Rosemount Greenway & Site N1 Restoration Plan

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Resilient Communities Project

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Introduction

The motivation for restoration along the greenway site differs according to the participating partners, although all of them have a come together around a central goal of restoring the landscapes within the greenway site. This has helped with the adoption of previous restoration plans, and the larger bikeway system through property owned by different entities. For the industry partners, (Flint Hills Resources & CF Industries) the motivation for restoration is two-fold, first the public relations boost for undertaking such a project is obvious and benefits the industries standing within the community. The public's perception of these companies is as important as the city and county relationships that also stand to benefit from cooperation with these large employers. The second motivation is also in their self-interest given that the unmandated restoration projects could allow the companies a better bargaining position with relevant government agencies (city, county, etc.) in terms of their expansion of facilities in the future. Although these motivations are not ecological in nature, the voluntary participation in restoration is a beneficial outcome when companies are working towards restoration on their own without a mandate. The participation of the City of Rosemount and Dakota county center around their motivation to enhance citizen well-being and the beneficial partnerships with local employers. First, citizen well-being is addressed in the addition of park land, and the bike trail that will be running through the greenway site. This additional service will be an obvious benefit to the surrounding communities and enhance the reputation of these two governmental entities in both social and ecological areas. Cooperation between governmental entities and industry allows both parties to benefit as stated previously with enhanced cooperation and understanding on both sides.

Overall, although some motivations for the ecological restoration projects going on within the greenway site are less than altruistic, their value should not be undercut due to the fact that they are still being undertaken. Any projects that work to enhance ecological functions are of value in this area. The partners on this site seem to have a solid existing relationship, and there is an open dialogue between both industry and government in this case.

Greenway location

The greenway site encompasses about 3,000 acres in the city of Rosemount in Dakota County, Minnesota. Rosemount is bordered by Inver Grove Heights to the north and Hastings to the south-east. The Mississippi River to the east, MN highway 52 to the north/west, and Courthouse Boulevard running parallel to the river to the west, establishes the sites boundaries. The site is situated along the Mississippi River, and its part of the larger Mississippi River Regional Trail system that is meant to run the length of the river once completed. There have been extensive changes made to the river in this area due to the installation of locks and dams further downstream. This has caused the river to expand its historical reach in this area, increasing water surface along the site. The Flint Hills refinery to the western side of the site borders the greenway, on the south the surrounding landscape has mixed uses, a combination of industrial, agriculture and some recreational sites (eg. golf courses). The south/eastern border of the greenway is again mixed use, but has a large county park located adjacent to it (Spring Lake Regional Park).

Historic and Current Land Use

There are two main land-uses within the greenway currently, industrial developments held by a number of companies, and forested open space. Two main companies hold the balance of land within the greenway area, those being Flint Hills Resources and CF Industries (540 & 380 acres respectively). Even with the large land areas held by these two corporations, only a small percentage of their acreage is actually being used for industrial purposes. There are three barge terminals along the river, two being owned by CF Industries and one by Flint Hills, which are points of heavy use within the greenway. Agriculture is also a part of the greenway, but holds a significantly smaller portion of the acreage when compared with industrial ownership or open space (~375acres). A number of residences (13) are also located within the greenway boundary, a majority of them are owned by private owners, but the companies in the area own a few to house workers and staff.

Historic land uses have been varied on the site, and range significantly throughout the decades. The site in 1937 looked to be largely comprised of forest and wetland in the northeastern portion of the area. In opposition the remainder of the site was agricultural land with some small low-density residential areas scattered throughout the site (mostly farmsteads). By 1940 the site remained largely in the same state from 1937, however some agricultural expansion could be seen into the previously forested areas. Significant changes have happened by the 1950's. The encroachment of agriculture into the wooded areas is more extensive than previously seen. Additionally, the damming of the river flooded most of the existing wetlands along the site, and some of the smaller islands now found themselves underwater. This allowed for the creation of an access road to down to the river for boat and barge access. The 1964 aerial shows the most extensive changes in land use on the greenway site with the introduction of large scale industrial

properties. The Flint Hills refinery now creates a border of the site along the western edge. A number of other industries have been created along the existing roadways and newly expanded highway. Two new barge docks were installed along the river allowing even greater water access to industry. The forested areas south of the road running parallel to the river were completely gone by this time, replaced with either the new industry or expanded agriculture. A ski-slope and lifts were put on thee side of the bluff in the northern portion of the site, which was a significant change from the previously dense forested cover. Additionally, one of the roads along the site was converted into a railroad track that runs the length of the site along the bluffs. The 1970's saw a slower development of the area, with industry creeping into previously held agricultural land south of the parallel road, and encroachment onto forested land north of the road for industrial purposes. Finally, by 2012, industry had once again expanded on both sides of the road, and more agriculture and forestland was converted for industrial use within the greenway.

Throughout the last 30 years there has been significant topographical changes on the site for both agricultural purposes and industrial purposes as well. Bluff land on the northern portion of the road had been flattened for the installation of both the road and farmhouses initially. By 1967 more significant changes had been done, most notably the introduction of the ski-slopes along the bluff and the excavation to put in a number of service roads to the newly created barge depots along the river. Land had also been smoothed out for the construction of new industrial sites and the expanded highway (and railroad) system in the area. Since then significant land changes have slowed and there has not been large modifications to the area topographically.

Regional context

The greenway site in Rosemount has a number of aspects that bind it to the larger region that surrounds the area. First, the site is part of the larger Mississippi River Regional Trail system that is intended to run the length of the Mississippi River and connect both unique built and natural features along the river. The trail system itself has a comprehensive plan that divides the Mississippi into a number of regions of which Minnesota and the segment in Rosemount is part of the Upper Mississippi region. This aspect is an important considering not only in terms of the trail connection itself, but for telling the story of the people that lived along the river and the unique aspects this site has in relation to other parts of the waterway. The second aspect of regional connectedness is the importance of the refinery. Even though the refinery itself is outside of the greenway site it's a critical center of jobs and refined fuels for not just Minnesota but the entire Midwest. Finally, the last aspect, which connects the site to the region, are its common flora and fauna. The greenway, along with most of southern Minnesota, shares the common bond of the upland prairie biome (including the southern dry prairie and southern dry savannah, this system extends throughout the region, and along the Mississippi river outside of the bluffs.

Greenway Geology and Soil

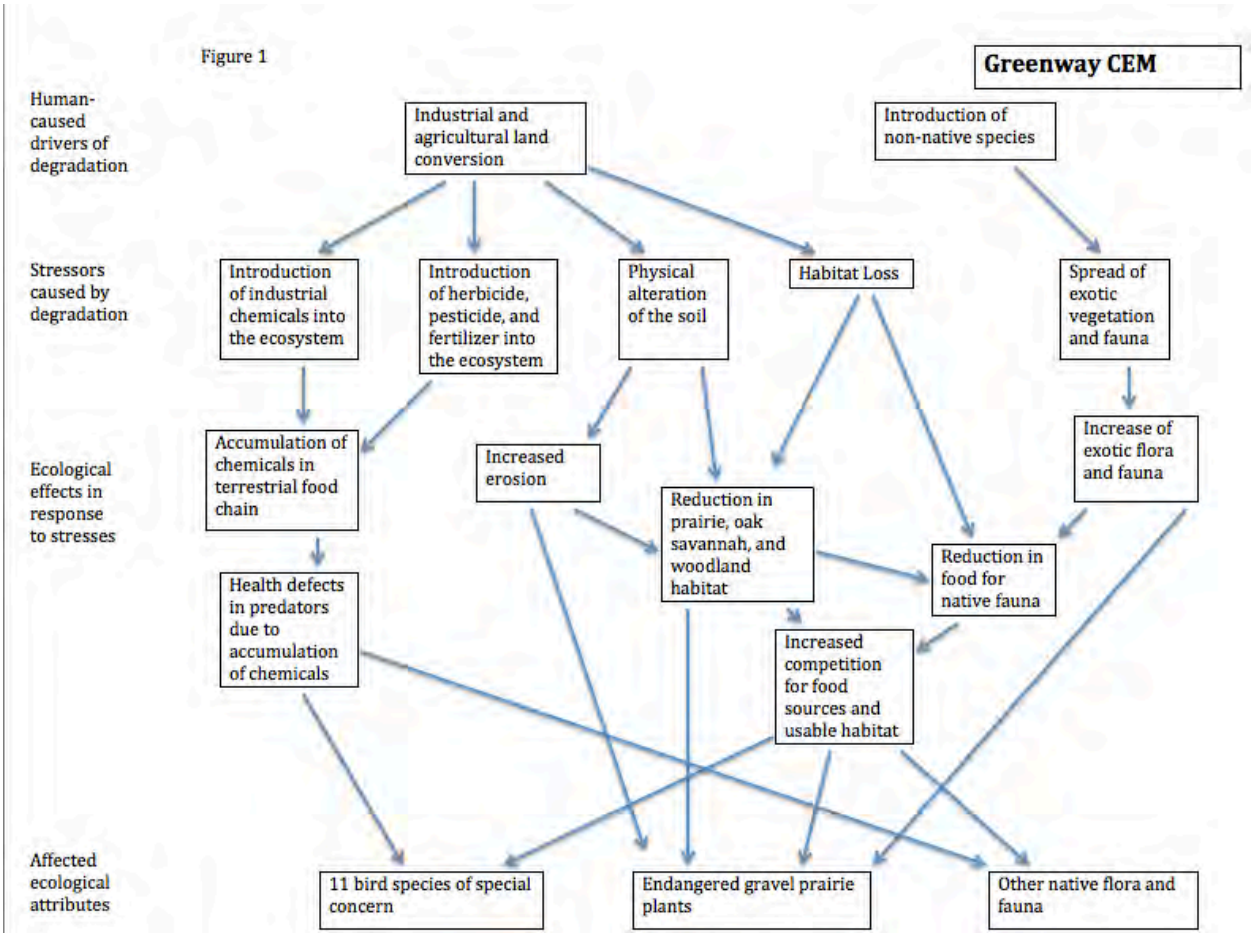
As is the case in of most of the state, the most prominent geological feature is the carving out of the river itself due to glaciation. From there the next largest change in the landscape is due to human influence in regards to the creation of locks and dams along the upper Mississippi river which created significant flooding and the creation of larger pools of open water along the river. This has allowed for increased river access for a number of industries along the river and improved navigability by increasing water depth for larger barges and goods carrying ships. In terms of soils one of the major influences in the current soil situation is the lasting effect of agriculture. A majority of the soil types in the area were impacted by the extensive agriculture in the area, and consist of two main soil types, Hawick and Wadena. Hawick series soils are characteristically deep, extensively drained soils found in sandy outwash plains and are part of the entic hapludolls taxonomy. This type of soil would have been most likely used for pasture land, some as cropland and few forested areas would exist overtop this soil type. The second major classes of soils found in the greenway area are of the Wadena series, which is characterized by well drained soils which were formed from glacial outwash (which is consistent with the region's geologic history). Wadena type soils are also of the hapludoll family but are of the mesic Typic type. Overall the soils in the area have changed from both the additional surface water introduced by the damming of the river, as well as the extensive agricultural and now industrial uses of the site. This has caused topsoil to be removed in a number of places along the greenway for the construction of buildings, the use of land for pastures, and the clearing of forests for both uses. At some points around the site all that remains is the subsoil, containing sand and gravel.

Historic and Current Greenway Vegetation

Historically two vegetation types, southern dry prairie and oak savannah, dominated the greenway. These areas would have been dominated by big bluestem, little bluestem, and prairie dropseed. Bur oak would have been the dominant tree species in the oak savannah. To keep these vegetation types a fire disturbance regime would have been present. However, this changed after the area was settled. Most of the land was converted for agricultural use and industrial use. Once the land was converted, the fire regime was altered and suppressed, and the dominance of native prairie and oak savannah species was threatened. As the greenway land and the land surrounding the greenway became more developed more woodland species became present in the greenway. Non-native species, such as smooth brome, sweet clover, spotted knapweed and common buckthorn, became present, and in areas, dominant among the landscape.

Drivers of Ecological Change Throughout the Greenway

Figure 1



There have been two main drivers of ecological degradation along the greenway due to the companies that own the land, the county of Dakota, and historical land use. The two main drivers are land conversion for agricultural and industrial purposes, and the introduction of non-native species. Both of these drivers of degradation have put a number of stressors on the ecosystem surrounding the greenway. These stresses include: the introduction of industrial chemicals, the introduction of herbicide, pesticide, and fertilizer, physical alteration of the soil, habitat loss, and the spread of non-native flora and fauna. A vast array of ecological effects have stemmed from the stresses put on the ecosystem.

