

# Hydroseeding Survey of IRVM Counties in Iowa

Final Report

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## Introduction

The Integrated Roadside Management (IRVM) Program was first implemented in Iowa counties in the late 1980s. According to the IRVM technical manual, “IRVM is an approach to right-of-way (ROW) maintenance that combines multiple management techniques with sound ecological principles to establish and maintain safe, healthy, and functional roadsides” (Brandt et al. 2012). Currently, 80 of Iowa’s 99 Counties have adopted and implement IRVM principles at some level; approximately half of those counties have a full-time, active IRVM program manager (Henderson 2012).

One relatively new technique that IRVM counties use for seeding native prairie seed in ROWs is hydroseeding. A few IRVM counties have experimented with hydroseeding natives in ROWs over the past several decades, but it is only been during the past decade that hydroseeding has become commonplace. According to Cerro Gordo County Roadside Manager Josh Brandt, “I have heard from previous IRVM staff that back in the early 1980s, that two ROWs in the north part of the county were hydroseeded with native grasses. It is clear that the county hydroseeded with natives because there is such a dense stand of switchgrass-*Panicum virgatum* and indiangrass-*Sorghastrum nutans* in those ROWs today.” As a result of this, and other hydroseeding experimentation which resulted in diverse native plant communities, hydroseeding practices have since spread to other IRVM counties.

A big part of the hydroseeding story involves the Iowa Legislature and Iowa Department of Transportation – Living Roadway Trust Fund (LRTF). The Iowa legislature adopted IRVM in 1988 and created LRTF the following year. Then as now, LRTF funds state, city and county roadside projects. One of those initial projects was the funding of a hydroseeder for Black Hawk County in 1992. This was the first hydroseeder funded by LRTF. Since that time, LRTF has invested \$677,977.00 to assist 43 counties with the purchase of hydroseeders for planting native vegetation in roadsides (Iowa Dept. of Transportation 2011). Today, hydroseeding has become the primary seeding technique used by most IRVM counties to seed natives in Iowa’s ROWs (Henderson 2011). This report looks at those LRTF investments into hydroseeding equipment, and begins to quantify and document the collective use of hydroseeders in IRVM programs, and evaluate the resulting plantings from some of those projects.

Hydroseeding combines seed, water, tackifier, and mulch into a slurry. This mixture is sprayed onto a planting site in a 1-step operation. This is how most operation manuals describe the hydroseeding process. Among IRVM Roadside Managers however, hydroseeding methods

vary among different counties. Some IRVM counties use a standard 1-step method, some use a 2-step method - spraying only water and seed in the first pass, followed by the hydro-mulch in the second pass, while yet others use a 3-step method - spraying only water and seed in the first step, followed by applying straw or cultipacking the site in the 2<sup>nd</sup>-step, and finishing with applying water and mulch in the 3<sup>rd</sup>-step. Within these processes, some counties have developed even more variations of seed, mulch, tackifier, fertilizer and water to enhance their efforts.

This hydroseeding report is based upon detailed telephone surveys of 44 Iowa IRVM counties that utilize hydroseeding to seed natives in ROWs. The phone survey questionnaire encompassed all aspects of county hydroseeding, including questions associated with equipment types, techniques, seeding rates. Respondents were asked about their use of natives and nurse crops, hydroseeding personnel involved in these efforts, types and rates of mulch used, bad hydroseeding experiences and finally, tricks of the trade. This summary report also contains detailed information from 10 counties that were selected for a site visit by UNI staff in July 2012, based upon unique hydroseeding methods revealed during the telephone survey. While in the each county, two hydroseeded plantings were visited and assessed.

The goals of the Hydroseeding Survey in Iowa Counties project were developed as follows:

- 1) To identify and summarize equipment used by IRVM counties,
- 2) To identify operator preferences when hydroseeding,
- 3) To broadly summarize hydroseeding methods employed across the state,
- 4) To determine strategies used to reduce erosion in ROWs on hydroseeded plantings,
- 5) To identify and document native seeding rates and nurse crops commonly used in the state and,
- 6) Evaluate native plant establishment on hydroseeded plantings.

Hydroseeded ROW site planted in the late 1990s in Fayette County, Iowa.

Photo taken in June 2012.

## Section 1

### Survey Implementation and Respondent Information

The hydroseeding survey was developed at the Tallgrass Prairie Center (TPC) at the University of Northern Iowa (UNI). Survey design was a collaborative effort by Dave Williams, project manager for restoration and research and Kirk Henderson, State Roadside Specialist, both staff at the Tallgrass Prairie Center (TPC) - University of Northern Iowa (UNI), and Maureen Collins-Williams, Director of the Regional Business Center and Entrepreneurial Outreach at UNI. Only Iowa Counties that have an IRVM program and hydroseed natives (tallgrass prairie species) in county ROWs were surveyed. A person in each county who had operated the hydroseeder was targeted for the survey. Surveys were conducted by telephone interviews in December 2011 and January 2012. Telephone interviews were recorded for transcription and to verify quotes and accuracy. Responses for some survey questions will remain anonymous.

Forty-four of 48 Iowa counties completed the survey (Appendix 1). County job titles varied greatly among respondents. Roadside Managers had the most respondents with twenty two. Maintenance/Secondary Roads ROW Superintendents had 6 respondents, 4 respondents were County Engineers and Engineer Assistants. Four respondents were Equipment Operators and Roadside Technicians or Natural Resource Technicians, four were Roadside Biologists, Natural Resource Manager/ROW Vegetation, and Vegetation Management Specialists. Two respondents were Park Rangers, one was the Director of a County Conservation Board and one was a Wildlife Manager.

The hydroseeding experience and expertise of respondents was impressive. Seventy-four percent of respondents had more than 5 years hydroseeding experience, 14% had some hydroseeding experience (1-5 years), and only 4 respondents had not used the hydroseeder (these were largely engineers and engineer assistants).

Respondents learned how to hydroseed from a variety of sources. The most common way operators learned to hydroseed was from other roadside managers. The second most common learning method was from trial and error in the field. In fact, while hydroseeding non-natives has been utilized by Iowa counties prior to adopting IRVM, learning how to hydroseed natives was developed almost exclusively by IRVM county staff. According to Jon Steege, Roadside Manager for Fayette County, “ The county hydroseeded ditch cleanouts before IRVM with an old 800 gallon Bowie and used non-native seed. We did a lot of experimenting with

hydroseeding natives but it was Don Dahl's 2-step method that worked for us (Dahl is a former Iowa roadside manager who worked in Des Moines County". Some respondents also mentioned IRVM Roadside Conferences (sponsored by the IRVM Office at UNI) as another source of hydroseeding information. One respondent mentioned that she had learned how to hydroseed natives while attending a two year Natural Resources Management Program offered at Hawkeye Community College in Waterloo, Iowa. Another respondent learned how to hydroseed from working part-time for two local landscaping companies.

Hydroseeded ROW site planted in 2007 in Fayette County, Iowa. Photo taken in June 2012.

## Section 2.

### Hydroseeder Specifications/Modifications, Towing Vehicle

Eighty four percent of the counties surveyed use either Bowie or Finn brand hydroseeders (Appendix 1). Three counties use Kinkaide hydroseeders; one county used a Victor or a TGMI Aquaseeder respectively and one homemade unit was recorded.

Hydroseeder tank capacities ranged from 500 gallons to 3,300 gallons (Appendix 1). Most of the hydroseeding units were 750-1,800 gallons, but three counties have hydroseeders with tanks larger than 2,800 gallons and seven counties have hydroseeders with 500-600 gallon tanks.

Hydroseeders appear to be durable equipment. Eighty seven percent of the counties use hydroseeders more than six years-old; eighteen of those units are more than 10 years old, including six Bowies, eleven Finns, and one homemade hydroseeder (Appendix 1).

Most of the counties surveyed were satisfied with their hydroseeder brand. The most common response when asked about replacement enhancements needed over their existing units was a desire for larger tank capacity so more hydroseeding can be done between tank fills.

Over half of the counties purchased factory ordered units without special equipment. Of those counties that did order special equipment with their unit nearly all had a hose reel and extra hose added to the factory unit.

Many counties however, have modified their hydroseeder or added after market equipment to the hydroseeder to improve efficiency. The most common modification was to alter the plumbing of the hydroseeder so a trash pump could be connected to the unit to fill the tank from a remote water source, such as a stream or lake. Audubon County installed a male hose end to the tower gun so a hose could be hooked up for ground application. Benton County installed a light in the towing vehicle that was synced with the unit beeper to communicate with the driver because the beeper was hard to hear with the machine running. Jones and Shelby counties welded wire mesh and cattle panels around the top railing to keep mulch bales from sliding off the unit. Boone County added a fire hydrant hose attachment so the unit could be filled at a fire hydrant. Boone County also added a meter to determine how much water was used during each fill. Sac county moved the gun sprayer to the back of the trailer because it was too difficult to hydroseed ditches with the gun tower mounted on top of the unit when it was mounted to a tall flatbed trailer. Des Moines County moved the battery box on the hydroseeder for improved



maintenance access. Dallas County plumbed in a high pressure sprayer unit so they could use the hydroseeder to spray brush. All of these modifications reflect the innovation and do-it-yourself nature of field work in IRVM programs.

Counties pull their hydroseeders with a variety of trailers, or mount them upon a wide array of vehicles (Appendix 1). The larger the tank capacity the larger the towing vehicle was typical for most units. Larger hydroseeders, those with 1,000 gallons or more, were pulled by or mounted to single or tandem axle dumptrucks, a semi truck, or in one case, a straight truck. Smaller hydroseeders were towed with 1-ton and  $\frac{3}{4}$  ton pickups.

Hydroseeded ROW planting (both slopes) seeded in the late 1990s in Montgomery County, Iowa. Photo taken in June 2012.

### **Section 3.**

#### **Operator's Hydroseeding Preferences**

Hydroseeding has become a valuable tool for seeding natives in ROWs. Thirty-three percent of survey respondents preferred hydroseeding in ROWs over other seeding methods like drilling and broadcast seeding. Respondents cited multiple benefits to hydroseeding, which made it a preferred seeding method, including:

**Efficiency** – It is faster to hydroseed small ditch cleanouts as compared to hauling, loading/unloading other seeding equipment to each site.

**Moisture Retention** –Moisture is held for the seed longer under the hydromulch than through other seeding methods promoting faster germination.

**Equipment Access and Safety** – ROWs are often too steep for equipment access; hydroseeding from the road is safer for the operator and driver.

**Prairie Seed** –Combine-harvested trashy (not cleaned) seed can be used in a hydroseeder.

**Seed placement/establishment** –Seed is spread more evenly on the planting, as compared to other seeding methods, and counties have seen improved prairie establishment with hydroseeding.

Six counties responded that hydroseeding was their last method of choice for seeding natives in ROWs. Some reasons included: poor seed-to-soil contact because seed gets suspended in the mulch, poor native plant establishment on steep slopes, and hydroseeding takes longer, as compared to other seeding methods, on larger planting sites.

Hydroseeding can be employed throughout the year. Seventy percent of counties hydroseed in all three seasons-spring, summer and fall. Five counties reported hydroseeding during the winter, particularly during the most recent 3-5 years as Iowa has had open (snowless) winters leaving ditch soil exposed. Those counties hydroseeded when temperatures were above freezing, noting that the hydromulch would still dry and hold to the soil. Counties that hydroseeded in the winter noted that some elements of hydroseeding operation changed during the winter. Cold water from creeks can crack the hose when filling the tank and water pumps might find it difficult to draw exceedingly cold water into the tank during colder months. Hydroseeders had to be stored in a heated bay at night so the water won't freeze. Nurse crops (annual rye in particular) can be used in winter hydroseeding, as a portion of the seed will over-winter and germinate the following spring. Two counties noted that they had successful stands of natives on their older ROW plantings that were hydroseeded in the winter.

Most counties preferred to hydroseed in the spring or the fall. They cited adequate soil moisture for seed germination and improved mulch bonding with soil that had loosened overwinter as reasons to hydroseed during the spring. Fall hydroseeding was favored because of improved seed-to-soil contact by snow compaction after hydroseeding, good soil moisture typically exists to promote nurse crop germination, low temperatures and overwintering vernalize prairie seed for better spring germination, and fall freezing and thawing loosens the soil. Counties noted that mid-summer was the least preferred time to hydroseed because of the potential for seed to dry out and not germinate.

Most counties didn't have a preference on a time during the day to hydroseed. Hydroseeding tends to be conducted during normal working hours. However, some counties prefer to hydroseed in the mornings when wind conditions tend to be lower, noting that the hydroseeder operator has better control slurry spray with lower wind speeds. One respondent prefers to hydroseed in the morning because there are fewer vehicles on the roadway during that time making hydroseeding safer for the driver and operator. He noted that, "It's scary when you are on top of a 15' hydroseeder on a narrow blacktop road and 2 semis pass at the same time." One county prefers to hydroseed later in the day so the moisture stays longer on the seed to promote germination.

Nearly 100% of counties had weather preferences when hydroseeding. Most respondents do not hydroseed in rain or high winds. Two counties will not hydroseed if winds exceed 15 mph, noting that high winds can result in mulch blowing back at the operator and it is difficult to control slurry placement. Many counties noted that some wind is preferred because it will dry the mulch faster to form the protective crust in case there is an impending storm. In addition, counties will select planting sites in the ROW based on favorable winds (speed and direction) to blow slurry toward the planting site for increased spray distance and away from the operator. One county preferred hydroseeding on partly cloudy days to minimize sunburns.

Most counties had soil preferences when hydroseeding. Many counties preferred soil that was bare, moist and loose (friable). They noted that seed placement in the soil was improved and mulch adhered better in loose, moist-soil as compared to dry, hard-packed soil. They also preferred non-compacted, loamy, and fertile soil with low slopes for the ideal seedbed but noted that the soils left in ROWs after grading operations were often less than ideal soil conditions for planting.

## Section 4.

### Hydroseeding Methods and Techniques

This section will define the various hydroseeding methods currently used by IRVM staff. See Section 7 of this report for or more detailed information on mulch/tackifier (brands, application rates).

A ‘hydroseeding method’ is a discreet series of steps (or a step) that encompasses the complete seeding activity for a ROW site where a hydroseeder is used. Three basic hydroseeding methods were identified through the survey: 1-step, 2-step and 3-step. Within these processes, some counties have developed additional variations of seed, mulch, tackifier and fertilizer to enhance their efforts (Appendix 2). It is important to note that 45% of counties surveyed use more than one hydroseeding method.

Forty of the forty-four counties surveyed hydroseed with at least the 1-step method (Appendix 3). Thirty-five of those counties hydroseed with a combination of seed, mulch, and tackifier although the name brands used, and their application rates differed (Appendix 2, Appendix 4). Counties use the one step method for many different kinds of seeding projects. According to Josh Brandt, Cerro Gordo Natural Resource/Right-of-Way Vegetation Manager, “For small ditch cleanouts we use the 1-step method. This was the method of choice because we had lots of small ditch cleanouts all over the county and 1-step hydroseeding was the quickest and most efficient way to get those sites seeded.” Aaron Samuelson, Roadside Manager for Pocahontas County noted, “Hydroseeding small ditch cleanouts with the 1-step method is a lot easier than hauling around the drill. When the cleanouts get to be ¼ mile long, I’ll drill the ditch bottoms and hydroseed the slopes.” One county roadside manager determines which hydroseeding method he uses is based on the erosion potential of the planting site. According to Linn Reece, Hardin County Roadside Manager, “We hydroseed with the 1-step method on planting sites that are less erosive and use the 3-step method on highly erosive sites.” There were many variations of the 1-step method (Appendix 2). Mitchell County’s 1-step method includes only water and seed (see the Mitchell County vignette for more details). Polk County’s 1-step method includes only water, seed and fertilizer for reseeding projects. They don’t include mulch because vegetation is established on the planting site prior to hydroseeding. Fertilizer is added to benefit the existing vegetation.

