingly (Kilde, 2000).

In the second year, mowing should again be undertaken, albeit at a reduced rate. Mowing frequency should be limited to one to two times per year. The plants should be kept to 12 inches tall so that unwanted weeds are prevented from forming seed heads and reproducing. This will allow for biennial prairie species to begin growing. In subsequent years, burning can be conducted if appropriate to the site (Kilde, 2000), otherwise the prairie can be intermittently mowed as in year two. Prescribed burning can speed up the establishment and progression of prairie plant succession. It also acts as soil enrichment for the burgeoning prairie.

A primary benefit of prairie are reduced maintenance costs. All three of the recommended sites are owned by the University of Iowa and managed in cooperation with the Iowa Department of Transportation and the city of Iowa City. The sites represent a portion of the 493 acres maintained by the university (73% of which is turf grass) at an average cost of $3049 per acre per year (Gritsch, email, 2016). Although the initial costs of sowing and maintaining young prairie can be high, in the long term it will save the University of Iowa money by requiring less intensive maintenance. It will also provide additional services such as mitigating storm water runoff. A comparison of estimated costs if offered in Table 5 below, based on pricing from Shooting Star Native Seeds, United Seeds, and data from the University of Iowa.

Table 5: A comparison of seeding and maintenance costs

Location	Acreage	Cost of over-seeding turf*	Cost of seeding new turf grass*	Estimated costs of prairie seeds[+]	Estimated annual maintenance costs
Site 1: Myrtle Hill	3.6	$1,764	n/a	$1,440	$10,976
Site 1a: Myrtle Hill, top section	1.1	$539	n/a	$440	$3,354
Site 2: Riverside Parking Area	0.5	$245	n/a	$750	$1,525
Site 3: Hawkins Dr.	0.6	n/a	$588.06	$498	$1,829

*Turf grass costs based on Super Turf II price from United Seeds
[+]Site 1 and 1a: Estimate based on Basic Prairie Mix from Shooting Star Native Seeds
[+]Site 2: Estimate based on component seeds from United Seeds in university short grass seed mix
[+]Site 3: Estimate based on quote price from United Seed representative for IowaDOT mix

Controlled Burn Maintenance

Fire can be used for both the short-term and long-term maintenance of prairie. The process releases nutrients and fertilizes the soil, supporting prairie growth. Drip torches are used to better control the areas being burned. Spray backpacks with a 100-gallon capacity and 500-gallon tow-behinds are used to ensure the fire does not spread outside of the preordained burn area (Kilde et al., 2000). It is not necessary to burn the entire area, as burning a portion of land can provide enough nutrients to foster prairie growth. Weather conditions are an important consideration when conducting prescribed burns. Days with low wind speed and high relative humidity are suitable conditions for burning as the fire can be controlled more easily (Schramm, 1990). Mowing the area prior to burning and burning while soil moisture is high can also help control the fire and restrict it to the desired area.

Both because of its proximity to the roadway and because the short grass prairie mix recommended for it can be maintained through mowing and raking, the Riverside Drive Parking Area site is not a good candidate for a fire-based maintenance regime. Similarly, potential smoke from the portion of Myrtle Hill adjacent to the road may present similar visibility concerns for passing motorists, suggesting any prescribed burn would need to be careful managed if undertaken. The University may choose to maintain this area through occasional mowing, or work with the City of Iowa City and the IowaDOT to divert traffic from Highway 6 for a short period during which the area is burned. Of the three sites, the Hawkins Drive area is the best candidate for a fire-based maintenance regime. The road is less trafficked than Highway 6, so any necessary diversion of traffic will be less disruptive, and the area is near other prairie plots currently managed with fire by the university. Thus, Hawkins Drive could be added to that maintenance program and the same precautionary principles used at the other sites applied there.

Conclusions & Next Steps

Collaboration between the various political entities is integral to the success of this project. The University of Iowa, IowaDOT, and the city of Iowa City will be key players in implementing and managing the various sites selected for prairie. The University of Iowa owns all three of the selected sites, and is

thus responsible for their maintenance. However, they are subject to IowaDOT regulations regarding plant heights, and collaboration with Iowa City's local government could help to expand the project to other areas. Andy Dahl, the University's arborist, is properly licensed to conduct prescribed burns. In addition, the Office of Sustainability has expressed great interest in expanding the presence of prairie on campus.