Physical alteration of the soil is also a major ecological effect. By changing the physical structure of the soil, the chance and severity of erosion increases. Not only is this dangerous to the users of the proposed greenway, but it also reduces available habitat for native flora and fauna. Erosion, along with other stressors, can cause habitat loss of the prairie, oak savannah, and woodlands surrounding the greenway. The decline of habitat has various ecological effects.

Food availability is directly linked with habitat availability. By removing potential habitat through land conversion there will be an increase in competition for food and suitable habitat. The increasing population size of non-native flora and fauna along the greenway will also have an impact on food and habitat availability. Some of these non-native species are able to outcompete native species, which in return will cause the decline of native flora and fauna populations. The ecological effects caused by land conversion and non-native species introduction has degraded the ecosystems found along the greenway. These ecological effects will need to be dealt with for the successful restoration of the greenway.

Site N1

Site Location

Map 1

Basic info – Twn.Shp., Rge, Sec: 115N, 18W, 18.

The specific site under consideration for restoration is located on the far northern portion of the greenway site and is owned by Flint Hills Resources. It's bordered by MN hwy 52 on the western side and a cemetery to the north. The southern and eastern edges of the site are more interesting however. The eastern side of the site is bordered by land also owned by Flint Hills, but has already undergone a prairie restoration. The southern border of the site contains a deep ravine with significant erosion along the side of it. In terms of size the area contains no surface water, and is approximately 4 acres.

Current and Historic Land Use

The historical land use of the site did not significantly change from 1937 until somewhere around 1964. Previous to somewhere in the mid 60's the site was maintained as some kind of pastureland abutting a small collection of village buildings including a school and farmhouse. This situation remained unchanged until some of the buildings were removed with the expansion of the highway somewhere in the early 60's. This is also the time when the biggest change occurred on the site with the removal of several feet of soil used to build the highway. This significant change has dominated the site since then, and little, if any, changes have occurred since this dramatic event. Currently the site is dominated by invasive species, and contains a low level of biodiversity given the poor soil quality and significant changes in the topography (highly eroded steeply graded slopes along three sides). This is true in both the open 'prairie' area and the forested portion of the site. Additionally, the actual *use* of the site is really in an unused state. As the site is part of the Flint Hills buffer zone, it is not considered for development and really does not hold value in other respects, so is a prime candidate for restoration.

Landscape Context

The site fits into the larger greenway site in a couple of ways. First it shares a similar ecosystem heritage with parts of the greenway site. Oak savannah and dry prairie were dominant habitats on much of the greenway and current sites. This connection is important as it helps the restoration become a part of the rest of the landscape and guides restoration efforts to some extent in providing a framework to work in. Secondly, the site is impacted by a lot of the same stressors that other parts of the greenway also suffer from. These include significant land conversion projects, pollution both point and non-point and invasive species introduction.

Rare Features

No rare features are present on the site. The one unique feature is the dug out pit which dominates the site and provides challenges but also opportunities for a more successful restoration.

Geologic History

The site was impacted by the same factors as the larger greenway including glaciation and then land conversion over the years. The dug out pit on the site used for the construction of the nearby highway and as foundation materials for buildings is a dramatic topological feature of the site. Due to this excavation, the site suffers from erosion problems along three sides (North, East, West) due to the steep grades created during the soil removal in the 1960's.

Site N1 Soil Conditions

Soils along the greenway corridor formed from glacial outwash plains, stream terraces and valley trains and glacial moraines. Generally prairie, savannah and river forest complexes are the different plant communities that contributed to soil biotic formations.

Soils of the N1 site are described by two soil series, Hawick and Wadena. The taxonomy of these soils are Entic Hapludoll's which are mollisol's. The Hawick series was formed in outwash plains, stream terraces and glacial moraines. The texture is comprised of deep sandy outwash sediments with rapid infiltration and may include a loamy mantle. Slopes range from 2-70% pitch with an average annual precipitation of 819 cm and a mean temperature of 9 degrees. Wadena soils are well drained due to 24-40 inches of loamy sediments over a sandy fast draining subsoil. Glacial outwash plains, stream terraces and valley trains, formed this soil. Slopes of Wadena soils vary from level to 18% pitch. Climate where Wadena soils are located averages around 48 degrees F. with of 28 inches of precipitation.

As previously mentioned, the N1 site was heavily excavated to a deeper gravel and sand mineral substrate. Any organic matter and microbial life of the preexisting savannah topsoils were removed with the excavation leaving more than half of the N1 site with highly disturbed soils. Erosion from the loss of vegetation and pitched slopes has also depreciated the soils a great deal as to limit vegetation re-colonization and in some gullies and hills. Minor contamination is found on the site within the forested portion. This litter includes a large tractor tire, plastic bottles and some solvent cans. There are a few sparsely vegetated areas that are suspect of some sort of chemical contamination, although this would require some sort of soil test to confirm.

Historic and Current Vegetation

Historic Vegetation

Prior to European colonization of the area, the floral community was likely a dynamic southern dry prairie or savannah ecosystem. This community would have had sparse tree stands of predominantly *Quercus macrocarpa.* The herbaceous layer would be dominated by graminoids (25-100%) like *Schizachyrium scoparium* and *Stipa spartea.* Forbes in this community would be patchy (5-50%) and commonly would include: *Phylaris virginiana, Ambrosia psilostachya, Solidago nemoralis, Lithosperum carolinense* and *Smilacina stellata.* Wild fire was a frequent disturbance regime that shaped the vegetation of the dry prairies and savannah. Sandy, gravely soils and general evapotranspiration tendencies created drought conditions that promoted relatively frequent fire disturbances. Fire resistant trees and other shrubs became established in situational pockets that had more moisture or steep sloped

topography. Most pioneer woody shrubs and trees would not become established with frequent fires, which maintained the full sun preferences of drought tolerant prairie forbs and grasses.

Current Vegetation

The vegetation of this site changed dramatically after it was used as a gravel pit. Poor soil conditions and a change in hydrology allowed for an establishment of different invasive species. The most prominent species in the prairie section are smooth brome and sweet clover. Land conversion around the site also brought in new non-native species. Buckthorn now dominates the shrub layer of the woodland area, which was historically an oak savannah.

Woods portion current vegetation list

Binomial	Common Name	Cover class & notes
Shrub Layer		
Strepulus lanceolatus	Twisted rose stalk	
Galium trifolium	Sweet-scented bedstraw	
Diervilla lonicera	Bush honeysuckle	
Ribes cynosbati	Gooseberry	
Rosa spp.	Wild rose	
Rubus ideas	Raspberry	
Rhamnus cathartica	Common Buckthorn	
Canopy Layer		
Acer negundo	Box elder	1-5%
Celtis occidentalis	Hackberry	1-5%
Quercas macrocarpa	Bur oak	

Excavated meadow current vegetation List

Binomial	Common Name	Cover class & notes
Forbs		
Centura maculosa	Spotted knapweed	
Panicum vacunarium	Witch grass	
Artemisia dracuculus		25-50%
Madia molina	Tarweed	one specimen
Melitotus alba	Sweet clover	50-75%
Phisometrella patens	Moss	1-5%
Solidago canadensis		5-25%; thick patches
Lotus cornicuolatus	Bird's foot trefoil	1-5%
Unidentified aster w/ ½" white heads		one plant

Centaurea maculosa	Spotted knapweed	5-25%; patchy
heterotheca villosa	Hairy golden Aster	5-25%; patchy
Unkown dissected foliage		5-25%; coverage
Asclepias communis		1-5%; toe of the hill
Cirsium arvense	Canada thistle	
Osmorhiza claytonii	Hairy sweet cicely	1-5%
Verbana stricta	Hoary vervain	1-5%
Berteroa incana	Hoary alyssum	

Moss

Phisometrella patens		1-5%

Grasses

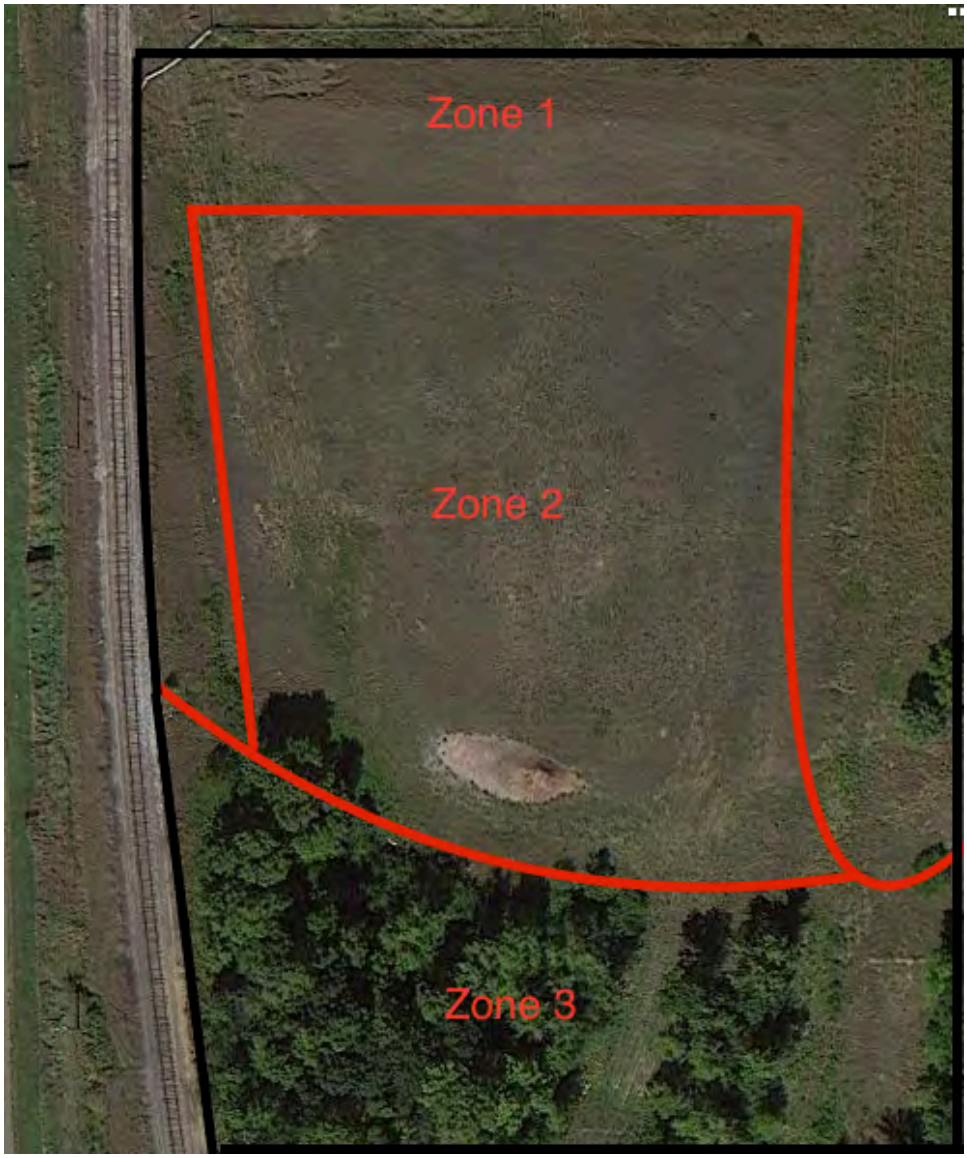
Setaria viridis	Fox tail	
Digitaria snaguinaria	Crab grass	
Bromus inermis	smooth brome grass	50-75%; patchy
Eragrostis elliotii	Blue love grass	
Panicum vergatum	Switch grass	1-5%

Shrubs

Lonicera mackii	Honeysuckle	1-5%
Rosa spp.	Wild rose	1-5%; on high land
Rubus strigosus	Raspberry	