Eighteen counties hydroseed with the 2-step method (Appendix 3). The use of seed, mulch, and tackifier with the 2-step method varied by county. These counties use the 2-step method on highly erodible steep slopes as a way to promote better seed to soil contact. Some counties stated they hydroseed with the 2-step method on highly traveled roadways more visible to the public because they get a better stand of natives. Larry Sorensen, Audubon County Secondary Road Superintendent/Roadside Manager/Shop Foreman, uses the 2-step method on steep slopes. For highly erosive steep slopes, Larry applies water, seed and tackifier to the planting site in the 1<sup>st</sup> step and waits until the ground dries before applying the 2<sup>nd</sup> step (water, mulch and tackifier). According to Larry, “Seed will run down slope if the ground is not dry before applying the second step.” Sherlyn Hazen, Roadside Manager for Buchanan County uses the 2-step method on highly traveled roadways to create a showy stand of natives for the public. Sherlyn’s background with working for a native seed nursery had taught her the importance of seed-to-soil contact was for native seed to germinate. Sherlyn noted, “I can see seed imbedded in the mulch with the 1-step method and not find any seed in the mulch with the 2-step method.” Jeff Chase, Des Moines County Roadside Manager had the most interesting variation of the 2-step method (see the Des Moines County vignette for more details). Jeff 1<sup>st</sup> broadcasts only forb seed onto the planting site for the 1<sup>st</sup> step, then he follows that up with hydroseeding a slurry consisting of water, only prairie grass seed and nurse crop seed, mulch, and tackifier for the 2<sup>nd</sup> step. Jeff noted, “We first tried this method using the drill and had a fantastic stand of forbs a few years later so we tried this method with the hydroseeder and also have had great success.”

Three counties hydroseed with the 3-step method (Appendix 3). As with the 1-step and 2-step methods, counties use the 3-step method in a variety of ROW projects. All three counties have a variation of the 3-step method. Joe Kooiker, Roadside Biologist for Story County uses the 3-step method for gateway projects with high visibility. Joe hydroseeds a slurry of water, prairie and nurse crop seed, and some mulch for the 1<sup>st</sup> step. Some mulch is used in the 1<sup>st</sup> step so the operator can see what has been seeded on the planting site. The site is allowed to dry and then the planting site is cultipacked for the 2<sup>nd</sup> step. It’s been Joe’s experience that cultipacking after applying seed with the hydroseeder improves seed-to-soil contact resulting in improved germination. The 3<sup>rd</sup> step involves hydroseeding a slurry of water, mulch, and tackifier to finish. Black Hawk County uses the 3-step method on larger planting sites. IRVM staff hydroseed a slurry of water, prairie and nurse crop seed for the 1<sup>st</sup> step. Straw is blown onto the site or a wood excelsior mat is stapled to the ground for the 2<sup>nd</sup> step. In the 3<sup>rd</sup> step, a slurry of water, mulch, and tackifier is hydroseeded over the straw to hold it in place. Black Hawk County

hydroseeded a demonstration plot on the campus of UNI using their 3-step approach. The site was hydroseeded in the fall on an erosive slope and the straw was still intact the following spring. Three years later, the site is a beautiful diverse stand of prairie plants. The only other county that indicated they use the 3-step hydroseeding method was Hardin County. Linn Reece, Hardin County Roadside Manager, uses 3-step hydroseeding for highly erodible sites. His 3-step method is almost identical to Black Hawk County's 3-step method except Linn adds mulch to the 1<sup>st</sup> step. Linn noted, "Straw has longer and stronger fibers than most mulches and when we apply our mulch and tackifier over the straw it creates a mat that acts like erosion control blankets."

Most counties do not change their hydroseeding methods based upon site characteristics and/or the season, rather, they change up seeding rates, nurse crops species, and mulch/tackifier to account for site and seasonal characteristics (see section 7 for further details). Five counties however, do use different hydroseeding methods based on site and/or season. Four of these counties switch from the 1-step method to the 2-step method if soils are dry, as with summer seeding projects, or if the sites have steep slopes. By switching to the 2-step method, they expect to improve seed-to-soil contact on the steep slopes and to preserve moisture for the seed in dry soils. One county, Linn, switches from the 2-step hydroseeding method to the 1-step method on sites that were previously seeded with only a cover crop. According to Rob Roman, Linn County Vegetation Management Specialist, "For ROW sites that are ready for seeding in mid to late-summer, it's not the best time to plant natives so we seed only a cover crop of winter wheat or winter rye to stabilize the soil. If there is not too much growth of those cover crops by fall and I feel confident that native seed will get good seed-to-soil contact, I will hydroseed into the established cover crop with only water and native seed using the 1-step method. We use this same hydroseeding method for dormant and frost seedings on other planting sites already vegetated if seed-to-soil contact of the natives can be achieved."

The amount of slurry (in gallons) required to hydroseed an acre of ROW varied by county and by hydroseeding method (Appendix 3). Mitchell County reported the lowest number of gallons (275) to hydroseed an acre with the 1-step method (without mulch). Webster County had the highest number of gallons (4,800) applied per acre with the 1-step method (32 bales of mulch included). Operator's manuals for both Bowie and Finn hydroseeding companies include suggested application rates (Bowie 2012, Finn 2012). The largest units –the Bowie 3,000 gallon and the Finn 3,300 gallon units cover approximately 1 acre per tank load with 30 bales of mulch

included. Both companies indicate that decreasing the mulch rate increases the area of coverage per tank load. While slurry volumes and mulch rates applied per acre varied among counties, all counties that included mulch in their hydroseeded plantings were within the range of slurry coverage recommended by the manufacturers. Counties that use the 2-step and/or 3-step method reported that the volume of slurry required to hydroseed 1 acre doubles from 1-step to the 2-step or 3-step methods (Appendix 3).

As with any method of seeding, it is important to know how much material (seed, fertilizer, mulch, and tackifier) is being applied to a planting site to ensure adequate application. The process to do this is called calibration. Counties were asked if they calibrate their hydroseeder. Many counties responded that they did not calibrate their hydroseeder, rather they used the recommendation of the dealer representative and/or operator's manual to determine how much ground area one load (or tank) covers. Based on that value, they simply adjusted the ground speed and application of the slurry according to the size of the planting site to insure adequate coverage. Joe Kooiker, Roadside Biologist for Story County, shed some light on hydroseeder calibration by indicating how he calibrated his hydroseeder. Kooiker explained that, "We went to a potential planting site with a walking wheel and installed wood lathes at regular intervals on the roadway. We calculated the area of the planting site, loaded up the hydroseeder with all the ingredients (except seed) and experimented with ground speed and slurry application between the lathes until I was satisfied with the mulch coverage. This is how I know how much area one load will cover with our hydroseeder."

The number of hydroseeder loads a county can apply in the ROW during an 8-hour day varied however, most counties indicated they averaged 4-8 loads per day. Those counties with larger tank capacity in their hydroseeders were able to apply 1000's of gallons more slurry in an eight hour day because they did not have to stop, refill and return to the planting site as often. It can be assumed that more slurry applied in a given day means more area planted in the ROW. Many counties noted that they could make more loads in a day if there were a water source nearby for filling. Two counties responded that they could double their loads per day if water was brought to the planting site or if there was a stream/lake near the planting site for filling with their trash pump. Typical water sources for filling hydroseeders are as follows: city maintenance shop, Secondary Road shop, COOP elevators, city water department, rural hydrants, nature center, chemical plant, stream/lake, county parks, fire department, concrete plant, city hydrant,

and a rock quarry. Counties often noted they received water from a 2” diameter discharge line at the filling locations.

Most counties use a crew of two for hydroseeding (hydroseeder operator, driver). A few counties use an additional one to two people for tenders. Black Hawk County had the largest crew size at six, including a water truck driver, hydroseeder operator and driver, mulch operator and driver and a tender for their 3-step hydroseeding method.

Nearly all counties indicated that they use the fan nozzle for most hydroseeding projects in ROWs. There was an even split of counties that use the wide and narrow fan types. Five counties indicated they prefer using a medium fan for most of their ROW seeding projects.

It seems obvious that the number of passes the hydroseeder makes on a given planting site would be the same as the hydroseeding method used for seeding the ROW. While many counties make one pass on the planting site to apply the slurry with the 1-pass hydroseeding method, many counties make two-three passes to apply the slurry. Black Hawk County makes two application passes on the planting site with the 1-pass method on wide ROWs to improve coverage of the slurry. Benton and Sac Counties make two application passes – one pass forward and one pass in reverse for the 1-step hydroseeding method. They noted that 2 application passes are needed to reduce the shadow effect created when hydroseeding ROWs. The hydroseeding shadow effect is simply areas on the planting site that are missed when the slurry is applied. The cause of hydroseeding shadow effect can be explained by the following - The profile of a typical ROW consists of a foreslope, bottom, and backslope. When hydroseeding slurry is applied in the ROW, from top of the hydroseeder on the top of the road, the angle of the slurry relative to ditch profile decreases from the backslope to the foreslope. When slurry is sprayed on the foreslope, small areas are missed (shadows) due to the narrow angle of application. As the operator applies slurry to the back of the ROW, on the backslope, the angle of slurry increases (relative to the ditch) and fewer shadows are created. Counties noted that applying the slurry going forward and then in reverse reduces the shadow effect and coverage of the slurry is improved.



## Section 5.

### Prairie Seed and Establishment

It's no secret that ROWs are subjected to extreme disturbances: periodic flooding, scouring by moving water, siltation, inputs of crushed road rock and salt, herbicide drift and/or intentional spraying, tillage, unauthorized mowing, disturbance from ATV's and snowmobiles, and illegal dumping and burning of garbage/brush. Prairie plants are what IRVM counties count on to withstand and overcome these extreme disturbances in the ROW. Hydroseeding adequate amounts and types of prairie seed are essential to maximize germination and establishment for a healthy long-lived native stand.

All counties surveyed for this report use prairie seed when hydroseeding ROWs. It appears that prairie seed from the Roadside Office at UNI is essential for county hydroseeding efforts; nearly 100% of counties surveyed have received prairie seed from UNI and most do not rely upon any other seed sources. Prairie seed that the Roadside Office has distributed to counties is entirely grant funded by Iowa DOT Transportation Enhancement (TE) Program. Kirk Henderson, State Roadside Specialist (retired) at UNI, noted that counties have received prairie seed from the TE program since 1998. Typical seed mixes have included up to 45 species (Henderson 2012). Counties that use prairie seed exclusively from the roadside office were asked, "Would your county continue to hydroseed natives if the prairie seed giveaway from the Roadside Office were discontinued?" They responded that they would continue to use prairie seed for hydroseeding, but with fewer species to reduce seed cost to their program.

Thirteen counties hydroseed with prairie seed from other sources. Ten of these counties hand and/or machine harvest seed from older native plantings, native production plots, and/or remnant prairies (see Story County vignette for more details). Eight of these counties purchase prairie seed from native seed nurseries and Pheasants Forever.

Seeding rates varied greatly among counties (Appendix 5). Seeding rates for natives ranged from 5.5 lbs/ac. of grasses and forbs to 70 lbs/ac. of only grasses (Appendix 5). While quantities of individual species was not known from the survey, many counties responded that they hydroseeded natives at the rate recommended by the Roadside Office at UNI. Native seeding rates recommended by the Roadside Office for 2009 TE seed include 52 seeds/ft<sup>2</sup> for grasses, and 96 seeds/ft<sup>2</sup> for forbs/legumes (Henderson 2012). Henderson noted that seeding rates of natives in the ROW's is based on slope (Smith et al. 2010). He notes that, "On level ground,

seeding rate can be 40 seeds/ft<sup>2</sup>, for 3:1 slopes seeding rate should be 60 seeds/ft<sup>2</sup> and on highly erosive 2:1 slopes the seeding rate should be at least 80 seeds/ft<sup>2</sup> (Smith et al. 2010).” It appears from county responses that native seed is hydroseeded at (or higher) than the recommended seeding rate.

Over half of the counties vary native seeding rates according to site characteristics, season, or landowner meddling when hydroseeding (Appendix 6). Counties tend to increase seeding rates of natives on sites with poor soils and/or steep slopes and a few counties increase seeding rates of forbs on highly visible sites. Fayette County for example, increases their native seeding rates for fall hydroseeded plantings. According to Jon Steege, Roadside Vegetation Manager for Fayette County, “We increase our native seeding rate for hydroseeding in fall because some seed is lost from weathering and erosion. We sometimes also have leftover seed at the end of the season from cleaning out the drill and/or from hand harvesting that we add to the hydroseeder for fall projects.” Linn County increases seeding rates of selected species based on planting site characteristics; wet species for wet ditches and increased dry species for dry, sandy ditches. Poweshiek County utilizes shorter native species on sites that are prone to snow drifting. Page County hydroseeds more grass seed and less forb seed on highly erosive sites, and more forb seed with fewer grass seeds on highly visible sites. Story County hydroseeds only cool-season, non-native seed on driveways, intersections, and shoulders because these areas are mowed frequently or have sight-distance issues. In addition, they seed only native grasses on sites that the county suspects the adjacent landowner might spray for weeds.

Counties observed differences in native plant establishment based on the season the site was hydroseeded but no clear patterns emerged. Some counties observed improved establishment of grasses and forbs in spring plantings while other counties observed increased establishment of grasses and forbs in fall plantings. A few counties observed improved establishment of only forbs in fall plantings while others observed improved establishment of only grasses in their spring or fall plantings. Both Mitchell and Page counties noted that fall native plantings developed faster than native plantings hydroseeded at other times. Mitchell County stated that establishment differences disappeared after 5 years. Jeff Chase, Des Moines County Roadside Manager noted, “I have observed that weather conditions in the month of hydroseeding determines success or failure the natives. I’ve have great native stands hydroseeded in May and poor native stands hydroseeded in May. If the conditions are hot and dry or too wet around the time the site is hydroseeded poor native plant establishment will result.”

## **Section 6.**

### **Planting Site Management**

Work done to prepare a good seedbed and managing vegetation after seeding, are both critical to prairie plant establishment. One roadside manager indicated that soil in some of their ditch cleanouts was so smooth, compacted, and dry that hydroseeding over the top of them was like hydroseeding over the top of my desk. ROW's can be a tough place for plants to get established from seed. Factors for failed plantings included: poor soil conditions, flooding, hot and dry soil, siltation, compaction, steep slope erosion, reed canarygrass taking over, seed washed away, and excessive shading from weeds. Under those circumstances, it was no surprise that most counties had some failed native plantings.

Site preparation prior to hydroseeding is common if equipment can be safely used. Many counties responded that they disk to break compacted soil. For smooth (non-compacted soil) with a few weeds, they use a harrow to scratch the soil. Some counties use a drag to break apart large clods and roughen the surface. A few counties will mow or burn the weed duff to improve seed-to-soil contact before hydroseeding. Webster County has the grading contractor roughen up the site after bulldozing. Grading contractors agree (under contract) to leave ROW sites seedable when the project is completed in Black Hawk County. Joe Kooiker, in Story County has convinced Secondary Roads staff to use the toothed bucket for ditch cleanouts instead of the smooth bucket, leaving divots on the slope. (see Story County vignette for more details).

Research has shown that mowing a native planting in the 1<sup>st</sup> growing season promotes native plant establishment and growth and reduces overwinter seedling mortality (Williams et al. 2007). Half of the counties do not mow their hydroseeded native plantings for the following reasons: the ditches are too steep for mower access, lack of manpower, and time constraints. However, half of the counties responded that while it was infrequent, if they could get a mower in the ditch they mow 1 – 3 times in the first growing season.

## Section 7.

### Erosion Control Products and Strategies

Erosion control is of great concern when hydroseeding in ROW's. The ditch is extremely vulnerable to soil erosion when not vegetated (bare soil). It's expensive to repair a ditch that has been damaged by excessive erosion. When a ROW project is completed and bare soil conditions exist, re-vegetating the site to stabilize the soil is the highest priority for the roadside manager. This chapter discusses the tools and techniques roadside manager's have at their disposal to quickly and permanently re-vegetate ROWs using the hydroseeder.