The public, though not directly involved in management of these sites, is nonetheless also a key stakeholder for the project. Policymakers can be hesitant to replace turf grass with native vegetation on the grounds that there may be a negative public reaction to the more rustic appearance of prairie plants. For this reason, keeping the public informed about the nature of the project and the many benefits has proven critical in garnering public support and helping projects move forward (Lucey, 2010). This can be done many ways, from special events such as groundbreakings to soliciting public involvement in the planning process. A particularly cost effect method of garnering public support is the use of signs on site (Stewart, 2004). This can be as simple as a sign identifying the area, i.e. "Myrtle Hill Prairie," in large enough letters that passing motorists understand this space has been designated for a different kind of vegetation. It can also involve information-rich signs identifying species planted on site and the benefits of native vegetation at locations where pedestrians are likely to pass, pause, and read.

With cooperation between the university, city, and state DOT and support from the public, it is possible that the sites identified in the report can act as a first step toward a larger presence of prairie plants both on the University of Iowa campus and within Iowa City. Such efforts could increase the visibility of the university's and city's commitment to sustainability and also act as a celebration of the prairie heritage of the state. At the same time, it could realize many ecosystem benefits along these roads and help reduce long term maintenance costs during a time of tightened budges. The three sites in this study were selected, in part, because of the ways they differ from one another. Thus, establishing native vegetation in these three areas can help establish a range of practices that can be applied in analogous areas elsewhere. However, several similarly suitable sites were identified along Highway 6, and interviews with university staff suggest that additional locations not immediately adjacent to the road (such as an orchard area on campus) may also be good candidates for prairie plantings. Likewise, current redesign projects in the Riverfront Crossings area of Iowa City offer opportunities to incorporate native vegetation in the streetscapes. There are many possibilities for building on the efforts recommended in this report, and it is the hope of the authors that this project may serve as a jumping off point for future work.

Appendix A: Sample Site Evaluation Rubric

Vegetative Cover	☐ Trees ☐ Shrubs ☐ Turf grass ☐ Long-stemmed grasses ☐ Weeds ☐ Bare ground ☐ Sealed with concrete or other hard surface		Predominant cover type for this area:
Turf maintenance	☐ Unmaintained ☐ Mixed mown and unmaintained areas ☐ Mowed regularly (grass appears short)		Predominant maintenance regime for this area:
Slope	☐ Steep ☐ Moderate ☐ Flat		Predominant characteristic for this area:
Soil – erosion indicators	☐ Bare ground ☐ Runnels or rills ☐ Cracks along a slope ☐ Muddy runoff on hard surfaces ☐ Exposed tree roots ☐ Coarse, gravelly surface soil ☐ Soil pillars		
Soil samples (taken along a diagonal transect	Root depth: Soil quality: ☐ Loose, easily worked ☐ Compacted ☐ Rocky	Root depth: Soil quality: ☐ Loose, easily worked ☐ Compacted ☐ Rocky	Root depth: Soil quality: ☐ Loose, easily worked ☐ Compacted ☐ Rocky
Litter	☐ Low amounts ☐ Moderate amounts ☐ High amounts		Types of litter observed: Other potential pollutants:
Number of fire hydrants:	**Number of storm drains present:** **Number of curb cuts:**	**Potential access barriers for maintenance:**	
Additional notes and observations (use back as needed):			