Site N1 Unit Delineation

Map 2

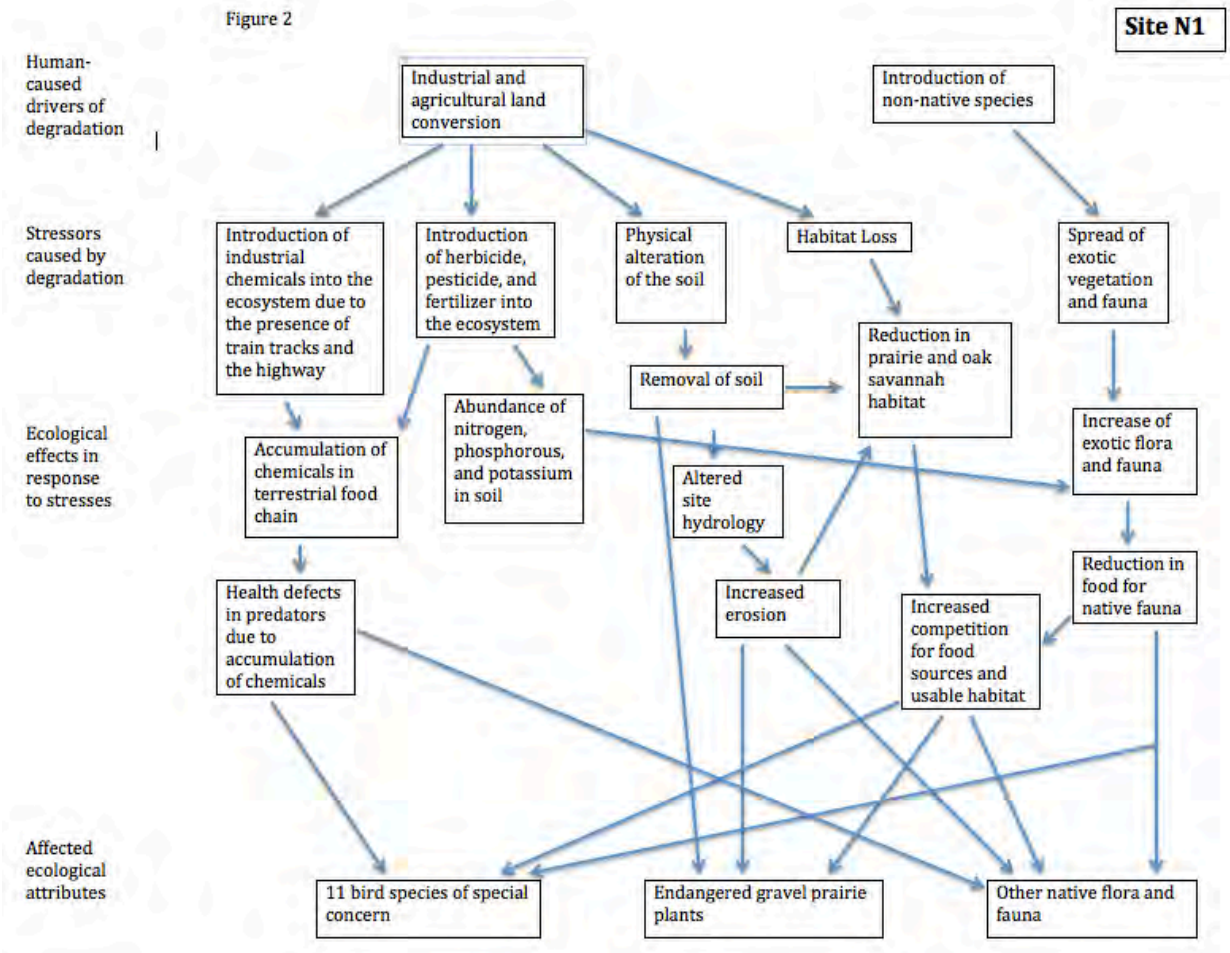


Site N1 is located just south of the cemetery on the Flint Hills Resources Pine Bends LLC portion of the corridor. Currently two different vegetation types dominate site N1. These two vegetation types are prairie and woodlands. For management purposes the site N1 will be split into three different management areas. The first management area will consist of the woodlands at the southern end of site N1. Due to the dominance of woodland vegetation this area, this area will need different management practices than the areas dominated by prairie vegetation. The presence of buckthorn in this management area will also pose as a challenge. The second management area will include the hillsides on the north, east, and west sides of the site. The hilltops on the north and east sides will also be part of this management area. The steep slopes in

this management area make it a high priority. Different management practices will need to be used to preserve the hillside. The third management area will include the area between the slopes. The southern border of this management area is where the woodland management area begins. This area needs to be managed differently due to historic land use. The topsoil has been removed through excavation, and only sand and gravel remains. Due to the removal of the topsoil and loss of fertility this area will need different management practices. The southernmost portion of management area three was not excavated, however, it will still be included in this management area. This is due to the fact that it is neither on highly erodible slopes nor in a woodland area. The small size of this area between the woodlands and the excavated area also makes it impracticable to form another management area.

Drivers of Ecological Change on Site N1

Figure 2



Site N1 is the northernmost site along the corridor. It shares the same drivers of degradation with the entire greenway. The degradation of site N1 was caused by industrial and agricultural land conversion and the introduction of non-native species. Stressors caused by the degradation of site N1 include: the introduction of industrial chemicals, physical alteration of the soil, habitat loss, and the spread of exotic flora and fauna. With the presence of the adjacent railroad, it is likely that industrial chemicals have been present in the site at some period in time.

Site N1 has also experienced extensive physical alteration of the soil. This site was also historically the location of a gravel pit. The excavation of large amounts of soil has drastically altered this site. By removing the soil the hydrology of the site has been tremendously altered, and the historic hydrology can never be restored. Soil erosion has increased in response to the removal of soil and the altered hydrology. The impact of overland flow of water has greatly increased due to the creation of the steep slopes surrounding the site. Erosion around the site reduces the amount of available prairie and oak savannah habitat. Another major ecological

effect affecting this site is the increase of non-native flora and fauna. Site N1 has large amounts of sweet clover, brome, spotted knapweed, and buckthorn. These species tend to outcompete native prairie and oak savannah species. One repercussion of outcompeting native species is that there is a reduction in available food for native fauna, which leads to an increase in competition among the species found on site N1. These ecological effects resulting from land conversion and the introduction of non-native species need to be addressed in the restoration of site N1. The restoration of site N1 will fail if these ecological effects are not dealt with.

Greenway Restoration Goals

1. Within five years the greenway will have southern dry prairie and southern oak savannah cover 90% of the greenway.

Rationale

Currently many invasive species are found across the greenway. The establishment of southern dry prairie and southern oak savannah species will help control erosion, and it will provide more habitat for ground nesting grassland birds.

2. The amount of smooth brome, buckthorn, and sweet clover across the greenway will be reduced by 90% within four years.

Rationale

By removing 90% of these two species it will hinder the reestablishment of these two species along the greenway. Smooth brome dominates more of the prairie portions along the greenway, while buckthorn dominates the wooded areas. Success of the native vegetation depends on the removal of these two invasive species.

3. Within five years of restoration, the abundance of endangered plant species on the southern portion of the greenway will be increased by 25%.

Rationale

This species is a native gravel prairie species that can be used as an indicator species for the restoration. It is also important to increase the abundance of this species because there is a diminishing amount of individuals left.

4. The abundance of the 11 bird species of special concern will increase by 50% within six years of the completion of the restoration.

Rationale

These 11 species are ground nesting grassland birds that rely on the native prairie vegetation to reproduce successfully. The abundance of these birds will act as an indicator to the success of the restoration of the greenway. Abundance can be measured by doing point-counts along the greenway.

Site N1 Restoration Goals

1. Within four years the slopes on the site will be stabilized to stop the erosion of soil by having 60% prairie vegetation cover.

Rationale

When looking at the site we noticed rill erosion on the slopes, and extremely loose soil was found on the southern slope. Due to the steep grade of the slopes on the perimeter of the site it is imperative that erosion is stopped before the slopes become unstable. Eroding slopes will also create a problem for the proposed path planned to go through the site. Prairie grass species have deep roots that will help hold the slopes in place, and this will be critical to stopping erosion.

2. Dry southern prairie species will cover 90% of the site within five years of seeding.

Rationale

Currently the site is dominated by brome and sweet clover. It is important to restore native vegetation to this site. These specific graminoids were picked because they grow well on dry, sandy soils. Specific dominant forbs were not picked due to the dozens of species that can be present in a southern dry prairie. The establishment of native prairie vegetation will also help control erosion.

3. The abundance of sweet clover, smooth brome, and common buckthorn will be reduced by 90% by the fourth year of the restoration project.

Rationale

The 90% is high enough where will be a majority of invasive species removed so they cannot reestablish themselves. Currently brome and sweet clover dominate the open portion of the site while common buckthorn dominates the wooded portion. Controlling invasive species will increase the success of native vegetation establishment.

4. Within five years there will be a self-sustaining population of skinks on the site. Native vegetation on a site is only the first step in restoring a site.

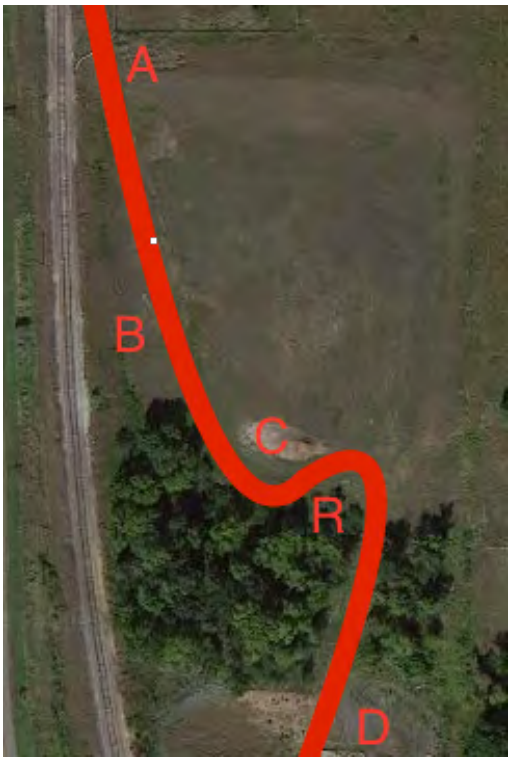
Rationale

For a site to be successful there needs to be native fauna that use the restored area as habitat. A skink population would be an indicator that the site not only has had native vegetation restored, but it also has had some form of vertebrate reintroduction. A healthy skink population would help consider the restoration a success.