Roadside managers use nurse and cover crops extensively in hydroseeding ROW's (Appendix 7). Nurse and cover crops consists of annual or short-lived perennial grasses and cereal crops that typically germinate within 10 days and grow rapidly during a single growing season. They provide temporary cover to stabilize the soil until the permanent vegetation (natives) are established. A cover crop is planted without native seed (applied later) and a nurse crop is planted at the same time as native seeds. Typically, cover crops are used when it is not the ideal time to plant natives for example, in mid-summer when germination and growth of natives can be poor. Most counties include a nurse crop when hydroseeding natives (Appendix 7). Nurse crop species and quantities varied by county and by planting season (Appendix 7). Oats was the most common nurse crop used by counties followed by annual rye, winter rye, and winter wheat respectively (Appendix 7). Seeding rates (bushels/acre) for oats ranged from 1 – 5 bu/ac. but it was 1.5 and 2 bu/ac. that were the most used seeding rates for hydroseeding (Appendix 5). Seeding rates (lbs/ac) for annual rye ranged from 3 – 100 lbs/ac. Average seeding rate of annual rye was 40 lbs/ac. Fifteen counties responded that they use annual rye but only seven counties listed their annual rye application rate. Seeding rates (bushels/acre) for winter rye ranged from 0.1 – 4.0 bu/ac. Average seeding rate for winter rye was 1.4 bu/ac. Seeding rate (bushels/acre) for winter wheat ranged from 0.5 – 4 bu/ac. Average seeding rate for winter wheat was 2.0 bu/ac. See Appendix 7 for more information on the other nurse crop species that counties use for hydroseeding.

Over half of counties surveyed changed nurse crop species and seeding rates according to the season the site was hydroseeded (Appendix 7). Most counties hydroseed oats in the spring and a few counties also include annual rye and timothy. Counties diverged from their spring hydroseeded nurse crops of oats/annual rye to different nurse crops when summer hydroseeding. Six counties indicated they use winter wheat for mid to late summer hydroseeding. Jones

County adds hairy vetch and a little timothy with the winter wheat when summer hydroseeding. Linn County takes summer hydroseeding one step further by including slender wheatgrass with hairy vetch and winter wheat for their summer hydroseeding. Other nurse crops used for hydroseeding in summer included: grain sorghum, Piper Sudangrass, red clover, alfalfa, pearl millet and Japanese millet (Appendix 7). These nurse crops germinate and grow well in warm and drier soils. Most counties switched to winter rye or winter wheat for fall hydroseeding (Appendix 7).

Another tool roadside managers utilize to prevent soil erosion when hydroseeding ROWs is mulch. Nearly all counties include mulch when they hydroseeding although mulch brands, mulch blends and application rates vary (Appendix 4). Mulches contain three basic ingredients: wood fibers, cellulose (paper), and/or corn stover. Mulches can contain only one basic ingredient; 100% wood fibers, 100% paper, 100% corn stover; or multiple ingredients that are blended; 80:20, 70:20, or 50:50 of wood to paper or 80:20 and 70:30 of corn stover to paper. In addition, there are two specialty mulch types - Bonded Fiber Matrix (BFM) and Flexible Growth Matrix (FGM) that contain extra binding agents and water holding ingredients that manufacturers report creates a stronger mat and holds water longer than traditional mulches. A few counties use BFM and FGM mulches. Most counties reported that the mulch they currently use was determined by experimenting with other mulches they had used previously. Half of the counties prefer using single ingredient mulches and the other half prefer blended mulches (Appendix 8). Of the single ingredient mulches, 14 of 34 counties use 100% recycled paper mulches (Appendix 8). Counties reported that it creates a solid mat, can be applied in a thin coat as compared to other mulches, is easy to use or mix in the tank and can be carried over in the tank for the next day. They also noted these mulches support local recyclers, are reasonably priced as compared to other mulches plus, counties can get mulch as they need it from the local plant and don't have to store it at their own facilities. A few counties reported some problems with using 100% recycled paper; plastic contaminants get into the bale and plug the nozzle, bales can get hard if they sit around and are hard to break apart for mixing, and applying it too thick can suffocate the seed. A paper mulch mat doesn't hold as well as wood or wood blended mulches and can sometimes run on steep slopes. Counties that use blended mulches preferred wood-paper blends and a 70:30 blend was the most common (Appendix 8). Counties reported this mulch holds better in rain, lasts longer and binds tighter to the soil. They note improved coverage and spraying distance as compared to paper mulch and that the bales are easy to break apart when mixing. Counties reported increased stand establishment and that it works well with Flexterra

bales (Appendix 8). A few counties reported some problems with using 70:30 wood-paper blended mulch. The slurry can get foamy in the tank and it can clog the pump if too many bales are added. Wood-paper mulch needs to be broken apart by hand or added slowly in the bale chopper, otherwise the chopper will stop. It costs more to purchase wood-paper mulch than 100% paper mulches.

Mulch rates varied greatly among counties (Appendix 4). Mulch rates ranged from 0.5 – 40 bales/ac. The most common response of mulch rate was 30 bales/ac. and 32 bales/ac (Appendix 4). Many counties noted that instead of adding more bales in the tank to increase the mulch rate, they simply apply more mulch to sites that have steeper slopes and/or poor soils. A few counties responded that they varied mulch brands and rates based on site characteristics. Des Moines County responded with the most diverse utilization of different mulch brands and rates for hydroseeding (see Des Moines County vignette for more details). Des Moines County uses certain mulch brands and rates based on how erosive a ROW site is. For low erosion sites, they use a 50:50 wood-paper blend mulch with tackifier and apply 24 bales/ac. On more erosive sites, they add 100% wood fiber mulch with the wood-paper mulch and apply it at 32 bales/ac. For highly erosive sites they also include bonded fiber matrix (BFM) mulch to the other two mulches and apply it at 40 bales/ac. According to Jeff Chase, Roadside Manager for Des Moines County, “BFM is expensive but it creates a much stronger mat than the other mulches. In addition, BFM has zero cure time and holds over the winter. Three years ago we hydroseeded a very steep ditch with BFM and it there was a 6” rainfall event that night and the entire mat was still intact the next day. That is what sold me on using BFM.”

A third tool roadside managers utilize to prevent soil erosion when hydroseeding ROWs is tackifier. According to manufactures, tackifiers improve adhesion of the mulch to mulch fibers and mulch fibers to soil particles, creating a stronger mat more resistant to weathering. It also lubricates the slurry thereby improving mulch agitation and mulch delivery through the nozzle. A majority of the counties use a tackifier- either an add-in tackifier or one pre-blended in the mulch (Appendix 4). Tackifier brands varied by county and most responded that they use the recommended application rate listed on the label.

The final tool roadside managers commonly utilize to prevent soil erosion for ROW hydroseeding projects are straw and wood excelsior blankets (Appendix 9). On some hydroseeded projects, counties used the 2-step and 3-step hydroseeding methods when straw or wood excelsior blankets were used. Typically, these projects involved highly erodible sites.

Washington and Palo Alto counties use the 2-step hydroseeding method, first hydroseeding the site with a slurry that consists of prairie and nurse crop seed, mulch, and tackifier and finish by installing a wood excelsior blanket over the top for the 2<sup>nd</sup> step. Washington County noted that on a few projects, they substituted straw for wood excelsior blankets for the 2<sup>nd</sup> step and didn't crimp the straw. Audubon, Des Moines, and Story Counties use a 3-step hydroseeding method on some projects when using wood excelsior blankets. These counties first broadcast prairie and nurse crop seed on the site with a broadcast seeder, then they install the wood excelsior blanket for the 2<sup>nd</sup> step, and finish by hydroseeding over the blanket with a slurry that consists of some prairie and nurse crop seed, mulch, and tackifier. Black Hawk and Hardin Counties use the 3-step hydroseeding methods similar to the previous three counties but with a few differences. Hardin County and Black Hawk County hydroseeded some sites with a slurry that consists of prairie and nurse crop seed, and some mulch for the 1<sup>st</sup> step, applies straw to the site for the 2<sup>nd</sup> step, and finishes with hydroseeding over the straw with mulch and tackifier for the 3<sup>rd</sup> step. Black Hawk County noted that they don't use mulch in the 1<sup>st</sup> step.

Hydroseeded ROW site planted in 2008 in Hardin County, Iowa. Photo taken in June 2012.

## **Section 8.**

### **Worst Hydroseeding Experiences**

This section includes worst hydroseeding experiences that counties were willing to reveal. As is the case with most projects, we learn from our mistakes. A county starting a hydroseeding program is no exception. Consider that hydroseeders are very large and heavy pieces of equipment with many dangerous moving parts- all pulled (or carried) on soft, narrow gravel roads. Hydroseeder operators stand on top of the unit six to fifteen feet above the ground, on a platform slick with tackifier and mulch, applying the product while a driver moves forward, stops, goes into reverse and back again. Under these circumstances, it's no surprise that a few poor hydroseeding experiences have been recorded. Responses were organized into nine 'worst hydroseeding experiences' categories: weather related, items dropped into the tank, hydroseeding failures, potential personal injury, plugged unit, uh-oh, premature bragging, hydromulching in areas other than in ROWs, needing more hydroseeding practice. Respondents were promised anonymity for this section.

Weather related (4 counties) – All counties in this category noted that a heavy rainfall (7", 6", 4", 3") a day or two after hydroseeding sometimes meant having to go back and re-hydroseed the site.

Items dropped into the tank (4 counties) – Adding mulch into a hydroseeder tank is awkward. There is a small access hole on top of the unit. Staff has to crouch down to cut bale wrappings, break apart 50 lb. mulch bales and insert this material into the hole. Anything in their chest pockets, and/or worn on the hands and head are fair game. Note the plural form in responses – safety grasses, cell phones, gloves, plastic mulch bags, and utility knives have all been dropped into the tank. Counties noted that if the items go through the pump, they will always get hung up in the nozzle tip that results in mulch being spraying back at the operator. Items that don't go through the pump have to be fished out of the slurry or in the worst case, the slurry has to be dumped out to retrieve the items.

Hydroseeding failures (4 counties) – Counties noted that it's tough to get anything to grow when hydroseeding steep, rock hillsides or using seed more than 2 years old, or hydroseeding over snow and ice, or when the soil is loaded with giant ragweed seed.



Potential personal injury (5 counties) – A pin holds the tower gun to the standpipe. If the machine is turned on and the pump is engaged, an unpinned gun will fly off the stand pipe creating an “Old Faithful” geyser of mulch. One county reported that a grown man standing near the hydroseeder was knocked to the floor by the flying mulch. Another county responded that the geyser created a huge mess on the shop floor that took some time to clean up. Another county warned about being careful when adding dry powder tackifier in the tank. They noted that tackifier burns bad if it gets into your eyes. Another county urged caution when pouring gas into a hot trash pump. Their spilled gas ignited. One county was operating the tower gun on a narrow roadway and two semis passed the hydroseeder at the same time almost knocking him off the hydroseeder. Note, real injuries could have resulted from these incidents, but no serious injuries were reported in these experiences.

Plugged unit (13 counties) – There were 13 ways to plug a hydroseeder! Words of hydroseeder pluggin’ wisdom from 13 counties – Don’t take too long of lunch, always run the agitator when operating, don’t add too much mulch, don’t drop a mulch bag in the tank, check 100% recycled newspaper bales for non-newspaper items; like large chunks of plastic, and car keys given away as a promotion. Also, don’t operate a hydroseeder facing down a steep hill. An interesting side note from the plugging responses. Quote, “We call our auxiliary hose the “Black Mamba”. Plug the black mamba and it will weigh 500 lbs.”

Uh-oh (3 counties) – One county lost a 50lb mulch bale from atop the hydroseeder while travelling down the highway. The bale hit a bridge abutment and it exploded. Another county pulled their hydroseeder with an old vehicle that leaked transmission fluid. It was a hot day and some of the fluid leaked onto the hot exhaust manifold and the engine caught on fire. They had a fire extinguisher handy and prevented the vehicle from burning up. Another county had the emergency breakaway trailer brake system activate and locked the wheels on the hydroseeder driving down the highway going 55 mph. Another county had the drain plate on the bottom of a full 1500 gallon tank of hydromulch disconnect while traveling down the highway. They saw the green trail left on the roadway, pulled over and were able to reconnect the drain plug.

Premature bragging (1 county) – Touting to the supervisors and engineer that a new native hydroseeded planting will be beautiful in three years was a bad idea. Quote, “I took so much grief on this planting. Three years later, I had to spray it out and replant because it

developed into a production plot of musk and Canada thistles.” His advice was to brag about a successful native planting only *after* it has become a successful native planting.

Hydromulching in areas other than in ROWs (5 counties) – Two counties accidentally sprayed hydromulch into the interiors of other nearby vehicles. This can happen if the pump is left on before starting the machine. Two counties admitted that they accidentally sprayed themselves. This happened when the operator hit the safety railing with the hydromulch stream and the hydromulch ricocheted back or by standing near the auxiliary hose (hose valve left on) while engaging the pump. Hydroseeder drivers have also been accidentally sprayed with hydromulch. Two things have to happen here: the window has to be down in the vehicle and it has to be windy enough to blow hydromulch back into the cab.

Do it again (2 counties) – Two counties responded that they hydroseeded ROW projects after grading was completed. Soon after, they had to re-hydroseed those projects because the shoulders had to be reshaped. One project was a 6.5 mile re-grade.

Hydroseeded ROW site planted in 2002 in Story County, Iowa. Photo taken in June 2012.

## Section 9.

### Tricks of the trade

This section includes hydroseeding advice counties felt was important to contribute to hydroseeding natives. Many counties noted that most of what they learned about hydroseeding was from experimentation and trial and error. Their advice includes do's and don'ts and recommendations that cover a wide range of topics.

General Quotes – *‘To determine the best hydroseeding techniques for you and your machine, experiment with different hydroseeding methods and mulches, and assess the plantings; Hydroseeding is “hands on”, the more you hydroseed the more you will get a feel for how much seed and mulch to use; Drill if the site can be drilled and hydroseed the site if it can't be drilled; Bring rubber boots and hand rakes along to hand seed areas you can't get with the hydroseeder; Hydroseeding does not prevent soil erosion; Take your time hydroseeding – it can be dangerous with traffic and climbing on/off the machine; Use a driver that doesn't slam on the brakes; Always seed heavy in the ROW because conditions are harsh’.*

Equipment and Maintenance – A number of counties recommended purchasing the largest hydroseeder possible- the larger the unit, the more area that can be hydroseeded in a day. Larger units do require staging areas for mulch or an extra truck to haul mulch to the planting site; Get the lightest trash pump possible to save effort when hauling it to the water source; Share a hydroseeder with an adjacent county- make an agreement that one county does the maintenance and the other county pays for parts; Thoroughly clean the tank at the end of each day, otherwise, mulch will plug the lines that will require much more time unplugging the unit.

Water for filling - One county claimed filling the unit with a trash pump from a stream/lake took more time than filling at the nearest hydrant, while another county claimed that filling with a trash pump at a stream or lake saved time; One county recommended finding as many filling locations throughout the county as possible and record them on a map so the hydroseeding crew can fill at a location nearest to the planting site; Two counties send a water truck to the planting site to save on travel time between filling tanks.

Mulch – Mulch in the slurry helps seed stay in suspension in the tank and improves even distribution when applied to the site. Most of the seed in the tank will be sprayed out in the first ¼ of the tank if no mulch is added; Adding too much mulch in the tank makes slurry too thick and hard to spread; Mulch applied too thick on the planting site makes it hard for seed to grow

through; Use enough mulch to keep seed in place long enough for it to grow and stabilize the soil; BFM and FGM mulch types require more water to be applied, are harder to mix and pump through the machine, and don't shoot as far as wood or paper mulches; Adding a green dye in the tank if the mulch is not colored improves detection of where the mulch is applied on the ground.

Mixing – Keep forbs and grasses separate, mix all forbs together and mix all grasses together so each can be easily measured out for every planting site; Premix seed and put bales and seed on the tailgate before adding in the tank so you don't lose count of the bales and/or lose track of the seed, premixing seed before going to the planting site saves time in the field; To easily remove mulch from the bag - cut an 'X' on top of the bag and cut a slit down the side. Add Guar Gum (tackifier) slowly in the tank otherwise 'fish eyes' will shoot out of the nozzle. Fish eyes form in the tank if the tackifier is added too quickly and doesn't get mixed thoroughly.

Improve establishment – Scuff up smooth ground to get better seed-to-soil contact; Rolling (cultipacking) the site after hydroseeding improves seed-to-soil contact; Blasting seed into the soil improves seed-to-soil contact; Use the fire hose nozzle to blast seed into the soil on slopes; Covering the site with straw after hydroseeding improves stand establishment; Hydroseeding onto wet soil improves germination; Have the soil tested for extreme sites and use soil amendments and fertilizer if needed; Summer plantings take more site preparation and hydroseeding effort to promote establishment of the natives. Leave those sites fallow till fall - mow the weeds, harrow the site, then hydroseed.