Appendix B: GIS Maps showing soil data for the three recommended sites

Figure 1

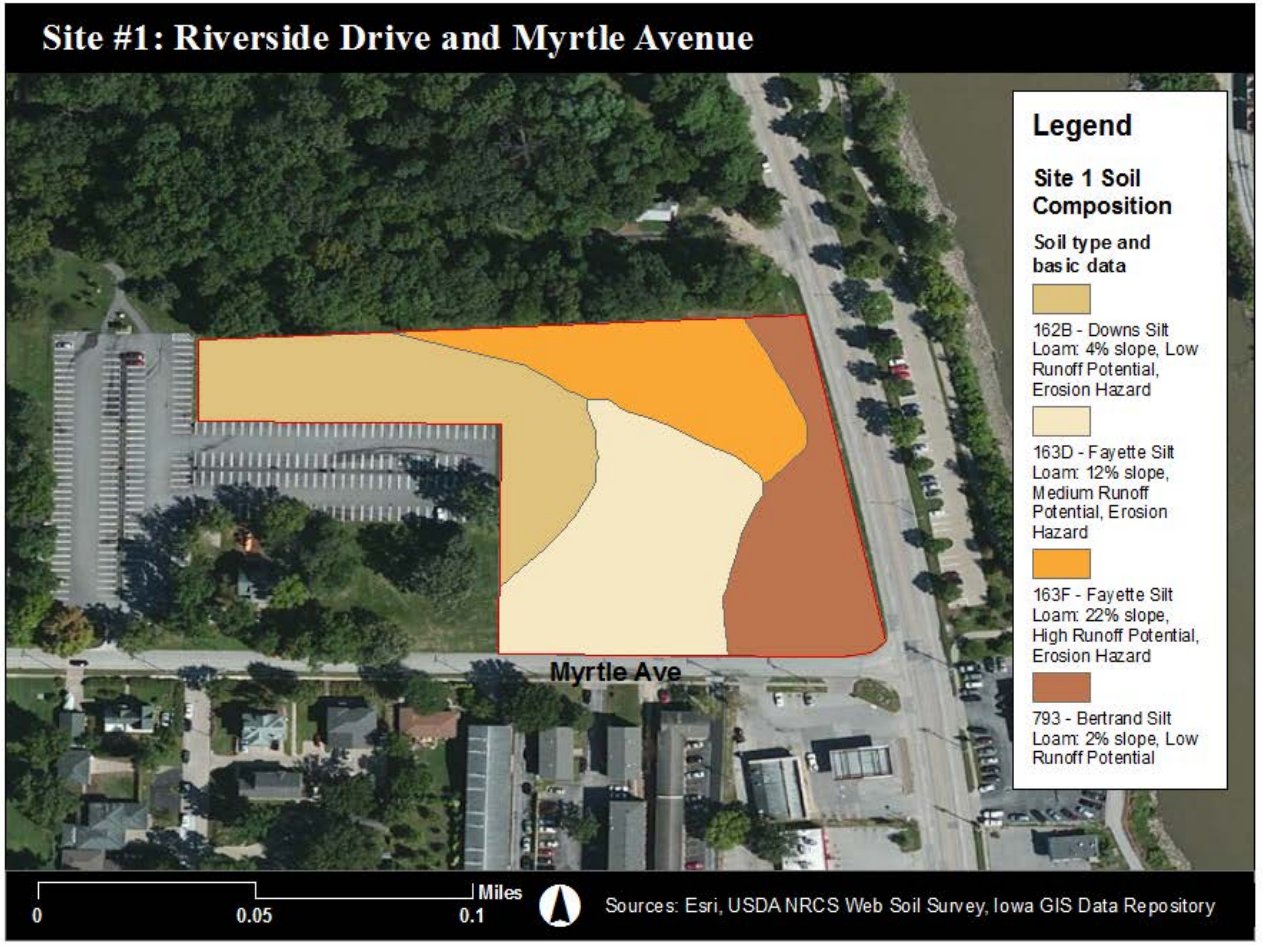

Figure 2

Figure 3

Appendix C: Shooting Star Native Seeds Prairie Mixes

The following mixes, available through Shooting Star Native Seeds, are examples of prairie mixes that are commercially available. The "Basic Prairie Mix" is presented first as a basis of comparison as to the species and proportions of grasses and forbs in a mix designed for full prairie restoration versus a roadside blend designed to withstand higher salt concentrations and other roadway conditions. Source: http://www.shootingstarnativeseed.com/seed-mixes-introduction.htm

Basic Prairie Mix
Recommended sowing rate: 10 lb/acre
Price: $400/acre (as of 5/1/16)

Common name (scientific name)	Percent of mix	Seeds/ft^2	Rate/Acre in PLS lb
GRASSES:			
Big bluestem *(Andropogon gerardii)*	24%	8.8	2.4
Sideouts gramma (*Bouteloua curtipendula)*	16%	3.5	1.6
Canada Wild Rye (*Elymus canadensis)*	8%	1.5	0.8
Little bluestem (*Schizachyrium scoparium)*	12%	6.6	1.2
Indianagrass (*Sorghastrum nutans)*	18%	7.9	1.8
Switchgrass *(Panicum virgatum)*	2%	1	0.2
FORBS:			
New England aster (*Aster novae-angliae)*	0.40%	1	0.04
Yellow coneflower (*Ratibida pinnata)*	1%	1.1	0.1
Partridge pea (*Chamaecrista fasciculata)*	2.40%	0.2	0.24
Black-eyed Susan (*Rudbeckia hirta)*	0.80%	2.7	0.08
Prairie blazingstar *(Liatris pycnostachya)*	1%	0.4	0.1
Wild bergamot *(Monarda fistulosa)*	0.40%	1	0.04
Canada milk vetch (*Astragalus canadensis)*	0.60%	0.4	0.06
Smooth blue aster (*Aster laevis)*	0.40%	0.8	0.04
White prairie clover (*Dalea candidum)*	1.60%	1.1	0.16
Purple prairie clover (*Dalea purpurea)*	2%	1.1	0.2
Purple coneflower (*Echinacea purpurea)*	2%	0.5	0.2
Rattlesnake master (*Eryngium yuccifolium)*	1.60%	0.4	0.16
Ox-eye sunflower (*Heliopsis helianthoides)*	1.20%	0.3	0.12
Round-headed bush clover (*Lespedeza capitata)*	0.80%	0.2	0.08
Foxglove beardtongue (*Penstemon digitalis)*	0.40%	1.9	0.04
Compass plant (*Silphium laciniatum)*	2%	0	0.2
Stiff goldenrod (*Solidago rigida)*	0.40%	0.6	0.04
Golden Alexanders (*Zizia aurea)*	1%	0.4	0.1