Soil and Landform Modification

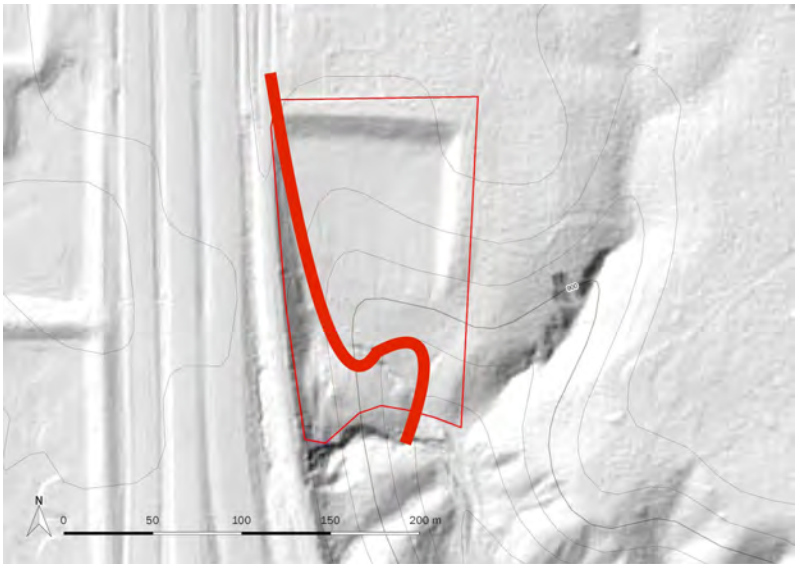
Considerations for Trail Construction

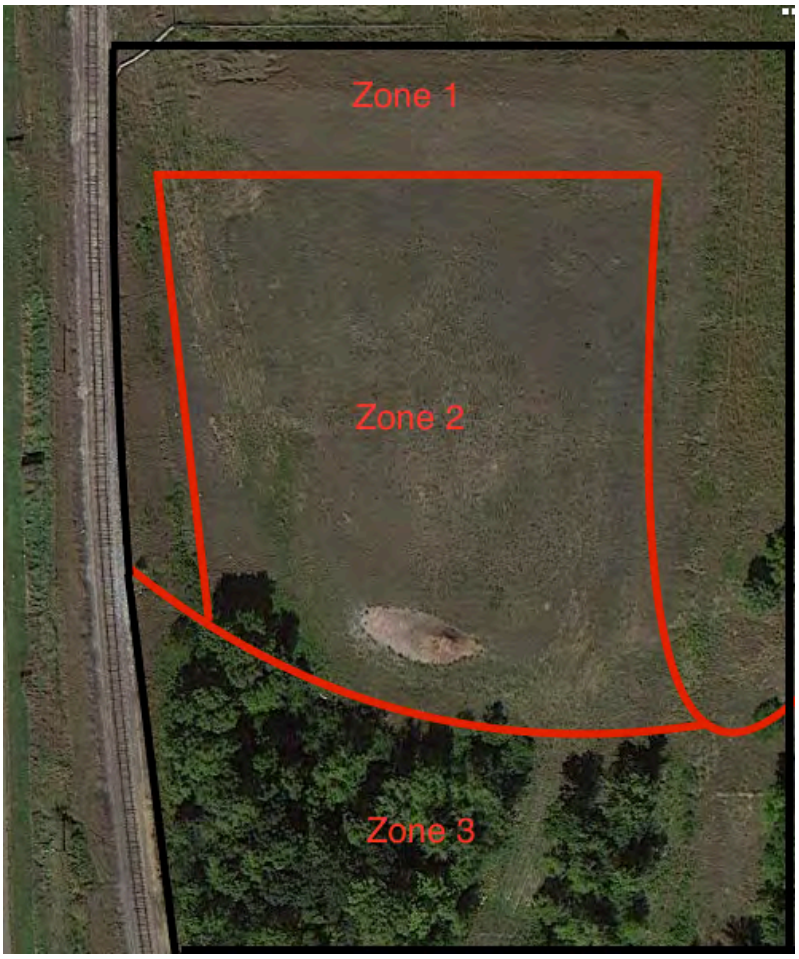
Figure 3



The Mississippi river regional trail system comes through the northwestern portion of the current site, located at A (Figure 3). Once on the site the paved trail will follow a natural slope that exists on the site that will serve as the path for the trail to minimize the amount of disturbance with other parts of the restoration as well. The trail will continue on a gentle eastern curve still maintaining a direct southward direction, located at B on (Figure 3). This part of the trail allows bikers and hikers to lookout over the prairie portion of the site, giving them a wide viewing angle and plenty of sunlight in contrast to the oak savannah further down the trail. The trail then reaches an existing patch of woods and curves around it, given the better slope provided by going around rather than through the woods (see label C, Figure 3). The trail exits the site through two patches of oak savannah providing a more immersive experience from the previous open and bright prairie ecosystem (see Label D, Figure 3).

Figure 4 (top), Figure 5 (bottom)





Due to the placement of the trail along an existing gradient the impacts of erosion should be minimal given the flow of water through the site already follows this path (Figure 4). Minimizing the landform changes on the site should help control erosion forces, mostly in the form of surface water in this case given the addition of an impervious path on the site. Additionally, dense vegetation near the path and along the slopes of where the path is located will also help to slow down surface water flow. This is especially important at the main curve before the largest portion of oak savannah (located at Point R, Figure 3), a higher density of shrubs (compared to other sites within Zone 2, Figure 5) will be planted here to ensure erosion and surface water flows are controlled. This includes a higher portion of initial ground cover species to retain soil integrity.

Construction/Restoration timeline

The trail construction will be conducted during the initial phase of restoration process where significant disturbance to the site will already be occurring to minimize the impacts to the existing flora/fauna on the site in terms of time. An outline for the timeline of the restoration is below and shows that the major effort in trail construction would occur alongside the removal of invasives, and general site cleanup effort.

Restoration Timeline*

	Year 1			Year 2			Year 3			Year 4			Year 5			Year 5+		
Task	**Sp.**	**Su.**	**Fall**	**Sp.**	**Su.**	**Fall**	**Sp.**	**Su.**	**Fall**	**Sp.**	**Su.**	**Fall**	**Sp.**	**Su.**	**Fall**	**Sp.**	**Su.**	**Fall**
Invasive Removal									#			#			#			#
General Site Cleanup																		
Erosion Control Measures																		
Trail Construction																		
Initial Seeding																		
Initial Planting																		
Secondary Seeding										^	^	^						
Skink Monitoring																		
Erosion Monitoring																		
Invasive Monitoring																		
Species Richness Monitoring																		

(*) - All estimates are relative; tasks may take longer or shorter periods of time than estimated above and thus effect other tasks timelines.
(#) - Invasive removal would only occur if monitoring shows above threshold level of invasives on the site.
(^) – Secondary Seeding would only be conducted if monitoring indicated seeding failure or lower than expected vegetation levels.

Soil Erosion

Site N1 is subject to moderate to high water erosion in sparsely vegetated and steeply sloped areas. In general, the heavier sand and gravel textures of the soil are less susceptible to erosion than silty loam, but the infertility of the soil surface means that there is little microbial activity that contributes to soil aggregation. Evidence of high erosion is visible in two different gullies forming on N1 near the future trailhead, in the NE corner and the eastern edge near the woodland. Moderate erosion is expected to be occurring on steeper slopes on the west, North and East sides of the N1 excavated area. Other erosion is possible on the mellow slope that spans the greater portion of the prairie body in N1, but precipitation is likely to infiltrate soils quickly, lessening the likelihood of sheet runoff event. In areas of zone 1 and 2 that require considerable invasive eradication, erosion and combative measures will follow. The zone 3 woodland on N1 has several walkways that have the potential to channel water and erode. There is a considerable amount of buckthorn in the shrub layer of the woodland area that currently holds the soil in place. Removal is intended and soil management practices will need to be implemented quickly to control soil erosion.

Gullying areas will be treated with a living mattress containing wattles staked in a grid and fastened by twine to hold wattles. Live stakes of wild rose and raspberry will be incorporated in gullies as well. Erosion blanket (burlap/hay) appropriate for seed germination will cover zone 1; the steeper slopes of the east, north and west borders of N1. Seedlings and young plantings will be considered for these steep embankments, as well. A cover crop, of either winter wheat or oats depending on the time of the year, will be applied with the native seed mix across the entire site after initial invasive flora removal to stabilize soils and build organic matter. Zone 3 will be need to be seeded directly after removal of buckthorn, and erosion control blanket will need to be installed on the slopes to stop soil movement. Shorter coconut core bio-logs will be staked along trails to avoid washouts within the woodland (zone 3). Bio-logs and erosion control blanket will installed for temporary erosion control. Long-term erosion control will be achieved through the establishment of native southern dry prairie species.

Soil Condition and Amendments

The major ecological disturbances of N1 are consequence of previous excavations of zone 2; 50%-65% of the N1 area to now exposed parent material gravel and sand horizons some three to four meters below the most recent A horizon. The current organic material and microbial activity is result of 40 plus years of exotic and sparse native vegetative colonization and is inconsistent with soil series profile. Compaction from dump trucks and bulldozers is another factor that requires attention through the mellow sloped, herbaceous vegetated portions of N1(zone 1 and 2). The woodland currently has many allelopathic buckthorn rhizomes that will some years to eradicate from the soil.

A combination of straw mulch, municipal compost, rotted manure and leaves will be layered on portion B. Thermophilic composting processes are expected to occur for the following three weeks. After amendments have cooled, soil ripping by a sub-soiler will incorporate organic material deeper (6”) in the soil. Soil inoculum taken from representative sites will be cultured and added to the seed mix prior to seed to introduce potential specialized indigenous mycorrhizae, rhizobia and other appropriate microbes. These measures will ideally

give the seeds favorable conditions for germination and better support seedling development for a stronger start. Increasing soil fertility with organic matter and microbes will support symbiotic mycelium to root networks to better resist drought kill. Using a thicker composted mulch for invasive eradication will be better for the soils and biotic community than using herbicides across the entire site that may have residual and unintended consequences.

Site N1 Monitoring an Evaluation Plan

Parameters

1. Cover percentage and species richness of southern dry prairie species on Site N1.

   Strengths/Limitations

   This parameter will allow the restorationists to monitor the progress of the restoration. One of the goals of this restoration is to restore native prairie vegetation on Site N1, and the success of this project depends on the cover and richness of southern dry prairie species. One of the strengths of this parameter is that it is interpretable. This parameter easily gives restorationists an idea if the site is in acceptable or unacceptable conditions. If there were a low cover and richness than something would need to change to correct the problem. This parameter is also anticipatory. Since data will be collected annually, if cover or species richness begin to fall then managers can change management practices. It allows for restorationists to use adaptive management. This parameter also demonstrates cost-effectiveness. One limitation of this parameter is that it is not sensitive. Surveyors will have to spend time on the site walking through prairie and establishing sample plots. There is also error. There is a chance that surveyors will not be able to find, identify, and accurately estimate the cover of each individual, and species, within the plot. This parameter is also not very timely. Surveyors will require large amounts of time to evaluate all plots within the site.

2. Cover percentage of invasive species on Site N1.

Strengths/Limitations

The presence of invasive species is a major concern on Site N1. It is currently dominated by smooth brome, buckthorn, and sweet clover. By measuring the abundance of invasive species on the site it will allow restorationists to use adaptive management protocol. Different management practices can be implemented for varying coverage of invasive species on the site. One of the strengths of this parameter is that it is socially relevant and measurable. It gives restorationists a direct way to measure the total cover of invasive species on site one, and it also gives shareholders a way to see the progress of the restoration. Like the previous parameter, this

parameter is also interpretable and cost-effective. One limitation of this parameter is low cover does not mean that the invasive species found on the site are gone. Invasive species are persistent, and just because they are removed above ground does not mean they are completely removed from the site. The extensive root structure of some invasive species allow for it to grow back after the aboveground portion is removed. Another limitation is that this parameter has poor timely management. Data is only taken once a year, and a large amount of time is needed to evaluate all the plots within the site. Redundancy could also become a limitation with this parameter. Once the desired coverage of invasive species is reached, the data will become redundant. The coverage will hover around the same point during sample years, and few things will be gained from the data.

3. Percentage of vegetation cover on slopes.

Strengths/Limitations

The stabilization of the slopes on Site N1 is required not only for the establishment of the native prairie species on the site, but also for the safety of the greenway bike path users. One strength of this parameter is that it is socially and biologically relevant. Shareholders will see that the direct benefit of non-erodible slopes. It is biologically relevant because non-erodible slopes benefit the ecological community. It will be easier for plants to become established on stable slopes. This parameter is also interpretable. Vegetation cover on the slopes will give restorationists a direct way in measuring the stability of the slope. The deep rooting prairie species will help hold the soil on the slopes, and abundance is directly correlated with slope stabilization. Another strength of this parameter is that it is anticipatory. Lower cover percentage on the slopes will warn restorationists that the slopes are becoming unstable. However, there are limitations to this parameter. One limitation is that this parameter is not broadly applicable to other sites on the greenway. This data will only be useful to site N1, and none of the other sites along the greenway. This parameter is also limited by redundancy. Cover is being measured across the site with other parameters. However, different methods will be used for measuring the vegetation cover on the slopes, and there will be a variation on the data collected.

Abundance of skinks on site N1.

Strengths/Limitations

A major strength of this parameter is that it is measurable and interpretable. The population size of skinks on site N1 is easy to calculate and easily defined. This parameter is also interpretable. By observing the population size restorationists can determine whether or not the population is at an acceptable size. This parameter is also socially and biologically relevant. Having a skink population proves that trophic levels higher than vegetation are present on the site. This is important because it shows that the restoration site is an ecosystem, and not only a plant community. This data can also be used to show shareholders that the restoration is

functioning on the ecosystem level. It can show that more can be found on the site than just vegetation. There are limitations to this parameter, however. This parameter is not cost-effective because the box traps used to catch the skinks are fairly expensive. The parameter is also not diagnostic. Data gathered is only used for determining the size of the skink population. If there are any problems impacting the skink population there will not be any data to explain the factors causing the impacts. This parameter is also not anticipatory. Since data is collected once a year it will be difficult to anticipate the decline of the skink population. Data will not be taken on enough variables to anticipate the future of the population.