Communication – Establish good communication with other departments so you can hydroseed sites soon after completion of road construction projects and ditch cleanouts so that they don't get too weedy; Make sure that the hydroseeding crew knows what they need to do and why to create good crew dynamics; Have good communication between operator and driver.

Weather/Site conditions – Hydroseeding in excessively hot and dry conditions dries the mulch too fast and results in poor establishment; Use the wind to achieve distance for some sites; Don't hydroseed in excessive winds; Pay attention to the weather before hydroseeding a site, the best time to hydroseed is after a rainstorm when the soil is moist and the mulch will hold that moisture longer for seed to germinate and establish. Do not hydroseed if rain is predicted a day or two before.

Hydroseeder's other uses – One county tried using the hydroseeder for ditch burning and foliar brush spraying. They added extra plumbing and attached a high pressure sprayer to the

hydroseeder and found it didn't work well because water delivery was too high - making burning and spraying more difficult.

Hydroseeded ROW site planted in the early 1990s in Des Moines County, Iowa. Photo taken in June 2012.

## Section 10

### General Summary

- Forty-four of 48 IRVM counties that hydroseed participated in the survey.
- Most of the respondents had operated a hydroseeder.
- Most counties own either a Bowie or Finn hydroseeder.
- Most hydroseeder tank capacities were between 750 – 1800 gallons
- Most common addition to a factory unit were a hose reel and additional hose
- Hydroseeding can be used throughout the year if temperatures are above freezing and there is no snow in the ROW.
- Spring and fall were the most preferred seasons to hydroseed.
- Most counties preferred not to hydroseed in rain or high winds.
- Counties preferred bare, moist and loose soil to hydroseed into.
- Three hydroseeding methods were identified (1-step, 2-step, and 3-step).
- Nearly all counties use 1-step hydroseeding.
- Most counties include: water, native and nurse crop seed, mulch, and tackifier for 1-step hydroseeding.
- Nearly half of the counties use multiple hydroseeding methods (1 and 2-step or 1 and 3-step).
- Three counties use the 3-step hydroseeding method.
- Most counties applied slurry volumes according to manufacturers recommendations.
- Hydroseeders with larger tank capacities typically could seed more area in a day.
- Wide and narrow fan types were the most used nozzles to hydroseed ROWs.
- Many counties make 2 application passes on a planting site to get better coverage and reduce shadow.
- Most counties rely on getting their native seed from the Roadside Office at UNI.
- Most counties hydroseed native seed at a rate that meets or exceeds recommended seeding rates.
- Many counties apply more slurry that increase native seed and nurse crop seed for steep slopes and poor soils.
- Counties have observed that hydroseeded plantings take longer to develop than plantings that were drilled.

- If equipment access into the ROW is possible, many counties will condition the soil by harrowing to improve conditions for mulch and seed to hold and grow.
- Most counties include cover or nurse crops when hydroseeding ROWs to stabilize the soil.
- Half of the counties change nurse crop species according to season of the hydroseeding project.
- Half of the counties use non-blended mulch and the other half use blended mulch.
- Many counties apply more mulch to an erosive site rather than adding extra bales in the tank.
- Most counties use a tackifier to create a stronger mat more resistant to weathering.
- Other erosion control products like wood excelsior mats and straw were used with hydroseeding on highly erodible sites.
- Heavy rainfall events will occur and some sites will have to be re-hydroseeded.
- Dropping something into the tank other than seed, mulch, and tackifier will plug the unit.
- Disengage the pump before starting the machine.
- Make sure the pin is in the tower gun before engaging the pump.
- Secure loose bales to prevent them from flying out.
- Clean the unit out at the end of the day.
- Read section 9 of this report carefully.
- Natives that established in ROWs from hydroseeding and were subjected to severe flooding, erosion and/or landowner disturbances have persisted.
- An average of 94% of all ditch cleanouts were hydroseeded in IRVM counties visited.
- An average of 67% of all ROW seeding projects were hydroseeded in IRVM counties visited.
- Nearly all ROW hydroseeded plantings that were assessed had native plant cover of 50% or greater.
- Most species that were included in the native seed mix were detected in assessed hydroseeded plantings.
- All assessed hydroseeded plantings contained additional native species that were not included in the seed mix.
- Adding more native species in the seed mix could result in a more diverse stand of natives.

## **Section 11.**

### **County Visit Introduction**

This section includes detailed hydroseeding information from site visits of ten different IRVM counties that hydroseed natives. Selection of the ten counties was based on two criteria: hydroseeding method response from the telephone survey, and county location in Iowa. The goal was to get the 10 most diverse hydroseeding methods in the most diverse locations in Iowa. Results from the telephone survey identified 3 distinct hydroseeding methods (1-step, 2-step, and 3-step) with variations within each step. All hydroseeding methods and many variations of those methods were included in the 10 counties selected for site visits (Appendix 2, Appendix 10). While a few counties represent the four corners of Iowa, most of the counties selected for site visits were located in Northern Iowa. This was due to a concentration of IRVM counties in Northern Iowa that utilized unique hydroseeding methods with distinct variations that were needed for this project.

The primary goal of the site visit was to document native plant establishment in ROW plantings that were hydroseeded with different hydroseeding methods. As a part of vegetation assessment, we requested each county provided two hydroseeded plantings (Appendix 11). The first planting was to be approximately 5-7 years old, hydroseeded with the method they indicated on the survey, and seeded with native seed provided by the Roadside Office at UNI. These criteria enabled us to compare hydroseeded plantings among counties of similar age and seeded with similar types of native species. Sampling for the first planting included: a walking plant survey of the entire planting site and nine 0.25 m<sup>2</sup> quadrat samples taken at selected locations. Three sample locations were selected for quadrat sampling. Each sampling location included three quadrat samples (foreslope, bottom, backslope). Some plantings had only ditch bottoms that were seeded so three evenly spaced samples were taken at each location. All species (native and non-native) were identified within the quadrat and their overhead cover was estimated. Due to extreme variability of vegetation the ROW, quadrat sampling was conducted in parts of the planting that had a preponderance of established native vegetation. The second hydroseeded planting that we visited and assessed was chosen by the county. The only criteria requested for the second planting was that it had been hydroseeded. This was an opportunity for the county to show us one of their best hydroseeded plantings. Vegetation assessment for the second planting included only a walking plant survey. Some counties used a different hydroseeding method for their second planting and it was noted in their vignette. See (Appendix 12 and Appendix 13) for



a complete listing of all plant species; all sedges and rushes detected in the assessed hydroseeded ROW plantings. Note that this project assessed only native plant establishment and not soil erosion.

Hydroseeded ROW site planted in fall 2009 in Cerro Gordo County, Iowa. Photo taken in June 2012.

## Section 11a.

### County Vignettes (1-Step Hydroseeding)

#### Mitchell County (1-Step Hydroseeding)

##### MITCHELL COUNTY IRVM

- Natural Resource Technician/Roadside Manager – Andy Taets
- Length of service with Mitchell County – 4 years
- Hydroseeder Brand – Finn
- Purchased New - 2002
- Tank Capacity - 500 gallons
- Factory frame and trailer unit



##### IRVM/Hydroseeding History

Andy Taets

Andy Taets is the Natural Resource Technician for Mitchell County Conservation Board and he also serves as Roadside Manager for Mitchell County. His office is at the Mitchell County Nature Center in Osage, Iowa. Andy's supervisor is the Director of the Mitchell County Conservation Board. County Conservation Board staff assists Andy with Hydroseeding.

IRVM in Mitchell County began back in the late 1980s. Mitchell County started hydroseeding in 2002. According to Taets, "Jim Doidge initiated hydroseeding in Mitchell County ROWs with a unit that was funded by the Living Roadway Trust Fund in 2002."

Seeding in Mitchell County ROWs is unique as compared to other IRVM counties. Typically IRVM staff has the option to use different seeding methods (no-till drilling, broadcast seeding, hydroseeding) to seed their county ROWs. In Mitchell County, the Conservation Board is only responsible for hydroseeding county ROWs. Taets noted, "If the seeding project requires another type of seeding, such as drilling, the county engineer will contract that out."

##### Hydroseeding Techniques

The 1-Step hydroseeding method is the primary technique Mitchell County uses to hydroseed ROWs (See inset box for a description of this method). The following is a synopsis of an interview segment with Andy Taets on this topic.

## MITCHELL COUNTY HYDROSEEDING TECHNIQUE

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed only (Mulch and Tackifier not used)

Total gallons applied per acre – 278 gallons

According to Taets, “Jim Doidge used the 1-step method without mulch and tackifier so I was trained to use the same technique. Jim did try using mulch on an early hydroseeding project but had problems with the machine clogging so he left the mulch and tackifier out of the mix on subsequent hydroseeded projects. Most of our hydroseeding projects are done in the fall because we are short staffed in the spring.”

Mitchell County includes oats as a nurse crop with native seed to stabilize the soil (see insert text box).

## MITCHELL COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING

- Include a nurse crop with the prairie seed  
Oats @ 25lbs/ac.

### Seed Harvesting/Storage

Mitchell County does not harvest prairie seed for use in hydroseeded ROW projects. All prairie seed used for Mitchell County ROWs comes from the IRVM Roadside Office at UNI. Prairie seed is stored on a small shelf unit in a shop bay connected to the Mitchell County Nature Center.

### Plantings Visited

The 1<sup>st</sup> site we visited was a ditch cleanout, hydroseeded in the spring of 2007 (Figure 1). The planting has not been burned. Native cover for the entire site was estimated at 50% - 75% (Appendix 14). A walking plant survey produced 46 native species and 17 exotic (non-native) species (Appendix 15). All prairie plant guilds (warm-season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 15). Quadrat data showed species richness

averaged 5.4 native species and 1.9 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 75% and 16% respectively (Appendix 14).

The 2<sup>nd</sup> planting was one of the first hydroseeded plantings in Mitchell County (Figure 2). Andy noted, “I’m not exactly sure when Jim Doidge seeded this site but I would guess it was sometime after getting the new hydroseeder in 2002.” It is not known if the site had been burned after seeding. We observed that smooth brome was prominent near the top of the foreslope and backslope so we suspect that the site was an old ditch cleanout. What impressed us with this planting was finding leadplant-*Amorpha canescens*, and prairie dropseed -*Sporobolus heterolepis*. Both species are very difficult to get established in a prairie planting. Finding lots of leadplant and prairie dropseed in the planting was a real treat!



Figure 1. First assessed hydroseeded ROW site in Mitchell Co.



Figure 2. Second assessed hydroseeded planting in Mitchell Co.

# Montgomery County (1-Step Hydroseeding)

## MONTGOMERY COUNTY IRVM

- Current Roadside Manager – Damien Bond
- Length of service with Montgomery County – 18 years
- Hydroseeder Brand – Bowie
- Shares unit with Page county since 1998
- Tank Capacity - 800 gallons
- Factory frame and trailer unit



## IRVM/Hydroseeding History

Damien Bond

Damien Bond is the Roadside Manager in Montgomery County. His office is at the Montgomery County Secondary Roads building in Red Oak, Iowa. Damien’s supervisor is the Montgomery County Engineer. The roadside program in Montgomery County currently has 2 full time employees.

Hydroseeding was not used in Montgomery County prior to adopting the IRVM program. According to Bond, “I started hydroseeding for the Montgomery County back in 1998 with a hydroseeder we shared with Page County. Page County Conservation Board staff initially showed me how to operate the machine and how much seed to use. We may have seeded too heavy on those first few hydroseeding projects, so we scaled back the seeding rate on subsequent hydroseeding projects and still get a good stand of natives. Sharing the unit with Page County has worked well for both counties. We do maintenance on the unit and Page County pays for the parts.”

## Hydroseeding Techniques

The 1-Step hydroseeding method is the primary technique Montgomery County uses to hydroseed ROWs (See inset box for a description of this method). The following is a synopsis of an interview segment with Damien Bond on this topic.

### MONTGOMERY COUNTY HYDROSEEDING TECHNIQUES

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch

(32 bales/ac) + Tackifier

Total gallons applied per acre – 3,200 gallons

According to Bond, “We hydroseed using the 1-step method. I tried the 2-step method on a few projects but didn’t notice really much difference in establishment although I probably didn’t use the 2-step enough times to really determine how well it worked.” The last few years about 90 % of the total ROW seedings in the county were hydroseeded. Bond noted, “The total amount of hydroseeding we do each year really changes from year-to-year. The last couple of years we had a lot of flooding, creating smaller areas scattered around the county that had to be seeded. It was faster and more efficient to hydroseed those areas rather than hauling around our other seeding equipment. Typically 30% - 50% of the total ROW seeding projects in the county is hydroseeded.”

Montgomery County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). For steep slopes they increase the tackifier rate in each load to improve adhesion of the mulch. Damien uses 100% wood fiber mulch that he believes sticks better to the soil than paper or corn stover mulches. He also applies a thicker layer of mulch on steep slopes to eliminate any exposed soil. Damien recommends applying the hydromulch with the fan nozzle to reduce mulch runs on the slopes. To stabilize the soil, a fast growing nurse crop of oats is seeded with the natives.

**MONTGOMERY COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING**

- Increase tackifier rate/load
- Apply more mulch (100% wood fiber) on steep slopes
- Use a fan nozzle to reduce mulch runs down the slope
- Includes a nurse crop with the prairie seed  
Oats @ 100 - 150lbs/ac.

Seed Harvesting/Storage

Montgomery County does not harvest prairie seed for use in hydroseeded ROW projects. The county receives prairie seed from the IRVM Roadside Office at UNI. They also have purchased prairie seed from Custom Seed in Walnut, Iowa. Prairie seed is stored in a non air-conditioned cement block storage building.

## Plantings Visited

The 1<sup>st</sup> site we visited was remarkable. The county replaced a box culvert in the ditch bottom of a ravine directly adjacent to the road. The foreslope was nearly a 1:1 slope that extended at least 40' to the bottom of the ditch (Figure 1). According to Damien, "We had to use the jet nozzle on this site because the back of the ROW was so far away." The site was hydroseeded in fall 2007 with the diversity mix from the IRVM roadside office at UNI. The site has not been burned. Native cover for the entire site was estimated at 50% - 75% (Appendix 14). A walking plant survey produced 36 native species and 22 exotic (non-native) species (Appendix 16). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 16). Quadrat sampling revealed species richness averaged 5.2 native species and 2.3 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 84% and 14% respectively (Appendix 14). Native plant establishment was remarkable at this site given the excessively steep slopes.

The 2<sup>nd</sup> planting we visited was the first hydroseeding planting in Montgomery County (Figure 2). Damien noted, "We hydroseeded in spring of 1998 with seed from the IRVM Roadside Office at UNI. Slopes were burned in 2007 and 2009." Native plant establishment at this site was very impressive with over 75% native cover.



Figure 1. First assessed hydroseeded ROW site in Montgomery Co.



Figure 2. Second assessed ROW hydroseeded site in Montgomery Co.

## Pocahontas County (1-Step Hydroseeding)

### POCAHONTAS COUNTY IRVM

- Current Roadside Manager – Aaron Samuelson
- Length of service with Pocahontas County – 10 years
- Hydroseeder Brand – Finn
- Purchased New – 1997
- Tank Capacity - 500 gallons
- Factory frame and trailer unit



### IRVM/Hydroseeding History

Aaron Samuelson

Aaron Samuelson is the current Roadside Manager in Pocahontas County. His office is in the Pocahontas County Conservation Board building in Pocahontas, Iowa. Aaron’s supervisor is the Director of Pocahontas County Conservation Board (CCB). The roadside program in Pocahontas County has 1 full-time employee (Aaron), and a handful of seasonal employees. Secondary road employees and Pocahontas CCB staff assist on selected ROW projects.

Pocahontas County did not hydroseeded ROWs prior to adopting the IRVM program. According to Samuelson, “The IRVM program was started in Pochahontas County in 1994 and hydroseeding started sometime after the purchase of the hydroseeder unit in 1997. Our hydroseeder was funded by the Living Roadway Trust Fund and is the same unit we use today.”