IA DOT Native Grass Mix
Recommended sowing rate: 62.12 lb/acre
Price: $777/acre (as of 5/1/16)
***This mix is also available through United Seeds for $830/acre (as of 5/1/16)**

Common name (scientific name)	Percent of mix	Seeds/ft^2	Rate/Acre in PLS lb		
GRASSES:					
Big bluestem *(Andropogon gerardii)*	9.65%	22	6		
Sideouts gramma (*Bouteloua curtipendula)*	6.44%	8.8	4		
Canada Wild Rye (*Elymus canadensis)*	3.22%	3.8	2		
Little bluestem (*Schizachyrium scoparium)*	9.65%	33.1	6		
Indianagrass (*Sorghastrum nutans)*	9.65%	26.4	6		
Switchgrass *(Panicum virgatum)*	1.61%	5.1	1		
FORBS:					
New England aster (*Aster novae-angliae)*	0.20%	3	2		
*Yellow coneflower (*Ratibida pinnata)*	0.30%	2.1	3		
*Partridge pea (*Chamaecrista fasciculata)*	6.44%	4	64		
Pale purple coneflower (*Echinacea pallida)*	0.60%	0.7	6		
Black-eyed Susan (*Rudbeckia hirta)*	0.40%	8.4	4		
*Blue vervain (*Verbena hastata)*			0.05%	1.1	0.5
*Common ironweed (*Vernonia fasciculata)*			0.30%	1.7	3
COVER CROP:					
Oats (*Avena sativa)*	51.48%	14.1	32		

*Note: The current seed mixture for areas designated for native grass and wildflower plantings on the IA DOT site includes the same grasses but also includes additional forbs: purple prairie clover (*Petalostemum purpureum)*, prairie blazing star (*Liatris pycnostachya)*, and grayhead prairie (*Ratibida pinnata)*. It does not include the forbs in the mix above denoted with an asterisk. How often the mix is updated and whether previous mixes can still be planted could not be determined. It is therefore recommended that any organization getting ready to undertake a roadside prairie planting consult the IowaDOT first for the most up-to-date guidelines.
Source: http://www.iowadot.gov/erl/archives/apr_2007/US/content/9010.htm

WI DOT Mix 70
Recommended sowing rate: 17.42 lb/acre
Price: $1959.75/acre (as of 5/1/16)

Common name (scientific name)	Percent of Mix	Seeds/ft^2	Rate/Acre in PLS lb
GRASSES:			
Big bluestem *(Andropogon gerardii)*	15%	9.6	2.61
Sideouts gramma (*Bouteloua curtipendula)*	15%	5.8	2.61
Canada Wild Rye (*Elymus canadensis)*	15%	5	2.61
Little bluestem (*Schizachyrium scoparium)*	15%	14.4	2.61
Indianagrass (*Sorghastrum nutans)*	15%	11.5	2.61
FORBS:			
New England aster (*Aster novae-angliae)*	2%	8.4	0.35
Yellow coneflower (*Ratibida pinnata)*	2%	3.8	0.35
Purple prairie clover (*Dalea purpurea)*	2%	1.9	0.35
Prairie blazingstar *(Liatris pycnostachya)*	2%	1.4	0.35
Wild bergamot *(Monarda fistulosa)*	2%	9	0.35
Showy tick trefoil (*Desmodium canadense)*	2%	0.7	0.35
Wild geranium (*Geranium maculatum)*	2%	0.6	0.35
Western sunflower (*Helianthus occidentalis)*	3%	2.7	0.52
Showy goldenrod *(Solidago speciosa)*	2%	12.2	0.35
Ohio spiderwort *(Tradescantia ohiensis)*	2%	1	0.35
Golden Alexanders *(Zizia aurea)*	2%	1.4	0.35
Canada anemone (*Anemone canadensis)*	2%	1	0.35

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