Monitoring Protocol

Abundance and Diversity of Southern Dry Prairie Species

Measurements for the cover and richness of southern dry prairie species on Site N1 will be taken within the first two weeks of June during sampling years. Data will be collected once a year every year, and the data collection should take less than two weeks. A grid system will be used with multiple one-by-one meter plots across the site area to get spatially relevant data. In each of the plots data will be taken on the number of species and the cover percentage of each species per plot. This data will be used to estimate the success of the restoration. We will use the data to visualize overall species diversity and species abundance across the site. This data can then be used to adjust management practices to alter species composition or abundance if necessary.

Abundance of Invasive Species

The same method of data collection used for assessing the cover and richness of southern dry prairie species will be used to assess the richness of invasive species across the site. The same grid system and one-by-one meter plots will be used to collect cover estimates of individual invasive species. This data will be collected the same time as the southern dry prairie species, the first two weeks of June. The data collected from the sample plots will be used to visualize the overall cover of invasive species across Site N1. This will allow managers to determine if invasive species control needs to be increased, or if they are on target with the restoration goals.

Amount of vegetation cover on slopes

The first type of monitoring on the site will involve ground cover and use the line-point-intercept method. This will consist of placing two stakes along each slope of the site connected by a string and then subsequently measuring, cataloging and recording each different species the string touches along the transect. This method is appropriate to the site given the relatively similar grade across the slopes, and the need for a simple method to gauge plants across the

slopes. This setup can be left and checked continuously to get repeated readings along the same area of the site. Monitoring individuals can use a predefined list of codes to more rapidly assess the progress of the erosion control method along the transect, with particular attention in recording areas of bare soil.

In addition to the point-intercept method, the Daubenmire method will be used along the same transect to get a more detailed level of analysis than the previous method. This involves the placement 20x50cm frames along the transect at intervals of 25 feet. Once this is completed, frames are assessed for three items: canopy cover, frequency and composition. The most important aspect in this case is the frequency and also relative cover classes that come from this method. This allows the site to be monitored for both a diversity of species (differing root structures are important) along the eroded hillsides but also the general cover density found, which is essential for retaining soil. Since the Daubenmire frames will be placed along the same transect established before it helps cut down on the needed time and effort involved, additionally it uses shared materials.

Abundance of skinks on Site N1

Reptiles are important in many ecosystems. They fill a major role in ecological food webs as both predator and prey, but they are sensitive to habitat disturbance (Marks 2005). The skink will be used as an indicator species on site N1. Due to their sensitivity to habitat disturbance, it will give restorationists an idea of how the restoration is proceeding. Skinks are also a predatory species (Fitch 1954). Restorationists will be able to use this to see how the ecosystem is functioning on different trophic levels. An assessment of the population will be done once a year. The assessment will also take place during the spring of each sample year. One method, capture-mark-recapture method, will be used to determine the abundance of skinks on site N1. The capture-recapture test will use a grid system, while the nest abundance method will use a walk through of the whole site. A walk-through is possible due to the small size of the site (~3 acres). The data gathered from the capture-recapture test will be used to calculate a population estimate using a Lincoln-Peterson estimate.

Data Interpretation

All of the data gathered through the monitoring program will be used to practice adaptive management. Data on the cover and species richness of native southern dry prairie species will be used to determine the success of the seeding, and if other plant establishment practices need to be conducted. If cover is low or richness is low then these issues will need to be addressed. However, if the cover and richness is at a reasonable level that data can be used to show Flint Hills that the restoration is successful. Data gathered on the cover of invasive species on Site N1 will be used to determine how extensive the invasive species removal needs to be. If the cover of invasive species on the site is low then the amount of resources for invasive species removal can be lowered, or vice versa. Data gathered from measuring the plant cover on the slopes will be used to determine if erosion control practices need to be changed. Since vegetation cover and erosion are negatively correlated, restorationists can use this data to implement the best management practices. Skink population data will be used to develop best management practices

for the skink population on Site N1. If the population is low, then active management will be needed. All of the data gathered can be presented to Flint Hills to show the progress and the success of the restoration.

Data Management

Management of data both in terms of restoration activities and monitoring are crucial to the success of any restoration process, and this site is no exception. Restoration actions and monitoring data will be stored in multiple locations, each containing whole data sets to ensure both availability of data to all the partners involved and duplicity which will protect against data loss. Specifically paper records will be kept by the restoration company involved directly in the majority of restoration activities and transferred to digital form, which should be made available via a cloud service to be available to Flint Hills, the City of Rosemount and Dakota county for evaluation and interpretation. This approach is valued for two reasons. First, the data is available in an easily readable format, without having to transfer paper records around, which could result in data loss. Second, it allows for data safety and security as files are stored securely by a third party transferring those concerns to organizations with greater uptime than hosting files on individual pc's or internal servers and a heightened level of security over the systems available to non-tech related organizations.

Data Management Plan

1. Raw data is collected and transferred to standardized forms (as referenced in monitoring protocols)
2. Data cleaned and organized. Checking for errors/inconsistencies between paper and digital copies, labeled by type of data and date.
3. Monitoring files are secured to protect against data manipulation.
4. Cleaned files are uploaded and organized into folders pertaining to type of data (monitoring activities, protocols, project timelines, restoration activities).
5. Link to cloud storage site delivered to (and updated) when items are added to project partners.

Revegetation and Vegetation Management

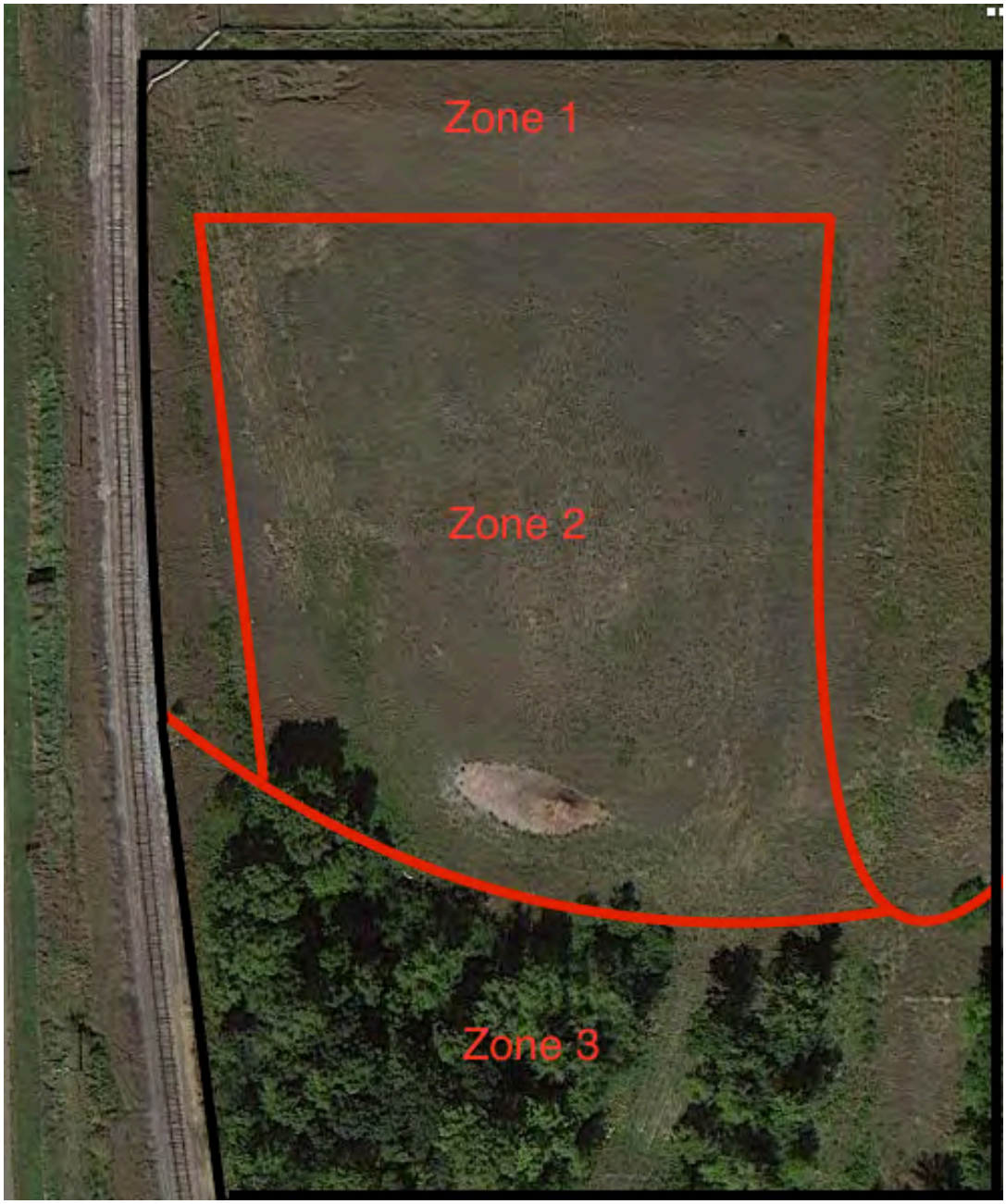


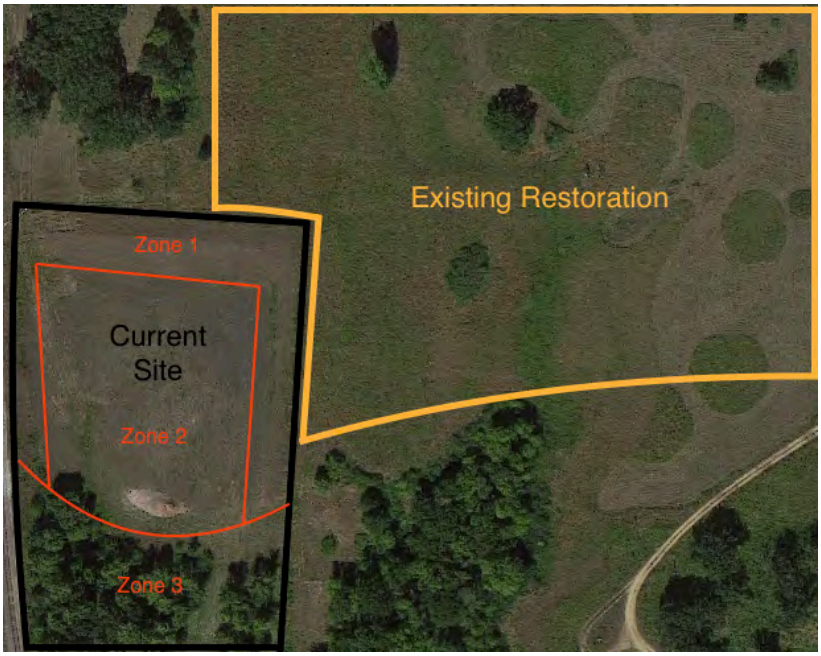
Figure 4. Black lines indicate the border of the restoration area. Zone 1 incorporates all the slopes on the site. Zone 2 includes the flat portion of the site in the center. Zone 3 is primarily wooded area on the southern portion of the area.

Restoration Action Areas

Figure 4 shows our 3 primary restoration action areas, these correspond to previous zoning of the site and this remains consistent here. Zone 1 includes all of the sloping areas on the site. The eastern, northern and western sides of the site are dominated by steeply graded terrain that needs some extra attention in terms of how they will be revegetated compared to the main portion in Zone 2. The bulk of the area is within Zone 2; this incorporates the largely sandy soil that predominates the center of the excavated site and all fits well within a single RAA. Finally Zone 3 was established to address the unique revegetation strategies and choices needed for a woodland area, in our case the restoration of a dry oak savannah. Although all distinct RAA's the areas are connected by its emphasis on prairie restoration.

Overall Revegetation Strategy

The overall strategy for revegetation on the site is restoration of an oak savannah and prairie ecosystem. This strategy was chosen given the geographic location of the site, which was historically on the edge of both of these types of ecosystems and the current conditions of the site which lend themselves to a transition between a more wooded environment and a more open environment. Additionally the existing prairie restoration that has already been accomplished to the north east of the site was a big factor in deciding how the current site would proceed. Making a connection with the previous restoration was important to create a contiguous prairie landscape that felt more natural to visitors and created connected habitat for wildlife.