### Hydroseeding Techniques

Pocahontas County primarily utilizes a 1-step hydroseeding technique. It has emerged as an important technique for many Pocahontas County ROW seedings- especially where there are concerns about soil erosion. (See inset box for a description of the 1-step method). The following is a synopsis of an interview segment with Aaron Samuelson on this topic:

“The 1-step hydroseeding method I use was handed off to me by previous roadside managers here in the county, noted Samuelson. “Hydroseeding makes up about 50% of the total seeding projects in our ROWs and 100% of our ditch cleanouts. Hydroseeding small ditch cleanouts is a lot easier than hauling around the drill. When the cleanouts get to be a ¼ mile long, I’ll drill the ditch bottoms and hydroseed the slopes.”



**POCAHONTAS COUNTY HYDROSEEDING TECHNIQUES**

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(32 bales/ac), no tackifier  
Total gallons applied per acre – 4,000 gallons

Pocahontas County employs a number of specific strategies to reduce soil erosion while hydroseeding (see insert box). Mulch is included for all hydroseeded projects. For very steep slopes, a tackifier is added to the slurry to increase bonding of the mulch- and applying more mulch to the site eliminates any exposed soil. Aaron noted, "Sometimes we make 2 passes with the hydroseeder to get more mulch on the site to insure good coverage." Oats are added as a nurse crop with the natives to all hydroseeded plantings in Pocahontas County.

**POCAHONTAS COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING**

- Apply mulch (70% corn stover, 30% recycled newspaper)
- Apply more mulch to the site
- Add tackifier on steep slopes
- Include nurse crop with the prairie seed  
Oats @ 48lbs/ac.

Seed Harvesting/Storage

Pocahontas County does harvest prairie seed for use in hydroseeded ROW projects. They deliver a prairie program to area schools each year where students' hand collect forb seed that is used in ROW plantings. Most of the prairie seed used in Pocahontas County ROW plantings however, comes from the IRVM Roadside Office at UNI. The county stores their prairie seed in an air-conditioned, mouse proofed, insulated room inside a large metal building.

Plantings Visited

The 1<sup>st</sup> site we visited was a ditch cleanout (Figure 1). Total native cover for the site was estimated to be 50% - 75% (Appendix 14). A walking plant survey produced 38 native species and 14 exotic (non-native) species (Appendix 17). Most prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 17).

Quadrat data showed species richness averaged 5.4 native species and 2.9 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 78% and 18% respectively (Appendix 14). Aaron noted that they mowed in July the 1<sup>st</sup> and 2<sup>nd</sup> growing season to control weeds. The planting has not been burned. What impressed us with this planting was the number of forbs in bloom. The ditches were full of blooming purple prairie clover-*Dalea purpurea* and yellow coneflower-*Ratibida pinnata* in spite of having a severe drought that summer.

The 2<sup>nd</sup> site we visited was Aaron's first hydroseeded planting with Pocahontas County back in 2001 (Figure 2). The site was a ditch cleanout; the landowner had seeded natives that they acquired on their own. Sometime after seeding, the ditch was sprayed for Canada thistle and ragweed, unfortunately destroying pumpkin vines the landowner had planted near the back of the ditch. According to Aaron, "To make things right with the landowner, we reseeded the ditch with the hydroseeder and included extra forb seed in with the prairie mix." It was clear when walking through the planting that extra forb seed had been added -the majority of the native cover at the site was forbs.



Figure 1. First assessed hydroseeded ROW site in Pocahontas Co.



Figure 2. Second assessed hydroseeded ROW site in Pocahontas Co.

## Sac County (1-Step Hydroseeding)

### SAC COUNTY IRVM

- Current Roadside Manager – Sean O’Neill
- Length of service with Sac County – 22 years
- Hydroseeder Brand – Bowie
- Purchased New – 2002
- Tank Capacity - 1,500 gallons
- Skid unit mounted to a trailer



### IRVM/Hydroseeding History

Sean O’Neill

Sean O’Neill was the first Roadside Manager in Sac County and continues in that role today. His office is at the Sac County Conservation Center in Sac City, Iowa. Sean’s supervisor is the Board of Supervisors for Sac County. The roadside program in Sac County currently has 1 full time employee (Sean) and 5 seasonal employees.

Sac County Secondary Roads Department hydroseeded their ROWs prior to adopting the IRVM Program. According to O’Neill, “ Sac County Secondary Roads staff hydroseeded county ROWs back in the early 1970s with an old Bowie Imperial. At that time, they only hydroseeded with non-native pasture mixes. When I first started working for the county, I didn’t have the personnel to help me haul and operate the hydroseeder so I primarily used the drill to seed ROWs. In the early 1990s, the county hired a new secondary road foreman who found me a lowboy trailer to pull the unit around and loaned me a driver from secondary roads to help me hydroseed natives in Sac County ROWs. Unfortunately, the trailer was also needed for hauling other equipment around for secondary road projects so we were constantly loading and unloading the hydroseeder from the trailer when we needed to hydroseed. It was a real hassle so the road foreman found me another trailer, an old army surplus trailer that we currently share with secondary roads. It’s worked well for us - we get to use the trailer exclusively for hydroseeding during the seeding seasons and the road department uses the trailer in the winter

for a brine tank. Frequent plugging was a problem with the old unit so we traded it off for a new hydroseeder in 2002 that was funded by the Living Roadway Trust Fund.”

### Hydroseeding Techniques

The 1-Step hydroseeding method is the primary technique Sac County uses to hydroseed ROWs (See inset box for a description of this method). The following is a synopsis of an interview segment with Sean O’Neill on this topic.

#### SAC COUNTY HYDROSEEDING TECHNIQUES

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(10 bales/ac), no tackifier is used  
Total gallons applied per acre – 3,400 gallons

According to O’Neill, “We hydroseed using the 1-step method using a low rate of mulch and no tackifier. This was the hydroseeding technique that the county used prior to my working here so I have continued with the technique and have had a lot of success. Typically 95% - 100% of the seeding we do in the ROWs is hydroseeded. In the past, the county did more road re-grading (which we drilled) so we didn’t hydroseed as much. In the last few years, most ROW projects are ditch cleanouts, culvert and bridge replacements that are easier and more efficient to hydroseed. Getting the drill into these sites to seed would be difficult and we could hydroseed the next day even if it rained the night before.”

Sac County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). For steep slopes they apply more mulch to create a thicker layer of cover and eliminate any exposed soil. Sean also has the grading operator leave the site rough to better hold seed and mulch. Sean includes oats as a nurse crop with the natives when hydroseeding and will increase the seeding rate of oats for more erosive sites.

#### SAC COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING

- Have the grading operator leave the site rough
- Apply more mulch (100% recycled newspaper) on steep slopes
- Use a fan nozzle to reduce mulch runs down the slope
- Increase the nurse crop seeding rate with the prairie seed  
Oats @ 50lbs/ac.

### Seed Harvesting/Storage

Sac County does harvest prairie seed for use in hydroseeded ROW projects. They harvest seed from an older 14 acre prairie planting (Figure 2). Sean uses a flail vac to harvest prairie seed. They also receive prairie seed from the IRVM Roadside Office at UNI and have purchased prairie seed from commercial vendors. The county stores their prairie seed in a non air-conditioned, mouse proofed wire enclosure located inside a large metal building.

### Plantings Visited

The 1<sup>st</sup> site we visited was a ditch cleanout and was hydroseeded in mid-May 2007 (Figure 1). The planting has not been burned. Native cover for the entire site was estimated to be over 75% (Appendix 14). A walking plant survey produced 36 native species and 10 exotic (non-native) species (Appendix 18). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 18). Quadrat data showed species richness averaged 5.0 native species and 1.5 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 90% and 10% respectively (Appendix 14). Natives were lush in this planting as compared to most other plantings we visited. It may have been due to more moisture available to the plants but in any case the natives had formed a closed canopy that appeared to suppress weeds. This may be why we detected so few non-native species in the quadrat sampling.

The 2<sup>nd</sup> planting site was in a low area adjacent to a wooded area with a creek nearby. The site was completely vegetated, however, reed canarygrass- *Phalaris arundinacea*, and smooth brome-*Bromus inermis* was a significant part of the grass component of the vegetation. The site had less than 50% cover of natives. Sean noted that the site had flooded multiple times a few years after they hydroseeded.



Figure 1. First assessed hydroseeded ROW site in Sac County.



Figure 2. Sac County site used for harvesting native seed for hydroseeding.

## Section 11b.

### County Vignettes (2-Step Hydroseeding)

#### Buchanan County (2-Step Hydroseeding)

##### BUCHANAN COUNTY IRVM

- Current Roadside Manager – Sherlyn Hazen
- Length of service with Buchanan County – 7 years
- Hydroseeder Brand – Finn
- Purchased New – 1998
- Tank Capacity - 1,000 gallons
- Skid unit frame mounted to tandem axle Ford 8000



Sherlyn Hazen

##### IRVM/Hydroseeding History

Sherlyn Hazen is the Roadside Manager in Buchanan County. Her office is in the Buchanan County Secondary Road Department building in Independence, Iowa. The IRVM roadside program is its own department with the county system and Sherlyn's supervisor is the Board of Supervisors for Buchanan County. The roadside program in Buchanan County currently has 1 full-time employee (Sherlyn), and two seasonal employees.

Buchanan County did not hydroseeded ROWs prior to adopting the IRVM program. The previous roadside manager, Greg Schmitt initiated hydroseeding in Buchanan County in 1998 when the hydroseeder was purchased. According to Hazen, "We acquired our hydroseeder using Living Roadway Trust Fund and we still use that same equipment in the field today."

##### Hydroseeding Techniques

While most hydroseeding projects are completed using the 1-step method, Buchanan County considers the 2-step method as an important technique to address specific site issues in Buchanan County ROW seedings. The following is a synopsis of an interview segment with Sherlyn Hazen on this topic.

Buchanan County utilizes two hydroseeding techniques on a regular basis. (See inset box for a description of these methods). Hazen noted, “I use the 1-step method for most hydroseeding projects because it’s easier and faster than hauling around our other seeding equipment. I use the 2-step hydroseeding method on heavier traveled roads. When I worked for Feder’s Seed Company, I learned how important seed-to-soil contact is for planting prairie seed. Seed-to-soil contact is much improved when hydroseeding with the 2-step method as compared to the 1-step method. You can see the seed imbedded in the mulch with the 1-step method and not find any seed in the mulch with the 2-step method.”

**BUCHANAN COUNTY HYDROSEEDING TECHNIQUES**

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(8 bales/ac.), No Tackifier  
Total gallons applied per acre – 1,250 gallons

**2-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed; **2<sup>nd</sup> Step** –  
Water + Mulch (8 bales/ac), No Tackifier  
Total gallons applied per acre – 2,500 gallons

Buchanan County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). Mulch is included for all hydroseeded projects. For steep slopes, a thicker layer of mulch is applied on those slopes to eliminate any exposed soil. Sherlyn noted, “To get more mulch on the site, we sometimes make 2 passes, applying a lighter coating with each pass.” Depending on the season, oats or winter wheat is added as a nurse crop with the natives to all Buchanan County hydroseeded plantings.

**BUCHANAN COUNTY STRATEGIES TO REDUCE SOIL EROSION  
WHEN HYDROSEEDING**

- Apply mulch (50:50 wood-paper blend)
- Apply more mulch to the site
- Apply two layers of hydromulch
- Has grading operator leave tooth/track marks
- Include a nurse crop with the prairie seed
  - Oats @ 48lbs/ac. – for spring/fall seeding
  - Winter wheat @ 75lbs/ac. – for fall seeding



## Seed Harvesting/Storage

Buchanan County does not harvest prairie seed for use in hydroseeded ROW projects. All prairie seed used in Buchanan County ROW plantings comes from the IRVM Roadside Office at UNI. The county stores their prairie seed in a non air-conditioned room inside a large metal building.

## Plantings Visited

The 1<sup>st</sup> site we visited was a mile long re-grade where ditches on both sides of the road had been completely cleaned to bare soil (Figure 1). Sherlyn noted, “The site was hydroseeded over a two month period (in June and in July 2006) using either the 1-step or 2-step method based upon erosion concerns in each section of the mile re-grade.” Prairie seed (diversity seed mix and ditch cleanout seed mix) for the project came from the IRVM Roadside Office at UNI. Native cover for the entire site was estimated to be 50% - 75% (Appendix 14). A walking plant survey produced 43 native species and 11 exotic (non-native) species (Appendix 19). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 19). Quadrat sampling was conducted only in areas where the 2-step hydroseeding method was used. Quadrat data showed species richness averaged 4.8 native species and 2.7 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 70% and 16% respectively (Appendix 14). Sherlyn noted that the site was mowed in the 1<sup>st</sup> growing season to control weeds and has not been burned. What impressed us with this planting was how many different plant community types were present at the site. Part of the planting had a wet- mesic component dominated by prairie cordgrass-*Spartina pectinata* that included prairie blazingstar-*Liatris pycnostachya*, a mesic component dominated by big bluestem-*Andropogon gerardii* and also included a suite of mesic forbs, and dry component with little bluestem-*Schizachyrium scoparium* and round-headed bush clover-*Lespedeza capitata*.

The 2<sup>nd</sup> planting site was hydroseeded in fall of 2007 with the 1-step method (Figure 2). The site was seeded with prairie seed (diversity seed mix and ditch cleanout seed mix) from the IRVM Roadside Office at UNI. Native cover for the entire site was estimated to be 50% - 75%. Sherlyn noted, “The ditch was full of flowering black-eyed Susan-*Rudbeckia hirta* in the first growing season.”



Figure 1. Quadrat sample in first assessed hydroseeded ROW site in Buchanan County.



Figure 2. Second assessed hydroseeded ROW site in Buchanan County.

## Cerro Gordo County (2-Step Hydroseeding)

### CERRO GORDO COUNTY IRVM

- Current Roadside Manager – Josh Brandt
- Length of service with Cerro Gordo County – 11 years
- Hydroseeder Brand – Bowie
- Purchased new – late 1990's
- Tank Capacity - 800 gallons
- Factory frame and trailer unit



Josh Brandt

### IRVM/Hydroseeding History

Josh Brandt is the Natural Resource/Right-of-Way Vegetation Manager in Cerro Gordo County. His office is at Lime Creek Nature Center in Mason City, Iowa. Josh's supervisor is the Director of Cerro Gordo County Conservation Board. The roadside program in Cerro Gordo County has 3 full time employees and 1 seasonal employee.

Cerro Gordo County hydroseeded natives prior to adopting the IRVM program. According to Brandt, "I have heard from previous IRVM staff that back in the early 1980s, two ROWs in the north part of the county were hydroseeded with native grasses. It does appear that the county hydroseeded with natives because there is such a dense stand of switchgrass-*Panicum virgatum* and indiangrass-*Sorghastrum nutans* in those ROWs today."

Cerro Gordo County began hydroseeding in the late 1990s with an 800-gallon Bowie which is the same unit currently used by the program. The Living Roadway Trust Fund provided funding for their first hydroseeder. IRVM staff has made some modifications to this unit to improve efficiency. "We installed a trash pump on the unit to fill from a nearby creek or lake," noted Brandt. "The trash pump is plumbed directly into the tank so the only item that needs to be carried to the water source for filling is the intake hose."

## Hydroseeding Techniques

The 2-Step hydroseeding method has emerged as an important process for a number of Cerro Gordo County seedings. The following is a synopsis of an interview segment with Josh Brandt on this topic.

Cerro Gordo County utilizes primarily two hydroseeding techniques. According to Brandt, “For small ditch cleanouts we use the 1-step method. This was the method of choice because we had lots of small ditch cleanouts all over the county and 1-step hydroseeding was the quickest and most efficient way to get those sites seeded. On sites that are more visible to the public and where we can’t get standard seeding equipment into the ROW we hydroseed using a 2-step method (See inset box for a description of each of these methods).

### CERRO GORDO COUNTY HYDROSEEDING TECHNIQUES

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + High Mulch  
(28 bales/ac) + Tackifier  
Total gallons applied per acre – 3,200 gallons

**2-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed; **2<sup>nd</sup> Step** –  
Water + Seed + High Mulch (28 bales/ac) + Tackifier  
Total gallons applied per acre – 6,400 gallons

According to Brandt, the 2-step method was implemented after an informative Iowa IRVM Conference. “We heard about the 2-step method from a Bowie representative at the IRVM Roadside Conference in Harlan (Shelby County) back in 2004”, he said. “We experimented with the 2-step method after the conference, resulting in multiple, diverse prairie plantings.” About 25% of overall Cerro Gordo ROW plantings in the county are hydroseeded. “A few years ago, Brandt noted, “the county hired a new engineer and there have been far fewer ditch cleanouts and re-grade projects than with the previous engineer. Even though hydroseeding makes up only a minor part of our ROW seeding, we continue to hydroseed more than 90% of the ditch cleanouts because slopes are too steep for access with other seeding equipment.”

Cerro Gordo County employs a number of strategies to reduce soil erosion on hydroseeded projects. For steep slopes they increase the tackifier rate in each load to improve

adhesion of the mulch. They also apply a thicker layer of mulch on steep slopes to eliminate any exposed soil. To stabilize the soil, they add fast growing nurse crops like oats and annual rye to the native seed mix.

**CERRO GORDO COUNTY STRATEGIES TO REDUCE SOIL EROSION  
WHEN HYDROSEEDING**

- Increase tackifier rate/load
- Apply more mulch (100% recycled newspaper) on steep slopes
- Include nurse crops with the prairie seed
  - Oats @ 72lbs/ac.
  - Annual rye @ 15lbs/ac.

Seed Harvesting/Storage

Prairie seed harvesting for use in hydroseeding ROW projects is a priority for Cerro Gordo County. IRVM staff have established 10 acres of native seed production plots at Lime Creek Nature Center. Plots include 1-3 acre grass fields of big bluestem-*Andropogon gerardii*, little bluestem-*Schizachyrium scoparium*, indianguass-*Sorghastrum nutans*, and switchgrass-*Panicum virgatum*. On average 800 -1000 lbs of bulk grass seed is harvested annually. In addition, 100–200 lbs of bulk forb seed (approx. 20 species) is hand collected annually. Prairie grass seed is machine harvested with a Prairie Habitats seed stripper. The county stores their prairie seed in a non air-conditioned, mouse proofed, wire enclosure located inside a large Morton building.

Plantings Visited

The 1<sup>st</sup> site we visited was a ditch cleanout (Figure 1). Non-native vegetation was left intact near the top of the backslope and foreslope but the rest of the site was dug to bare soil. The site had not been burned. Native cover for the entire planting site was estimated at 50% - 75% (Appendix 14). A walking plant survey produced 30 native species and 15 exotic (non-native) species (Appendix 20). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 20). Quadrat sampling revealed species richness averaged 4.3 native species and 2.7 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 64% and 22% respectively (Appendix 14).

The 2<sup>nd</sup> planting we visited had a unique seeding history (Figure 2). Josh noted, “It was a long fairly flat ditch cleanout that we were able to easily get equipment into. In spring of 2009, we broadcast seeded the site with a Vicon, using prairie seed (diversity mix) we received from IRVM Roadside Office at UNI.” The site was cultipacked immediately after seeding. There were many heavy rainfall events that summer eroding and flooding the planting. Believing that most of the seed had eroded off the site, staff re-seeded in fall 2009 with 1-pass hydroseeding. They used their our own harvested native seed for the re-seed. What impressed us was that it appeared that some seed from the original planting remained intact and germinated despite being flooded and eroded. We detected blue vervain-*Verbina hastata*, sneezeweed-*Helenium autumnale*, and swamp milkweed-*Asclepias incarnata* in the planting. These species were included in the original seeding and not in the reseed.



Figure 1. First assessed hydroseeded ROW site in Cerro Gordo Co.

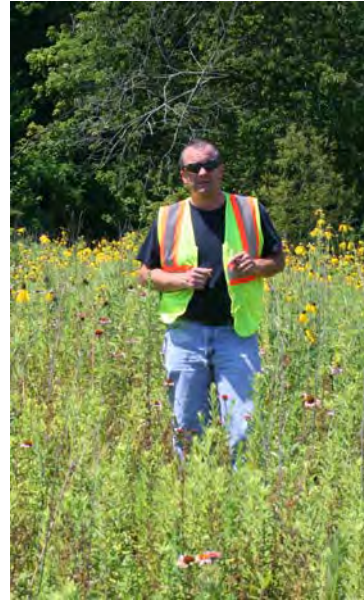


Figure 2. Second assessed hydroseeded ROW site in Cerro Gordo Co.

## Des Moines County (2-Step Hydroseeding)

### DES MOINES COUNTY IRVM

- Current Roadside Manager – Jeff Chase
- Length of service with Des Moines County – 16 years
- Hydroseeder Brand – Finn
- Purchased New – 2000
- Tank Capacity - 900 gallons
- Factory frame and trailer unit



Jeff Chase

### IRVM/Hydroseeding History

Jeff Chase is the Roadside Manager in Des Moines County. His office is in the Des Moines County Secondary Road Department building in West Burlington, Iowa. Prior to last year, the IRVM roadside program was its own department and Jeff's supervisor was the Des Moines County Board of Supervisors. Last year, the IRVM Roadside program was merged into the Secondary Roads Department. Jeff's current supervisor is the county engineer. Des Moines County IRVM currently employs 2 full-time staff (1 staff member is shared with secondary roads). Des Moines County IRVM uses seasonal employees that are also shared with secondary roads.

IRVM began hydroseeding natives back in the early 1990s. According to Chase, "The first IRVM Roadside Manager Don Dahl hydroseeded natives back in the early 1990's with one of the first hydroseeders funded by the Living Roadway Trust Fund (LRTF)." The old unit was replaced with a new hydroseeder in 2000 that was also funded by LRTF.

### Hydroseeding Techniques

The 2-Step hydroseeding method has emerged as an important technique for a number of Des Moines County ROW seedings. The following is a synopsis of an interview segment with Jeff Chase on this topic.

Des Moines County utilizes primarily two hydroseeding techniques. (See inset box for a description of these methods). Chase noted, "The idea of using the 2-step hydroseeding method

came from using the no-till drill. Feeder tubes often plugged on the small seed box with compass plant seed. On one particular seeding project, I decided to try broadcasting forb seed so the drill wouldn't plug and then drill only prairie grasses afterward. A few years later, the forbs were fantastic on that planting. I decided to use the same approach for hydroseeding – broadcast forbs on the site followed with hydroseeding that includes: water, prairie grass seed and nurse crop seed, and mulch with tackifier. We have had great success using this method for hydroseeding.” On an average year about 30% of the total seeding in Des Moines County ROWs are hydroseeded and 100% of ditch cleanouts are hydroseeded. Chase noted, “We did more hydroseeding in the last few years because the ditches were so wet. All our ditch cleanouts are hydroseeded because they are too steep to get equipment into.”

#### DES MOINES COUNTY HYDROSEEDING TECHNIQUES

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(24-40 bales/ac.) + Fertilizer (on poor soils only) + Tackifier  
(included in the mulch)

Total gallons applied per acre – 2,700 – 3,600 gallons

**2-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Broadcast forbs; **2<sup>nd</sup> Step** -  
Water + Seed (only grasses and nurse crop) + Mulch  
(24 – 40 bales/ac) + Tackifier (included in mulch)

Total gallons applied per acre – 2,700 – 3,600 gallons

Des Moines County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). Mulch is included for all hydroseeded projects. The type of mulch used for hydroseeding ROWs depends on how erosive the site is. For low erosion sites, they use a 50:50 wood-paper blend mulch with tackifier. On more erosive sites, they use a mulch with 100% wood fiber and for highly erosive sites they use almost exclusively bonded fiber matrix (BFM) mulch. Jeff noted, “BFM is expensive but it creates a much stronger mat than the other mulches. In addition, BFM has zero cure time and holds over the winter. Three years ago we hydroseeded a very steep ditch with BFM and it there was a 6” rainfall event that night and the entire mat was still intact the next day. That is what sold me on using BFM.” Jeff tries to get the equipment operator to use the toothed bucket instead of the smooth bucket when cleaning the ditch out. According to Jeff, “The toothed bucket leaves tooth marks in the soil to hold mulch and seed and the smooth bucket leaves the soil smooth. We often see after



hydroseeding, seed growing in the tooth marks and dozer tracks first before growing on the rest of the site.” Depending on the season, oats, winter wheat or winter rye is added as a nurse crop with the prairie seed for fall and spring hydroseeded plantings. Piper Sudangrass or sorghum is added to the prairie seed for summer hydroseeding projects. They have installed wood excelsior blankets on a few sites and hydromulched over the top of the blanket. According to Jeff, “If we use wood excelsior blankets, we broadcast seed 1<sup>st</sup> then staple the blanket to the ground, then roll (cultipack) over the blanket, and finish with hydromulching over top of the blanket.

#### DES MOINES COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING

- Apply mulch (50:50 wood-paper blend and 100% wood fiber) @ 24 – 40 bales/ac.
- Uses bonded fiber matrix mulch for more erosive slopes
- Apply two layers of hydromulch
- Has grading operator use the toothed bucket and leave dozer tracks
- Installs excelsior blankets and hydromulches over the top
- Include one nurse crop (listed below) with the prairie seed
  - Oats @ 100-130lbs/ac. – for spring/fall seeding
  - Winter wheat @ 150-200lbs/ac. – for spring/fall seeding
  - Winter rye @ 150-200lbs/ac. – for spring/fall seeding
  - Piper sudangrass or sorghum – for summer seeding

#### Seed Harvesting/Storage

Des Moines County does not harvest prairie seed for use in hydroseeded ROW projects. All prairie seed used in Des Moines County ROW plantings comes from the IRVM Roadside Office at UNI. The county stores their prairie seed in a non air-conditioned retired semi trailer box that is stored outdoors.

#### Plantings Visited

The 1<sup>st</sup> site we visited was a unique one. The planting site was a long steep slope between a paved road at the bottom with a steep gravel road meandering to the top of the site (Figure 1). According to Jeff, “This was a road regrade project and the slope was reshaped. The planting site was bare soil when the regrade project was complete. We hydroseeded, using the 2-step method. The slope was fairly steep so we used bonded fiber matrix mulch to reduce soil

erosion.” The site was seeded in late September or early October of 2007 with prairie seed from the IRVM Roadside Office at UNI. The planting had been burned in the past. Native cover for the entire site was estimated at 50% - 75% (Appendix 14). A walking plant survey produced 30 native species and 7 exotic (non-native) species (Appendix 21). Most prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 21). Quadrat data showed species richness averaged 1.8 native species and 0.9 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 68% and 11% respectively (Appendix 14). Native grasses were extremely dense in this planting. This may be why we detected so few forbs and weeds.

The 2<sup>nd</sup> site we visited was the first hydroseeded planting in Des Moines County (Figure 2). It was hydroseeded by Don Dahl back in 1994. It’s not known if the prairie seed came from the IRVM Roadside Office at UNI. The planting was amazing - Lots of wildflowers in bloom and virtually no weeds. Native cover for the entire site exceeded 75%. There were many native species that I hadn’t seen in most other hydroseeded plantings we visited such as: Sky blue aster-*Aster azureus*, leadplant-*Amorpha canescens*, and Illinois bundleflower-*Desmanthus illinoensis*.



Figure 1. First assessed hydroseeded ROW site in Des Moines County.



Figure 1. Second assessed hydroseeded ROW site in Des Moines County.

## Fayette County (2-Step Hydroseeding)

### FAYETTE COUNTY IRVM

- Current Roadside Manager – Jon Steege
- Length of service with Fayette County – 23 years
- Hydroseeder Brand – Finn
- Purchased New – 1999
- Tank Capacity - 1,200 gallons
- Factory frame and trailer gooseneck unit



Jon Steege

### IRVM/Hydroseeding History

Jon Steege was the first and is the current Roadside Vegetation Manager in Fayette County. His office is in the Fayette County Conservation Board building near Fayette, Iowa. Fayette County IRVM has 2 full-time staff and 1-2 seasonal employees.

Fayette County Secondary Roads Department hydroseeded their ROWs prior to adopting the IRVM program. Steege noted, “The county hydroseeded ditch cleanouts before IRVM with an old 800 gallon Bowie and used non-native seed.” Steege experimented with hydroseeding natives back in the early 1990’s with the old Bowie but hydroseeded only a few ROWs at that time because the unit required so much maintenance. Steege noted that secondary roads staff frequently added fertilizer to the tank, creating perennial rust problems and requiring a great deal of maintenance. The old unit was replaced with a new Finn hydroseeder in 1999 that was partly funded by the Living Roadway Trust Fund.

### Hydroseeding Techniques

Fayette County uses both 1-Step and 2-Step hydroseeding methods- but it’s the 2-step method that the county employs when hydroseeding diverse prairie seed mixes. The following is a synopsis of an interview segment with Jon Steege on this topic.

Fayette County utilizes two hydroseeding techniques (See inset box for a description of these methods). Hydroseeding is used in 50% of the total ROW seeding projects and 80% of all ditch cleanouts. According to Steege, “We use the 1-step method to hydroseed ROW ditch

cleanouts because the sites are too steep to get any other seeding equipment in the ditch. We did a lot of experimenting with different hydroseeding methods, but it was Don Dahl's 2-step method that worked for us (Dahl is a former Iowa roadside manager who worked in Des Moines county). We wanted to use a method that produced a successful stand of natives but it had to be both cost and time effective. Our first real attempt with hydroseeding using a diverse prairie seed mix was back in the late 1990s on a demonstration planting we did here in the county with Hawkeye Community College's hydroseeder and students." Steege noted, "We had good establishment on that planting and subsequent hydroseeded plantings. We think the key is hydroseeding in the spring when the ground is fresh and friable for good seed-to-soil contact. After a packing rain, the ground needs to be scarified before hydroseeding, to improve seed-to-soil contact for a good stand of natives."

**FAYETTE COUNTY HYDROSEEDING TECHNIQUES**

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch (8 - 12 bales/ac.) + Tackifier  
Total gallons applied per acre – 1,200 – 1,500 gallons

**2-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch (2 bales/ac); **2<sup>nd</sup> Step** - Water + Mulch (8 – 12 bales/ac) + Tackifier  
Total gallons applied per acre – 2,400 – 3,000 gallons

Fayette County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). Mulch is included for all hydroseeded projects. The type of mulch used for hydroseeding ROWs depends on the hydroseeding technique and how erosive the site is. They use 100% recycled paper mulch when hydroseeding with the 1-step method on low erosion sites and will add 50:50 wood/paper blend mulch on more erosive sites. When hydroseeding with the 2-step method, they add a few bales of 100% recycled paper mulch in the 1<sup>st</sup> step to mark what had been seeded at the site. For the second step, they use the 50:50 wood/paper blend mulch to get better coverage and create a stronger mat to reduce erosion. Tackifier is added to all hydroseeding projects to improve mulch adhesion. Fayette County utilizes fast growing nurse crops to stabilize the soil. Jon noted, "We include oats with the native seed when hydroseeding

in spring or fall and will use grain sorghum for summer seeding projects. We have included red clover on some ROW projects with very poor soil.”

**FAYETTE COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING**

- Apply mulch (50:50 wood-recycled paper blend) @ 8 – 12 bales/ac.
- Adds tackifier to improve mulch adhesion
- Apply straw and hydromulch over the top
- Include a nurse crop with the prairie seed
  - Oats – for spring/fall seeding
  - Grain sorghum – for summer seeding
  - Red clover – for poor soil sites

Seed Harvesting/Storage

Fayette County harvests local prairie seed for use in hydroseeded ROW projects. Forbs are hand collected and a flail vac is used to collect prairie grass seed. The county receives prairie seed from the IRVM Roadside Office at UNI and stores both collected and UNI prairie seed in a non air-conditioned, mouse-proofed room in a large metal building.