Prairie vegetation will dominate Zones 1 & 2, to connect the previous prairie site to ours as previously mentioned and seen in Figure 2. Zone 1 however will contain a slightly different seed mix given the slopes and need for erosion control as well as a connection to the other restoration area. This approach connects the revegetation plan to the goal of controlling erosion on the site. Zone 2 has a prairie focus as well, but more on native species diversity which aligns with the second goal of restoration of a thriving dry oak savannah ecosystem. Finally, Zone 3 focuses on the 'oak' part of the oak savannah and hopes to increase the abundance of native oaks and more shrubby plants in that area. All areas emphasis the introduction of native species and a reduction and control of invasive species that is critical to all

aspects of our goals. The restoration taken together will also increase the prevalence of skinks due to the increased habitat for them in both the prairie area and oak area.

Extant Vegetation Conditions

The pre-existing vegetation of N1's excavated area (Zone 1 & 2) is dominated by a variety of exotic invasive flora that are likely to out compete most of the selected indigenous flora if not eradicated. Among the most abundant exotics are spotted knapweed, sweet clover, and smooth brome grass that will be combated by full eradication with boom sprayed herbicide application. Furthermore, the current herbaceous layer will shade out native plant seeds prohibiting germination in many prairie species. It is evident that there is little resilience in the form of substantial native seed bank and will require extensive invasive species removal throughout the restoration.
The slopes surrounding the excavated area (Zone 1) are also dominated by invasive exotic flora that will compromise the successful establishment of native prairie plants. Given the risks of erosion on the steep slopes, immediate action of soft-scape measures will be needed to avoid further erosion and harbor preferred plant seeds after full eradication of current vegetation. A heavier seeding of annual cover crop will also be utilized to promptly stabilize slopes.
In the wooded section (zone 3), the shrub layer is dominated by common buckthorn (*Rhamnus cathartica*) that will inhibit the attempts of oak savannah understory establishment due to allelopathy, shading and rhizome colonization. In addition, the canopy is mostly full coverage with Box Elder (*Acer negundo*), Hackberry and bur oak (*Quercus macrocarpa*) that are inconsistent with restoration goals of a Bur oak savannah with 50% Canopy cover.

For full current existing vegetation species list of N1, see section: 'Historic and Current Vegetation'.

Site Preparation

The current exotic and invasive plant community will require at least two types of herbicide with specific modes of actions for forbes and grasses. To eradicate *Bromus inermis* we recommend spring and fall application of 0.33 kg ai ha^{-1} imazapyr and 0.10 kg ai ha^{-1} imazapic + 0.16 kg ai ha^{-1} imazapyr which has a record of decreasing it's coverage to less than 10% s and increased native species cover after three growing seasons (Bahm, Barnes, and Jensen 2011). After herbicide applications have run their course, dead herbaceous residues will be disintegrated by way of prescribed burn. Sweet clover is expected to be moderately eradicated with the introduction of mowing because it is a biennial. A fire regime will further the effectiveness of invasive plant eradication efforts and ensure following seeding have the necessary light conditions to germinate. A prescribed burn will also volatilize any residual herbicide compounds or endogenous cytokinins (a hormone linked to drought and germination inhibition) that may further compromise revegetation.

In the zone 3 wooded area, a diverse set of preparation actions will be pursued to convert this area to a historic dry land savannah. The first priority of intensive Buckthorn removal requires a few strategies. Buckthorn greater than ¾" will be cut and stump treated with herbicide. Buckthorn stumps will be treated with a mixture of one part Garlon 4 and four parts

Bark-Oil Blue (The Aldo Leopold Foundation 2014). Cut buckthorn will be dragged to an open site and assembled into a burn pile to remove debris and denature seeds. Buckthorn smaller than ¾" will be mechanically removed by weed wrenches to remove as much rhizome growth as possible and avoid overuse of herbicides (The Aldo Leopold Foundation 2014). Herbicide applications will occur in earlier spring or late fall when many other plants are dormant to avoid unintended environmental toxification. Mechanical removal may be repeated 3-4 years in a row to exhaust vegetative regrowth potential prior to most understories seeding. Mowing re-sprouts of buckthorn three times per growing season may be another option if monitoring confers a change of attack.

Furthermore, Box elder and most small-medium size Hackberry trees will be felled to open the canopy for sun light penetration and allow for prescribed burn. Fell trees will be put through a wood chipper to mulch over proximal colonies where mature female buckthorn were removed. Prescribed burns will need to be done at a 3-4 year interval to promote the continuance of savannah flora community, and to avoid succession to forest and to assist in the removal of invasive exotics.

These canopy trees are also removed because of the prescribed burn regime that does not favor these and other non-fire resistant plants. Larger Hackberry tree's will be preserved and may have some resistance to fire if surrounding fuels are short lived herbaceous plants. Alternatively, small fire breaks may be created prior to burning. Hackberries may not be recognized as a savannah species, but effort to preserve healthy mature Hackberries is justified due to the food source they provide wildlife and the niche they are thriving in.

Site Preparation Zone 1 and 2
Timeline
Year 1

- Spring: Application of 0.33 kg ai ha^{-1} Imazapyr and 0.10 kg ai ha^{-1} Imazapic + 0.16 kg ai ha^{-1} Imazapyr ((Bahm, Barnes, and Jensen 2011).
- Fall: Application of 0.33 kg ai ha^{-1} Imazapyr and 0.10 kg ai ha^{-1} Imazapic + 0.16 kg ai ha^{-1} Imazapyr ((Bahm, Barnes, and Jensen 2011).

Year 2

- Early Spring: Application of 0.33 kg ai ha^{-1} Imazapyr and 0.10 kg ai ha^{-1} Imazapic + 0.16 kg ai ha^{-1} Imazapyr ((Bahm, Barnes, and Jensen 2011).
- Spring: Prescribed burn of zones to remove dead vegetation.

Site Preparation Zone 3
Timeline
Year 1

- Fall: Cut and spray of buckthorn greater than ¾". It will be treated with a mixture of one part Garlon 4 and four parts Bark-Oil Blue (The Aldo Leopold Foundation 2014). Buckthorn smaller than ¾" will be mechanically removed by weed wrenches (The Aldo Leopold Foundation 2014).
- Fall: Removal of non-target tree species in the canopy.

Year 2

- Continued manual removal of buckthorn less than ¾" with weed wrenches (The Aldo Leopold Foundation 2014).

Revegetation Actions

Zone 1: Sloped Prairie Area

This area will be seeded with a southeastern Minnesota state dry prairie mix 35-621 (see Appendix III) adjusted for the slopes in the zone. Due to the slopes on the site, and the need for immediate stabilization of the soil, a larger amount of oats will be used as cover crop than the base mix. An addition of 9lb/acre of oats on the slopes will be sufficient. The base mix contains nine grass species along with many forb species well suited for the sandy soil in the zone. There will be one more addition to the seeding of this zone. There is an adjacent established prairie on the eastern side. Big bluestem is abundant in this prairie and with just the base state mix there will be a large height difference between the two prairies. In order to remove the height contrast between the two prairies, big bluestem will be interseeded. Big bluestem will be hand broadcasted from the adjacent prairie to the crest of the slope on the eastern side of zone 1 due to the small area. Seed mix will be sown using a mechanical broadcast seeder. This seed mix will result in a higher grass density than wildflower density, and it has a seeding rate of 20lb/acre including cover crop. Erosion control blanket will be installed to hold the seed in place, and slow water movement down the slopes.

Three chokecherry (*Prunus virginiana*) and three American hazelnut (*Corylus americana*) trees will be planted across the slopes of zone 1 on the north and east portions during the second year of restoration. Four to five feet tall, potted trees will be planted within the zone. Both species will be planted in the spring (Gillman & Johnson 2014). The planting locations are located in Appendix III. Establishing a canopy cover on the slope is not the goal of this planting. The goal of this planting is to break up the angular and manmade contrast of the slopes. Due to the excavation of the site, the slopes have become aesthetically unappealing. With the planting of six trees it will break up that contrast, and make the slopes look more natural. Each of the six trees will be planted in areas that will maximize a natural looking landscape.

Seed Mix cost ($2,290/acre) @ 1.0 acres = $2,290
Prunus virginiana cost ($13.52/tree) @ 3 trees = $40.56
Corylus americana cost ($10.42/tree) @ 3 trees = $31.26

Timeline
Year 1

- Spring: Broadcast of dry southeast prairie mix 35-621 across whole zone.
- Spring: Broadcast additional 9lb/acre of oats onto the slopes.
- Spring: Hand broadcast big bluestem seed on eastern portion of zone.
- Spring: Installation of erosion control blanket.

Year 2

- Spring: Plant three, four-five foot chokecherry trees (*Prunus virginiana*), and three, four-five foot American hazelnuts (*Corylus americana*) in designated areas. Install mulch around trees.

Zone 2: Flat Excavated Area

This area will use the 35-621 Dry Prairie Southeast (see Appendix III). The total mix will be applied at 11 lb/acre which includes 3 lb/acre of cover crop. The seeds will be applied to zone

2 through mechanical broadcasting. This seed mix is designed for sandier soils so it is suitable for the present soil conditions within zone 2.

Seed Mix cost ($2,290/acre) @ 1.5 acres = $3,435

Timeline
Year 1

- Spring: Broadcast of dry southeast prairie mix 35-621 across whole zone. Apply a little bluestem mulch across whole site.

Zone 3: Wooded Portion

This area will be seeded with the 36-211 Woodland Edge South & West mix (see Appendix III). The total mix will be applied at 34.5 lb/acre which includes 11 lb/acre of cover crop. All the species in this mix are suited for partial sun so this seed mix is ideal for restoring an oak savannah in this zone. The mix will need to be hand broadcasted because it will be difficult and dangerous to manage a mechanical broadcaster on the slope. There will be no planting in this zone due to the existence of native oak savannah tree species.

Seed Mix cost ($2,426/acre) @ 0.20 acres = $485.20

Timeline
Year 1

- Broadcast Woodland Edge South & West mix 36-211 across whole zone. Install erosion control blanket throughout zone.

Establishment Management

Zone 1 and 2 Post Seeding/Planting Management

The most important short-term management action is removal of fast growing weeds due to their ability to shade out native seedlings (Shirley 1994). This is important due to the dominance of invasive species in zone 1. To combat weedy and invasive species the zone will be mowed every month throughout the growing season as suggested by Shirley (1994). Weeds will be kept to a height of six to eight inches by mowing with a mulching or flail mower, and this will be done until late September (Kilde 2000). Wood mulch 3-6 inches deep will be placed around saplings and spread out to a 12-inch radius.

Year two of management will begin with a mow of the zone to six to eight inches before the weeds begin to grow (Kilde 2000). Sweet clover will be mowed before it goes to flower, and herbicide can be used sparingly for spot application to invasive and non-native plant species.

Timeline
Year 2

- Early Summer: Mow emerging weeds to a height of 6-8 inches with a mulching or flail mower, and repeat this monthly (Kilde 2000).
- Summer: Use spot application of herbicide sparingly, and only when needed.

Zone 3 Post Seeding/Planting Management

The same vegetation management practices for the other two zones will be used for zone three. Due to the slope of this area, a push flail or mulching mower might perform better since it will be difficult to drive a tractor throughout the zone. Most of the buckthorn should be removed

during the site preparation; however there will be resprouts. During the fall of the first and second year buckthorn sprouts will be foliar sprayed with Garlon 3A at a 4-5% solution with water and a surfactant (Pleasant Valley Conservancy 2014).

Timeline
Year 1
- Fall: Foliar spray buckthorn resprouts and new seedlings with Garlon 3A at a 4-5% solution with water and surfactant (Pleasant Valley Conservancy 2014).

Year 2
- Early Summer: Mow emerging weeds to a height of 6-8 inches with a mulching or flail mower, and repeat this monthly (Kilde 2000).
- Fall: Foliar spray buckthorn resprouts and new seedlings with Garlon 3A at a 4-5% solution with water and surfactant (Pleasant Valley Conservancy 2014).

Long-term Management

Long-term Vegetation Management: Zones 1-3
Begin prescribed burns on each of the zones starting the third year of management if possible (Kilde 2000). Continue to conduct prescribed burns every three to four years. Do not burn all zones at the same time to minimize skink and other fauna mortality. If burning is not feasible than mow and remove standing vegetation. Continue to monitor all zones for invasive and non-native species, and remove with spot application of the appropriate herbicide or spot mowing. Additional seeding may be necessary to maintain or increase species diversity (Kilde 2000).