Plantings Visited

The 1<sup>st</sup> site we visited was a unique one (Figure 1). It was a dry, very rocky site at the top of a large hill. Driving up the hill to the site we passed a lot of limestone outcrops in the ROW. According to Steege, “This was a road re-grade project and the ditches were reshaped. The planting site was bare soil when the grading was complete. We seeded in mid-summer of 2007 and used two different seeding techniques because it was a bad time of year to seed natives and it had been pretty dry that summer. We drilled part of the site and hydromulched over the top. Parts of the ditch where we couldn’t get the drill into, we hydroseeded using the 2-step method.” The planting has not been burned since seeding. Jon noted that they used the diversity mix from the IRVM Roadside Office at UNI. Native cover for the entire site exceeded 75% (Appendix 14). A walking plant survey produced 41 native species and 13 exotic (non-native) species (Appendix 22). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs, shrubs) were represented in this planting (Appendix 22). Quadrat data showed species richness averaged 6.1 native species and 1.8 exotic (non-native) species per 0.25 m<sup>2</sup>

(Appendix 14). Average percent cover of natives and non-natives was 102% and 8% respectively (Appendix 14). What had impressed us with this planting was that it looked like a prairie remnant. Many planted prairies are easy to identify because they either have too many grasses or too many forbs. This planting had an even blend of grasses and forbs with very few weeds.

The 2<sup>nd</sup> site we visited was a hydroseeding project Jon did with Hawkeye Community College students and their hydroseeder back in the late 1990s (Figure 2). Steege noted, “This site is the oldest hydroseeded planting that was seeded with the diversity prairie seed mix from the IRVM Roadside Office at UNI. It was a long ditch cleanout and was hydroseeded in spring. The planting has been burned once since seeding.” Native cover for the entire site exceeded 75%. The planting was forb rich and full of color of forbs in bloom. There were more butterfly milkweed-*Asclepias tuberosa* blooming in this one planting than in all the other plantings we visited combined.



Figure 1. First assessed hydroseeded ROW site in Fayette Co.



Figure 2. Second assessed hydroseeded ROW site in Fayette County.

## Section 11c.

### County Vignettes (3-Step Hydroseeding)

#### Hardin County (3-Step Hydroseeding)

##### HARDIN COUNTY IRVM

- Current Roadside Manager – Linn Reece
- Length of service with Hardin County – 14 years
- Hydroseeder Brand – Finn
- Purchased New – 1999
- Tank Capacity - 800 gallons
- Factory frame and trailer unit



Linn Reece

##### IRVM/Hydroseeding History

Linn Reece is the Roadside Manager in Hardin County. His office is in the Hardin County IRVM building in Eldora, Iowa. Linn's supervisor is the Board of Supervisors for Hardin County. Reece noted, "Back when I started with Hardin County in 1998, I was housed in the basement of the Engineer and Secondary Roads Building and my supervisor was the county engineer. About 5 years ago, the county moved me out to this new building and gave me my own department and budget and now I report to the County Board of Supervisors." The roadside program in Hardin County currently has 1 full-time employee (Linn), 1 nine-month assistant, 1 intern, and 6 seasonal employees.

It is not known if Hardin County hydroseeded ROWs prior to adopting the IRVM program. According to Reece however, "Doug Sheeley, the previous Hardin County Roadside Manager, hydroseeded ROWs with a very old hydroseeder. In Doug's planting notes he wrote that he to spend a lot of time breaking mulch bales into much smaller pieces so the unit wouldn't plug. When I started here in 1998, I used that same old hydroseeder and also had mulch issues, so we traded it in for a new unit that was funded by the Living Roadway Trust Fund in 1999."

## Hydroseeding Techniques

The 3-Step hydroseeding method has emerged as an important technique in Hardin County. The following is a synopsis of an interview segment with Linn Reece on this topic.

Hardin County utilizes primarily two hydroseeding techniques. (See inset box for a description of these methods). Reece noted, “Most Hardin County ROWs are narrow with steep slopes that make it impossible for tractor access so 95% - 98% of the total seeding in the ROWs is hydroseeded. Slopes are so steep on some of these ditches that you need a step ladder to get out of them! The hydroseeding method we use on any given site is based on its susceptibility to erosion. We use the 3-step hydroseeding technique for highly erodible sites, and the 1-step technique on sites that are less erosive. I got the idea to use the 3-step method for hydroseeding from Doug Sheeley’s notes.”

### HARDIN COUNTY HYDROSEEDING TECHNIQUES: PER ACRE

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(18 bales/ac) + Tackifier  
Total gallons applied per acre – 2,400 gallons

**3-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Mulch  
(9 bales/ac); **2<sup>nd</sup> Step** – Apply Straw (2000 lbs/ac.) to the Site;  
**3<sup>rd</sup> Step** – Water + Mulch (15 bales/ac) + Tackifier  
Total gallons applied per acre – 4,800 gallons

Hardin County employs a number of strategies to reduce soil erosion on hydroseeded projects (see insert box). Recycled paper mulch is included for all hydroseeded projects. For very steep slopes, straw is applied to the site as part of the 3-step hydroseeding method. Reece notes, “Straw has longer and stronger fibers than most mulches and when we apply our mulch and tackifier over the straw it creates a mat that acts like erosion control blankets.” Depending on the season, Linn includes either oats or winter wheat as a nurse crop with the natives and he always includes annual rye and timothy in all hydroseeding projects.



## HARDIN COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING

- Apply mulch (100% recycled newspaper) at 18-24 bales/ac.
- Apply straw (2000lbs/ac) for highly erodible sites
- Include nurse crops with the prairie seed
  - Oats @ 80lbs/ac. for spring seeding
  - Winter wheat @ 90lbs/ac. for summer and fall seeding
  - Annual rye and Timothy @ 3lbs/ac. each for all seedings

### Seed Harvesting/Storage

Hardin County harvests prairie seed for use in hydroseeded ROW projects. According to Reece, “Doug Sheeley established native seed production plots for use in ROW seeding. Plots are located at Calkins Nature Area and are managed by staff from Hardin County Conservation and Hardin County IRVM departments (Figure 1). Originally, there were individual plots of prairie grasses and forbs but over the years everything has grown together so we bulk harvest seed off the site. Last year we harvested about 800 lbs of bulk seed.” Prairie seed is hand collected and combine harvested with an AC model 72 All Crop Harvester. Hardin County also receives prairie seed from the IRVM Roadside Office at UNI and have on occasion, purchased forb seed from commercial vendors. The county stores their prairie seed on pallets located inside a shop bay adjacent to the IRVM office.

### Plantings Visited

Reece noted as we were walking up a steep gravel road to the planting site, “You guys have some nice planted prairies on the UNI campus in very controlled conditions but out here in the ROW it’s a whole different world. We have some nice prairie plantings here in Hardin County but don’t expect pristine prairie plantings.” The 1<sup>st</sup> site we visited was on a steep road, foreslope and backslope had nearly 1:1 slopes with a woodland adjacent to the ROW (Figure 1). A walking plant survey of the site produced 36 native species and 15 exotic (non-native) species (Appendix 23). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in this planting (Appendix 23). Quadrat data showed species richness averaged 4.6 native species and 2.7 exotic (non-native) species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives was 60% and 38% respectively (Appendix 14). Reece noted that after they had hydroseeded the ditch, there was a heavy rainfall that caused

severe erosion in the ditch bottom so the county dumped concrete pieces in the ditch to control erosion. After the concrete was dumped, Linn re-seeded with the hydroseeder. In spite of this, the site still had nearly 50% native cover (Appendix 14). Also on the site was a large area on the backslope where the vegetation was completely dead. Linn suspected overspraying from the adjacent landowner. In addition, there was a sterilized spot in the ditch bottom near a farmstead where Linn believed the landowner had burned a brush pile.

The 2<sup>nd</sup> planting site was very impressive for its age. It was a 4 year-old planting that was seeded with the diversity native mix from the IRVM Roadside Office at UNI. The site has not been burned. Other than a little white sweet clover-*Melilotus alba* near the top of the foreslope, there were virtually no weeds in the rest of the planting. Given the severe drought conditions from the summer of 2012, it was amazing how lush the native plants were in this planting.



Figure 1. First assessed hydroseeded ROW site in Hardin Co.



Figure 2. Second assessed hydroseeded ROW site in Hardin County.

## Story County (3-Step Hydroseeding)

### STORY COUNTY IRVM

- Current Roadside Manager – Joe Kooiker
- Length of service with Story County – 23 years
- Hydroseeder Brand – Bowie
- Purchased new - 1996
- Tank Capacity - 1,500 gallons
- Skid unit mounted to a tandem axle dump truck



Joe Kooiker

### IRVM/Hydroseeding History

Joe Kooiker is the Roadside Biologist in Story County. The Story County Conservation Board employs Joe but he is housed in the Story County Engineer and Secondary Road building in Nevada, Iowa. This has provided some interesting interdepartmental dynamics and across-program collaboration that other IRVM counties may not enjoy. Technically, Joe's supervisor is the Director of Story County Conservation Board but he works closely on a daily basis with the Story County engineer and maintenance superintendent. This relationship has fostered a direct line of communication between administrators and field staff of both programs, including positive working relationships with roadside maintenance staff and equipment operators. According to Kooiker, day-to-day cooperation has been critical to the success of the IRVM program. A good example of these benefits can be found in the way ditch cleaning has evolved in Story County. County personnel have traditionally cleaned out ditches leaving compacted smooth slopes. These slopes were difficult to seed and prone to excessive erosion. Joe's close contact with staff conducting ditch-cleans provided an opportunity for him to suggest changes in ditch cleaning methods including; leaving tooth marks on the slopes, which provide areas for seed to hold and establish and reduce erosion. Story County IRVM currently employs 2 full-time staff. The second full timer is actually 1/3 Drainage District maintenance and 2/3 IRVM and 2 seasonal employees (who have the option of extending hours into the spring and fall).

Story County did not use hydroseeding prior to starting the IRVM program. Story County's first IRVM roadside manager Tre Wilson and his assistant Joe Kooiker hydroseeded the first ROW in the county with a unit that they built from scratch in 1989. The unit consisted

of a poly water tank, motor, pump and hose. Mulch and tackifier were added to the tank and slurry was mixed by hand with a hand paddle. For seeding, they used a cyclone seeder mounted to an extending bracket that was connected to the front of a pickup. This allowed the seeder to extend into the ROW for better seed coverage. Joe added an old speedometer cable inside the hopper to better agitate fluffy prairie seed. According to Kooiker, Story Counties first hydroseeding project went like this...’Tre and Joe hand mixed a tank of hydromulch at the shop, and “busted a gut” lifting and connecting the seeder to the front of the truck. They drove to the planting site- first broadcasting the seed with the modified seeder then hydromulching over the top with the home made hydroseeder- spending a lot of time unclogging the hydroseeder.

After that first hydroseeding project, Joe realized the value of hydroseeding county ditches- but it wasn’t until 1996 that Story County purchased its first bonafide hydroseeder through the Living Roadway Trust Fund. The 1500-gallon Bowie hydroseeder was originally mounted on a whopping 24’ trailer. The trailer was low to the ground, making loading hydromulch easy, but it was difficult to maneuver along the ROW. According to Kooiker, the tires wore out rapidly on the gravel too. “Ultimately,” he said, “the county gave us an old tandem-axle dump truck that they were going to trade off. We removed the dump box from the truck and mounted the hydroseeder to the frame. This was a big improvement because it eliminated having to go around the block to get back to the planting site as we did with the old trailer! We still use the same old dump truck and hydroseeder today.”

### Hydroseeding Techniques

Story County utilizes a number of hydroseeding techniques, but the 3-step method they employ sets their program apart. According to Kookier, “Site conditions dictate the specific hydroseeding technique we use. For most ditch cleanouts, we use a 1-step method. On enhancement sites where more money is spent on seed, we use a 2-step method and for gateway projects with high visibility we use a 3-step method.” (See inset box for a description of each of these methods). Kooiker noted that, “We always use some mulch in every step to indicate where we have seeded when the slurry is sprayed onto the planting site. Most (75%) of our ROWs planting sites are hydroseeded and 80% of our ditch cleanouts are hydroseeded. For many hydroseeded plantings, we no-till drill the foreslopes and intersections with non-native pasture grasses to mitigate site distance issues.

## STORY COUNTY HYDROSEEDING TECHNIQUES

**1-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + High Mulch (36 bales/ac) + Tackifier  
Total gallons applied per acre – 4,500 gallons

**2-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Some Mulch (4 bales/ac);  
**2<sup>nd</sup> Step** – Water + Some Seed + High Mulch (36 bales/ac) + Tackifier  
Total gallons applied per acre – 9,000 gallons

**3-Step** Hydroseeding Method: **1<sup>st</sup> Step** – Water + Seed + Some Mulch (4 bales/ac);  
**2<sup>nd</sup> Step** – Cultipack; **3<sup>rd</sup> Step** – Water + High Mulch (36 bales/ac) + Tackifier  
Total gallons applied per acre – 9,000 gallons

The 3-Step hydroseeding method has emerged as an important process for a number of Story County seedings. The following is a synopsis of an interview segment with Kooiker on this topic, associated with a major public ROW project in 1999.

‘ We hydroseeded a new bridge project a number of years ago. There was going to be a public grand opening of the bridge and the supervisors wanted me to make the site green for the event. It was in late summer, so we hydroseeded the site with winter wheat for the event and planned to hydroseed over the site later in fall with the natives. I went back a few days later to check for emergence, walked all over the site and found nothing. A few days later I revisited the site again and found that the only emergence of winter wheat was in our boot prints from the previous visit. So, I figured that packing the mulch into the soil after it was dry would promote better seed-to-soil contact and improve emergence. I cultipacked it, the winter wheat emerged and the supervisors were happy because the site was green for the event. More importantly, I found that cultipacking after hydroseeding when the hydromulch was dry promoted emergence sooner - stabilizing bare soil quicker potentially saving the county time and money for costly re-grades.

Story County employs a number of strategies to reduce soil erosion on hydroseeded projects. For steep slopes Joe has grader operators leave the planting site rough so seed and mulch have a place to stick. For steep slopes Joe adds more mulch to each load and also has used bonded fiber matrix mulch for extreme conditions. Joe has also installed wood excelsior

mats on some erosion prone sites and hydromulched over the top. Depending on the season, he also includes nurse crops with the natives for fast germination and growth to stabilize the soil. If site is ready for seeding in mid-summer, Joe will plant only a cover crop to stabilize the soil and return later in the season when it's a better time to plant the natives. Joe's advice when hydroseeding steep slopes, "Seed heavy when the slopes are bad."

#### STORY COUNTY STRATEGIES TO REDUCE SOIL EROSION WHEN HYDROSEEDING

- Increase mulch (2<sup>nd</sup> nature-80% wood, 20% paper) rate (greater than 40 bales/acre)
- Have the grading operator leave tooth marks on slopes rough soil conditions
- Used bonded fiber matrix mulch
- Install wood excelsior mats and hydromulch over the top
- Add extra seed
- Seed only a stabilizer crop (Japanese millet) in summer and return later to seed natives
- Include nurse crops with the prairie seed
  - Annual rye @ 10lbs/ac. – for all seasons
  - Winter rye – for Sept. plantings

#### Seed Harvesting/Storage

Prairie seed harvesting for use in hydroseeding ROW projects is a priority for Story County. IRVM staff collects seed from a number of private and public prairie remnants and reconstructions in Story County. They add collected seed to native seed received from the IRVM Roadside Office at UNI. Joe believes that adding remnant seed to standard prairie seed mixes will result in more diverse prairie plant communities-ones better adapted to harsh ROW growing conditions and better at outcompeting weeds. In addition, local genetics of the collected seed will be transferred to other regions of the county thereby ensuring their survival. Prairie seed is hand collected and machine harvested with two restored AC combines. The county stores their prairie seed in an air-conditioned, mouse proofed, insulated room inside a large metal building.

#### Plantings Visited

Both plantings in Story County were hydroseeded with the 3-step technique and very impressive (Figure 1, Figure 2). Total native cover for both plantings exceeded 75% (Appendix 14). A walking plant survey of the 1<sup>st</sup> site produced 55 native species and 12 exotic (non-native)

species (Appendix 24). All prairie plant guilds (warm/cool season grasses, sedges, rushes, legumes, forbs) were represented in these plantings (Appendix 24). Quadrat sampling showed species richness averaged 7.0 native species and 1.1 non-native species per 0.25 m<sup>2</sup> (Appendix 14). Average percent cover of natives and non-natives were 94% and 6% respectively (Appendix 14).

It is clear from the quadrat data that Story County hydroseeded plantings had the highest species diversity and native plant cover as compared to the other nine counties that were assessed (Appendix 14). In addition, many of the species that were detected in the plantings were most likely a result of the remnant seed that was added to the standard prairie seed mix. Adding a mix of remnant prairie seed to a standard prairie seed mix has clearly enhanced plant diversity of hydroseeded plantings in Story County.