Timeline:
Year 3
- Conduct a prescribed burn of the site if possible. If not possible then mow site with a flail or mulching mower to a height of 6-8 inches tall (Kilde 2000).

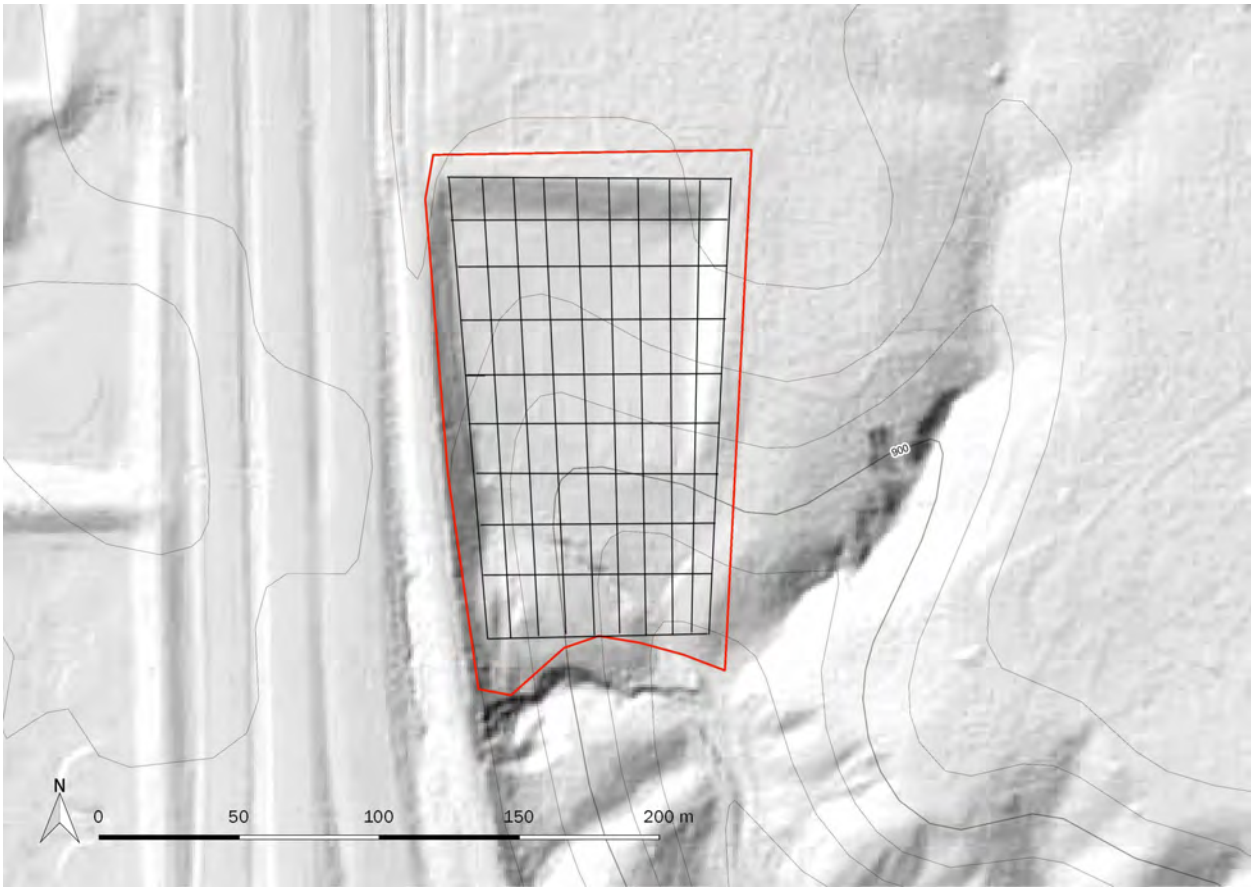
Year 4-5
- Spring: Mow site to a height of 6-8 inches with a flail or mulching mower (Kilde 2000).

Year 6 or 7
- Early Spring: Conduct a prescribed burn on the entire site, making sure to burn separate zones (Tallgrass Ontario 2014). Conduct prescribed burns on entire site every 3-4 years. Substitute mowing for burning if burning is not possible.
- Fall: Reseed areas in zones if needed for maintaining or increased species diversity (Kilde 2000).

Yearly
- Spot spray weeds or invasives with appropriate herbicide, and spot mow invasives if necessary. Repeat throughout growing season.

Appendix I.

Cover and Species Richness of Southern Dry Prairie Species and Abundance of Invasive Species



Sample plots will be used for gathering data on the cover and richness of southern dry prairie species on Site N1. Data will be collected during the first two weeks of June on sampling years to ensure that a large portion of prairie species are in bloom. Plots will be setup on a grid system across the site. There will be 100 sample plots evenly spaced throughout the site, and plots will be one meter by one meter. Using a grid system along with 100 sample plots will allow for spatially relevant unbiased data. At each plot a GPS will be used to mark the coordinates of the northwestern corner. This will allow for surveyors to revisit sites in the future since the same plots will be used every sample year. Once the one-by-one meter plot is set up, gently pull all vegetation into the plot. Only individuals rooted within the plot will be used. Create a list of all species rooted within the plot. Visual estimates of cover for each species within the plot will be made using the Daubenmire cover class system. This uses a 6-point scale, as indicated below (Daubenmire 1959). Notes should be made if only one to a few individuals are found in a plot. It is important to look under the canopy of taller vegetation. At the end of

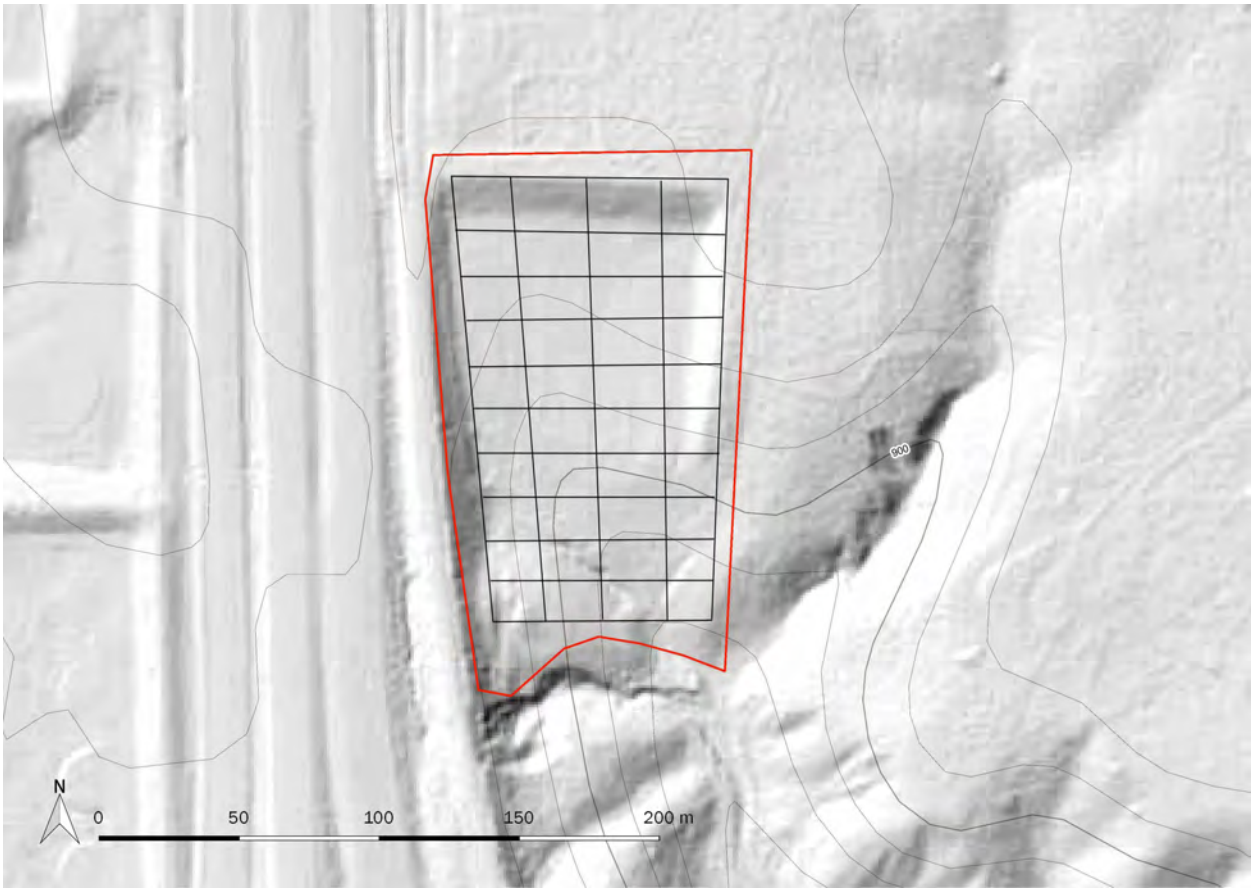
each monitoring unit, there should be a comprehensive vegetation list. Unknowns should be identified if possible.

Cover Class	Range of Coverage
1	<5%
2	5-25%
3	25-50%
4	50-75%
5	75-95%
6	95-100%

This plant data collection method will also be used to collect data on the cover of invasive species. The first two-week period in June coincides with the bloom period of many invasive species. This will give surveyors the advantage when conducting the surveys. Cover of invasive species will be estimated the same way as the cover of native southern dry prairie species. Once each plot has been evaluated, a separate comprehensive vegetation list should be made for only invasive species. This list will include species and cover.

This monitoring and assessment should take three to five hours, and should only require two people. These same people conducting the data collection for the cover and species richness of southern dry prairie species can also collect the data for the vegetation cover on the slopes

Abundance of Skinks on Site N1



An assessment of the population will be done once a year, and these assessments will take place during the first week of June during each sample year. An estimation of the population of skinks will be done by capturing, marking, and recapturing individuals. A grid of box traps will be placed around site N1. Ten meters will be the distance separating the box traps, and there will be 50 box traps placed around the site. Box traps will be baited and have cotton balls placed inside. Approximately five cotton balls will be placed in each trap to provide thermal cover, and the cotton balls should be lightly pulled apart. Two dead crickets will be used as bait in each trap. Traps will be set at 7 p.m. the night before, and checked at 7 a.m. the next morning. Individuals caught the first night will be marked, and released. If an individual is caught then the cotton balls and bait will be replaced for the following night. Traps will then be set again the following night at 7 p.m. and checked at 7 a.m. the following morning. Traps are opened for the night to not allow the skinks to overheat while in the box trap. It should take one to two hours to set the traps each night. It should also take one to two hours to check the traps the following morning, release all captured individuals, and close traps for the day. After the second day all traps should be removed and cleaned.

After data is collected on the number of skinks captured and recaptured a Lincoln-Peterson estimate will be used to calculate a population size. A Lincoln-Peterson estimate is a method of calculating a population size by using three measurements: number of individuals captured the first day and marked, the number of individuals caught the second observation day, and the total number of marked individuals. To calculate the population size one multiplies the number of individuals caught and marked in the first sample by the number of individuals caught in the second sample, marked and unmarked. This value is then divided by the number of animals marked in the second sample. This method has some assumptions: the population is closed to additions and deletions, all individuals have the same probability of capture, marking the animal will not affect future catchability, marked individuals are not lost, and all marks are reported upon capture. Surveyors will need 50 box traps, 500 cotton balls, 200 dead crickets, and a GPS unit for this method. The GPS will be used to mark the locations of the box traps.

Amount of vegetation cover on slopes Procedure

Line Point Intercept Method - Several materials are needed to complete this method including the following: measuring tape (long enough for the transect line), two steel pins to anchor the tape to, a pointer (steel, or similar rod), clipboard and data collection form (Sample is located in Appendix II). Attach the tape to the two steel pins and walk out the pins until the desired transect length of 100ft is reached. Once tape and anchors are secured and the tape is flush with the ground, or slightly above given the slope in this case, begin surveying plants. Record every plant that the transect tape touches, including species, and approximate height. In addition if the transect crosses a spot that is not covered by a plant, record the type of material in which the transect tape is touching (e.g. soil, rock). For each slope one transect should run parallel to the slope at ½ way up the slope and two transects should run perpendicular to the slope at ¼ the way across and ¾ along the length of the slope. Transects should be conducted on the three slopes of the site on a yearly basis, beginning pre-restoration, and ending when % ground cover reaches 90% or more. The timing of the transects should be done during an appropriate season but since the intercept method is looking at any and all cover the specific season is not required. Detailed instructions on the scoring and evaluation of Line-Point Intercept data can be found in the Bureau of Land Management Monitoring Manual, Volume 1, 2005.

Daubenmire Method - The details of this method are already addressed in the Abundance section and do not need to be extrapolated upon here. A number of the 100 sample plots used in the Abundance protocol will fall on the erosion prone slopes and cover will be assessed there in the same manner described for the rest of the site.

This monitoring and assessment will require two people to complete, and should take between 2-4 hours per slope. The same team as the abundance and invasive monitoring protocols, which would save on time and money involved, could complete this work.

Appendix II. Line Point Intercept Data Form

Page _____ of _____ **Shaded cells for calculations**

Plot: _____ Line #: _____ Observer: _____ Recorder: _____

Direction: _____ Date: _____ Intercept (Point) Spacing Interval = _____ cm (___ in)

Pt.	Top canopy	Lower canopy layers Code 1	Code 2	Code 3	Soil surface	Pt.	Top canopy	Lower canopy layers Code 1	Code 2	Code 3	Soil surface
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

% canopy (foliar) cover = ____ canopy pts (1st col) x 2 = ____ %

% bare ground* = ____ pts (w/NONE over S) x 2 = ____ %

% basal cover = ____ plant base pts (last col) x 2 = ____ %

Top canopy codes: Species code, common name, or NONE (no canopy).

Lower canopy layers codes: Species code, common name, L (herbaceous litter), W (woody litter, >5 mm (~1/4 in) diameter).

Unknown Species Codes:

AF# = annual forb
PF# = perennial forb
AG# = annual graminoid
PG# = perennial graminoid
SH# = shrub
TR# = tree

Soil Surface (do not use litter):

Species Code (for basal intercept)

R = rock fragment (>5 mm (~1/4 in) diameter)
BR = bedrock, M = moss
LC = visible lichen crust on soil
S = soil without any other soil surface code
EL = embedded litter (see page 10)
D = duff

Bare ground occurs ONLY when Top canopy = NONE, Lower canopy layers are empty (no L), and Soil surface = S.

Appendix III

35-621 Dry Southeast Prairie

Scientific Name	Common Name	% of Mix	Seeds/ft2	Rate/acre
GRASSES:				
Agropyron trachycaulum	Slender Wheatgrass	10.73%	3.0	1.18PLS lb
Bouteloua curtipendula	Sideoats Grama	10.27%	2.5	1.13PLS lb
Bouteloua gracilis	Blue Grama	6.18%	10.0	0.68PLS lb
Bromus kalmii	Prairie Brome	2.82%	0.9	0.31PLS lb
Elymus canadensis	Canada Wild Rye	13.64%	2.9	1.50PLS lb
Koeleria cristata	June Grass	3.73%	30.1	0.41PLS lb
Schizachyrium scoparium	Little Bluestem	13.73%	8.3	1.51PLS lb
Sporobolus cryptandrus	Sand Dropseed	2.00%	16.2	0.22PLS lb
Sporobolus heterolepsis	Prairie Dropseed	2.36%	1.5	0.26PLS lb
	Total Grasses	**65.46%**	**75.4**	**7.2**
FORBS:				
Asclepias tuberosa	Butterfly Milkweed	0.55%	0.1	0.06PLS lb
Asclepias verticillata	Whorled Milkweed	0.09%	0.0	0.01PLS lb
Aster azureus	Sky Blue Aster	0.09%	0.3	0.01PLS lb
Aster sericeus	Silky Aster	0.18%	0.2	0.02PLS lb
Coreopsis palmata	Prairie Coreopsis	0.45%	0.2	0.05PLS lb
Dalea candidum	White Prairie Clover	0.82%	0.6	0.09PLS lb
Dalea purpurea	Purple Prairie Clover	1.36%	0.8	0.15PLS lb
Heliopsis helianthoides	Ox-eye Sunflower	0.55%	0.1	0.06PLS lb
Lespedeza capitata	Round-headed Bush Clover	0.27%	0.1	0.03PLS lb
Liatris aspera	Button Blazingstar	0.18%	0.1	0.02PLS lb
Liatris punctata	Dotted Blazingstar	0.18%	0.1	0.02PLS lb
Monarda fistulosa	Wild Bergamot	0.27%	0.8	0.03PLS lb
Monarda punctata	Spotted Bee Balm	0.18%	0.7	0.02PLS lb
Penstemon grandiflorus	Large-flowered Beardtongue	0.36%	0.2	0.04PLS lb
Rudbeckia hirta	Black-eyed Susan	0.82%	3.0	0.09PLS lb
Solidago nemoralis	Gray Goldenrod	0.09%	1.1	0.01PLS lb
Solidago rigida	Stiff Goldenrod	0.55%	0.9	0.06PLS lb
Tradescantia bracteata	Prairie Spiderwort	0.09%	0.0	0.01PLS lb
Zizia aptera	Heartleaf Alexanders	0.18%	0.1	0.02PLS lb
	Total Forbs	**7.27%**	**9.4**	**0.8**
COVER CROP:				
Avena sativa	Oats	27.27%	1.3	3.00PLS lb
	Total Cover Crop	**27.27%**	**1.3**	**3.00**
	Total	**100%**	**86.1**	**11**

Seeding Rate: 11lb/acre
(86.2 seeds/ft2)

*Shooting Star Native
Seeds 2014

*Zone 1: Big bluestem will be interseeded at a rate of 0.5 lb/acre, or 3.05 seeds/ft2.
*Zone 1: An additional 9lb/acre of oats will be seeded on the slopes.

36-211 Woodland Edge South & West

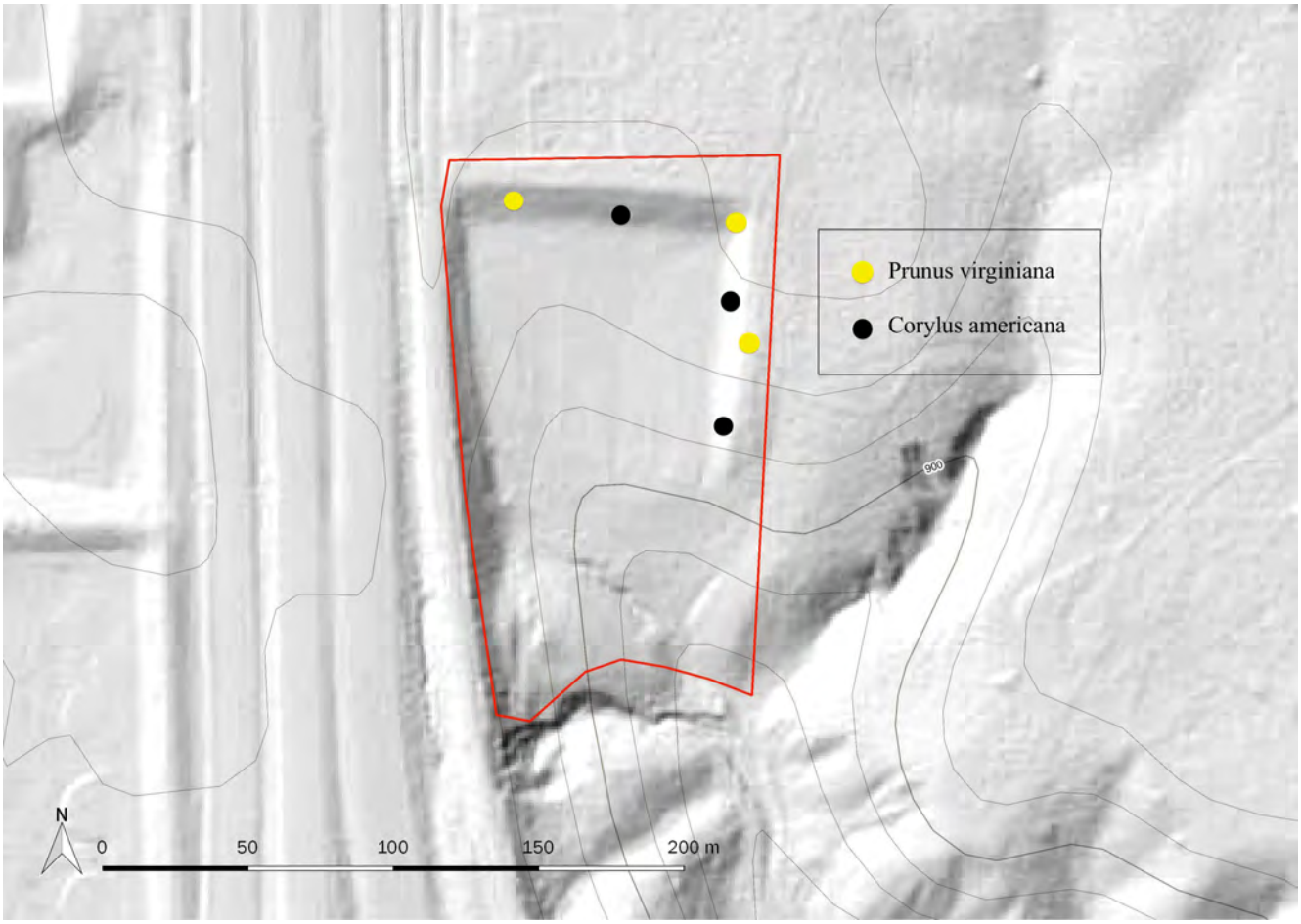
Scientific Name	Common Name	% of Mix	Seeds/ft2	Rate/acre

Agropyron trachycaulum	Slender Wheatgrass	3.62%	3.2	1.25PLS lb
Andropogon gerardii	Big Bluestem	2.90%	3.7	1.00PLS lb
Bouteloua curtipendula	Sideoats Grama	2.90%	2.2	1.00PLS lb
Bromus kalmii	Prairie Brome	4.35%	4.4	1.50PLS lb
Elymus canadensis	Canada Wild Rye	3.62%	2.4	1.25PLS lb
Hystrix patula	Bottlebrush Grass	0.93%	0.9	0.32PLS lb
Panicum virgatum	Switchgrass	0.17%	0.3	0.06PLS lb
Schizachyrium scoparium	Little Bluestem	1.80%	3.4	0.62PLS lb
Sorghastrum nutans	Indiangrass	2.90%	4.4	1.00PLS lb
	Total Grasses	**23.19%**	**24.9**	**8**
FORBS:				
Achillea millefolium	Yarrow	0.09%	2.0	0.03PLS lb
Agastache foeniculum	Anise Hyssop	0.29%	3.3	0.10PLS lb
Aster laevis	Smooth Blue Aster	0.17%	1.2	0.06PLS lb
Dalea candidum	White Prairie Clover	0.49%	1.2	0.17PLS lb
Desmodium canadense	Showy Tick Trefoil	0.41%	0.3	0.14PLS lb
Eupatorium rugosum	White Snakeroot	0.09%	1.7	0.03PLS lb
Heliopsis helianthoides	Ox-eye Sunflower	0.38%	0.3	0.13PLS lb
Monarda fistulosa	Wild Bergamot	0.17%	1.5	0.06PLS lb
Osmorhiza claytoni	Sweet Cicely	0.17%	0.1	0.06PLS lb
Rosa blanda	Early Wild Rose	0.17%	0.1	0.06PLS lb
Rudbeckia hirta	Black-eyed Susan	0.52%	6.1	0.18PLS lb
Scrophularia lanceolata	Early Figwort	0.14%	3.4	0.05PLS lb
Solidago flexicaulis	Zig Zag Goldenrod	0.06%	0.6	0.02PLS lb
Solidago rigida	Stiff Goldenrod	0.17%	0.9	0.06PLS lb
Solidago speciosa	Showy Goldenrod	0.17%	2.1	0.06PLS lb
Vicia americana	American Vetch	0.52%	0.1	0.18PLS lb
Zizia aurea	Golden Alexanders	0.32%	0.4	0.11PLS lb
	Total Forbs	**4.59%**	**25.3**	**1.5**
COVER CROP:				
Avena sativa	Oats	72.46%	11.0	25.00PLS lb
	Total Cover Crops	**72.46%**	**11**	**25.00**
	Total	**100%**	**61.2**	**34.5**

Seeding Rate: 34.5 lb/acre
61.2 seeds/ft2

*Shooting Star Native
Seeds 2014

Zone 1 Planting Map



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