Figure 1. First assessed hydroseeded ROW site in Story Co.



Figure 2. Second assessed hydroseeded ROW site in Story County.

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## Appendices

### Appendix 1. Hydroseeders used by IRVM counties in Iowa.

County	Hydro Brand	Capacity(gal)	Age (years)	Towing Vehicle
Allamakee	Finn	900	10+	3/4 ton pickup truck
Audubon	Bowie	800	6 to 10	1 ton duel truck
Benton	Finn	1700	>1	semi-tractor truck L900
Black Hawk	Bowie	750	10+	4x4 tractor, single axle dump truck
Boone	Finn	2800	6 to 10	double axle cement truck
Buchanan	Finn	1000	10+	double axle dump truck
Butler	Homemade	750	10+	3/4 ton pickup truck
Cerro Gordo	Bowie	800	10+	single axle dump truck
Chickasaw	KinKaide	750	6 to 10	1 ton F350 truck
Clay	Bowie	600	10+	1 ton F350 truck
Clayton	Finn	1200	6 to 10	3/4 ton pickup truck
Clinton	Bowie	3000	1 to 5	volvo straight truck 64,000 gvw
Crawford	Bowie	850	10+	1 ton 4x4 truck
Dallas	Finn	3300	10+	tandem axle dump truck
Des Moines	Finn	900	6 to 10	single axle dump truck
Fayette	Finn	1200	6 to 10	3/4 ton pickup truck
Franklin	Finn	800	1 to 5	GMC fuel trk converted to flat bed
Greene	not specified	not specified	not specified	not specified
Hardin	Finn	800	10+	3/4 ton pickup truck
Henry	TGMI Aquaseeder	800	6 to 10	1 ton truck
Iowa	Finn	1000	10+	1 ton duel truck
Jasper	Bowie	1800	6 to 10	single axle dump truck
Jefferson	Bowie	900	1 to 5	single axle dump truck
Johnson	Finn	1700	10+	tandem axle dump truck
Jones	Bowie	1100	6 to 10	single axle dump truck
Lee	Bowie	500	6 to 10	3/4 ton pickup truck
Linn	Finn	800	10+	single axle dump truck
Mahaska	Bowie	1100	6 to 10	1 ton truck
Marion	Bowie	800	1 to 5	single axle dump truck
Mitchell	Finn	500	10+	3/4 ton pickup truck
Montgomery	Bowie	800	10+	1 ton 4x4 duel truck
Muscatine	Finn	900	6 to 10	superduty 550 ford truck
Page	Bowie	800	10+	single axle dump truck
Palo Alto	Finn	500	6 to 10	3/4 ton pickup truck
Pocahontas	Finn	500	10+	1 ton truck
Polk	Finn	1200	6 to 10	single axle dump truck
Pottawattamie	KinKaide	1200	1 to 5	single axle dump truck
Poweshiek	Finn	600	1 to 5	1 ton truck
Sac	Bowie	1700	6 to 10	semi-tractor truck
Shelby	KinKaide	1200	1 to 5	1 ton truck
Story	Bowie	1500	10+	tandem axle dump truck
Washington	Finn	1000	6 to 10	3/4 ton pickup truck
Webster	Finn	600	10+	3/4 ton pickup truck
Winnebago	Victor	750	6 to 10	3/4 ton pickup truck

## Appendix 2. Variations of hydroseeding methods and ingredients IRVM counties use to hydroseed ROWs.

### 1- Step Hydroseeding Method

- 1st step - water, native seed only, no mulch, no tack
- 1st step - water, native&nurse crop seed, mulch, no tack
- 1st step - water, native&nurse crop seed, no mulch, no tack
- 1st step - water, native&nurse crop seed, mulch, tack
- 1st step - water, native&nurse crop seed, mulch, tack, dye
- 1st step - water, native&nurse crop seed, mulch, tack, fertilizer

### 2-Step Hydroseeding Method

- 1st step - water, native seed only; 2nd step - water, mulch, no tack
- 1st step - water, native seed only; 2nd step - water, mulch, tack
- 1st step - water, native&nurse crop seed; 2nd step - water, mulch, no tack
- 1st step - water, native&nurse crop seed; 2nd step - water, mulch, tack
- 1st step - water, native&nurse crop seed, tack; 2nd step - water, mulch, tack
- 1st step - water, native&nurse crop seed; 2nd step - water, native&nurse crop seed, mulch, tack
- 1st step - water, native&nurse crop seed, some mulch; 2nd step - water, mulch, tack
- 1st step - water, native&nurse crop seed, some mulch; 2nd step - water, some native&nurse crop seed, mulch, tack
- 1st step - broadcast seeded forbs; 2nd step - water, native grass&nurse crop seed, mulch, tack
- 1st step - water, native&nurse crop seed, fertilizer; 2nd step - install erosion blanket or apply straw to the site
- 1st step - water, native&nurse crop seed, mulch, tack; 2nd step - install erosion blanket or apply straw to the site
- 1st step - water, native&nurse crop seed, mulch; 2nd step - apply straw to site
- 1st step - water, native&nurse crop seed, tack; 2nd step - apply straw to site or install erosion blankets

### 3-Step Hydroseeding Method

- 1st step - water, native&nurse crop seed; 2nd step - apply straw to site; 3rd step - water, mulch, tack
- 1st step - water, native&nurse crop seed, some mulch; 2nd step - apply straw to site; 3rd step - water, mulch, tack
- 1st step - water, native&nurse crop seed, some mulch; 2nd step - cultipack the site; 3rd step - water, mulch, tack
- 1st step - broadcast seeded natives&nurse crop seed; 2nd step - apply straw to the site; 3rd step - water, tack
- 1st step - broadcast seeded natives&nurse crop seed; 2nd step - apply straw to the site; 3rd step - water, some native&nurse crop seed, mulch, tack
- 1st step - broadcast seeded natives&nurse crop seed; 2nd step - install erosion blanket; 3rd step - water, native&nurse crop seed, mulch, tack
- 1st step - broadcast seeded only forbs; 2nd step - water, native grasses&nurse crop seed, mulch, tack; 3rd step - apply straw to the site

Appendix 3. Hydroseeding methods used by IRVM counties in Iowa.

County	1-step	2-step	3-step	Total Applied (gal/ac)
Allamakee	yes	yes	no	2400
Audubon	yes (no tack)	yes	no	3200
Benton	yes	no	no	3400
Black Hawk	no	yes	yes	1500 (2,3-steps)
Boone	yes (no tack or mulch)	no	no	520
Buchanan	yes	yes	no	1250 (1-step), 2500 (2-step)
Butler	yes (no tack)	no	no	500-600
Cerro Gordo	yes	yes	no	3200 (1-step), 6400 (2-step)
Chickasaw	yes	no	no	not sure
Clay	no	yes	no	2400 (2-step)
Clayton	yes (no tack)	no	no	600
Clinton	yes	yes	no	2800 (1-step), 5600 (2-step)
Crawford	yes	no	no	800
Dallas	yes	no	no	3666
Des Moines	yes (+fertilizer on poor soil)	yes	no	2700-3600 (1,2-steps)
Fayette	yes	yes	no	1200-1500gal/ac
Franklin	yes	yes	no	800 (1-step), 1600 (2-step)
Greene	yes	no	no	not sure
Hardin	yes	no	yes	2400(1-step), 4800 (3-step)
Henry	yes	no	no	3200
Iowa	no	yes	no	1000
Jasper	yes (no tack,+fertilizer for poor soil)	no	no	3600
Jefferson	yes	no	no	1800
Johnson	yes	yes	no	3400
Jones	yes	yes	no	1200
Lee	yes	no	no	1000
Linn	no	yes	no	3200 (2-step)
Mahaska	yes	yes	no	3300 (1,2-steps)
Marion	yes (no tack)	no	no	3200
Mitchell	yes (no tack or mulch)	no	no	275
Montgomery	yes	no	no	3200
Muscatine	yes	no	no	2700
Page	yes	no	no	3200
Palo Alto	yes	yes	no	4000
Pocahontas	yes	no	no	4000
Polk	yes (+fertilizer for reseed)	no	no	3000
Pottawattamie	yes	no	no	3300
Poweshiek	yes	no	no	3600
Sac	yes (no tack)	no	no	3400
Shelby	yes	no	no	3600
Story	yes	yes	yes	4500 (1-step), 9000 (2,3-steps)
Washington	yes	no	no	2000
Webster	yes (no tack)	yes	no	4800
Winnebago	yes (+ dye)	no	no	1500

Appendix 4. Mulch brands, blends and application rates used for hydroseeding by IRVM counties in Iowa.

County	Mulch Brand	Mulch Blend	Mulch Applied (bales/ac)	Tackifier
Allamakee	Mat Blend	50:50 wood:paper w tack	6 to 8	Included in mulch
Audubon	Second Nature	100% recycled paper	20 to 24	Guar Gum
Benton	Finn product	100% wood	16	Finn product
Black Hawk	not specified	100% recycled paper	12	Guar Gum
Boone	doesn't use mulch	doesn't use mulch	doesn't use mulch	Not Used
Buchanan	Second Nature	50:50 wood:paper w tack	7 to 8	Included in mulch
Butler	Second Nature	wood	2	Not Used
Cerro Gordo	Mason City Recycling	100% recycled paper	28	Finn product
Chickasaw	Mason City Recycling	100% recycled paper	not sure	Yes
Clay	not specified	100% corn stover	24	Not Used
Clayton	not specified	100% corn stover	0.5	Not Used
Clinton	Terra Blend	70:30 wood:paper w tack	30	Included in mulch
Crawford	Second Nature	100% recycled paper	6 to 9	Yes
Dallas	Mat Blend	70:30 wood:paper	30	Not specified
Des Moines	Flexterra, Second Nature	100% wood w tack;50:50 wood:paper	24 to 40	Included in mulch
Fayette	Second Nature	50:50 wood:paper	8 to 12	Yes
Franklin	Finn product	100% wood	8	Finn product
Greene	not specified	not specified	not specified	not specified
Hardin	Second Nature	100% recycled paper	18	Finn product
Henry	Mat Ag	80:20 corn stover:paper w tack	24	Included in mulch
Iowa	round bales from farmer	100% corn stover	1 to 1.25	Not Used
Jasper	Second Nature	100% recycled paper w tack	16	Included in mulch
Jefferson	Second Nature	100% recycled paper	14 to 16	Finn product
Johnson	Enviroblend	70:30 wood:paper w tack	26	Included in mulch
Jones	Profile Terra mulch	70:30 wood:paper	20 to 24	Tack Tag, Guar Gum
Lee	Cedar Rapids Recycling	100% recycled paper w tack	2	Included in mulch
Linn	not specified	50:50 wood:paper w tack	30	Included in mulch
Mahaska	Second Nature	70:30 wood:paper	39	Guar Gum
Marion	Terra Blend	70:30 wood:paper	24	Not Used
Mitchell	doesn't use mulch	doesn't use mulch	doesn't use mulch	Not Used
Montgomery	ASP Mat	100% wood	32	Sloc Loc-Pro Plus
Muscatine	Mat Blend	100% wood w tack	25	Included in mulch
Page	not specified	wood	32	Yes
Palo Alto	Mat Ag Fiber	100% corn stover	32	Zetag
Pocahontas	Mat Ag Fiber	70:30 corn stover:paper	32	Finn product
Polk	Terra Blend	70:30 wood:paper	30	Finn product
Pottawattamie	Mat Fiber	80:20 wood:paper	30	Sloc Loc-Pro Plus
Poweshiek	Second Nature	70:30 wood:paper	30	Finn product
Sac	Mason City Recycling	100% recycled paper	10	Not Used
Shelby	Second Nature	100% recycled paper	18	Finn product
Story	Second Nature	80:20 wood:paper	36	Finn product, Hydropam
Washington	Mat Blend	100% recycled paper w tack	32 to 40	Included in mulch
Webster	Terra Blend	70:30 wood:paper	32	Not Used
Winnebago	Mason City Recycling	100% recycled paper	16 to 18	Yes

Appendix 5. Tallgrass prairie seeding rates used for hydroseeding ROWs in Iowa.

# Counties	Native Seeding Rate (lbs/ac)		Seed Source(s)
	Grasses	Forbs	
5	UNI Roadside Office recommended seeding rate		UNI Roadside Office
1	10.0	2.0	UNI Roadside Office
1	5.0 to 15.0	0.5 to 2.0	UNI Roadside Office
1	40.0 bulk seed (grasses and forbs)		Harvested
1	20.0	1.0	Harvested
1	25.0	2.0	UNI Roadside Office
1	15.0 to 20.0 ( grasses and forbs)		UNI Roadside Office
1	6.0 to 10.0	less than 1.0	UNI Roadside Office
1	8.0 to 10.0	3.0 to 5.0	UNI Roadside Office
1	15.0	5.0	UNI Roadside Office
1	26.0	4.0	UNI Roadside Office
1	11.0	3.0	UNI Roadside Office
1	20.0 to 40.0 bulk seed (grasses and forbs)		Harvested
1	8.0	2.0	Harvested
1	18.0 to 20.0	Roadside Office Rate	UNI Roadside Office
1	0.5 to 1 bag of seed	1.0 can full	UNI Roadside Office
1	25.0	0.5	UNI Roadside Office
1	20.0 to 25.0 bulk	20.0 to 25.0 bulk	UNI Roadside Office, Harvested
1	60.0	Roadside Office Rate	UNI Roadside Office
1	70.0	no forbs seeded	Purchased

Appendix 6. Factors influencing native grass and forb proportions in the seed mix.

# Counties	Native grass and forb proportion change	Reasons for proportional changes
10	increase total native seed quantity;increase grass and reduce forbs (1 county)	steep slopes, erodable sites
6	increase forbs; use short grasses (1 county)	more visible sites
6	increase total native seed quantity	poor soils (clay, light, rocky, compacted, smooth)
1	decrease forbs	if farmer mows
2	increase total native seed quantity	leftover harvested seed
1	increase total native seed quantity	compensate for seed loss for fall plantings
1	use only native grasses	if landowner sprays for weeds
1	use shorter native species	for snow drift areas
1	use wet species seed mix or dry species seed mix	for wet soils or dry soils
1	decrease total native seed quantity	for good soil (black loamy soil)
1	increase forbs and decrease grasses	flat areas (low erosion)

## Appendix 7. Nurse and cover crops used for hydroseeding ROWs in Iowa.

Nurse and cover crops used by IRVM counties for hydroseeding.			
COUNTY	SPRING	SUMMER	FALL
Allamakee	annual rye, waterway mix @ 5-10 lbs/ac	annual rye, waterway mix @ 5-10 lbs/ac	annual rye, waterway mix @ 5-10 lbs/ac
Audubon	oats @ 4 bu/ac	not specified	winter wheat or winter rye @ 4 bu/ac
Benton	oats @ 1.5 bu/ac	mid-summer winter wheat @ 3 bu/ac	winter wheat @ 3 bu/ac
Black Hawk	oats	oats, alfalfa	winter wheat, winter rye
Boone	Not used	Not used	Not used
Buchanan	oats @ 1.5 bu/ac	not specified	winter wheat 1.5 bu/ac
Butler	Not used	Not used	Not used
Cerro Gordo	oats @ 2.5 bu/ac and annual rye @ 0.25 bu/ac	oats @ 2.5 bu/ac and annual rye @ 0.25 bu/ac	oats @ 2.5 bu/ac and annual rye @ 0.25 bu/ac
Chickasaw	Not used	Not used	Not used
Clay	oats @ 1 bu/ac	oats @ 1 bu/ac	oats @ 1 bu/ac
Clayton	oats @ 2 bu/ac	oats @ 2 bu/ac	oats @ 2 bu/ac
Clinton	oats @ 1 bu/ac on a few plantings	oats @ 1 bu/ac on a few plantings	oats @ 1 bu/ac on a few plantings
Crawford	oats	not specified	winter rye @ 1 bu/ac
Dallas	oats 1-2 bu/ac and annual rye 10-15 lbs/ac	oats 1-2 bu/ac and annual rye 10-15 lbs/ac	winter wheat @ 25-35 lbs/ac and winter rye 1/3-1 bu/ac
Dallas		or pearl millet and annual rye @ 5 lbs/ac each (hot, dry conditions)	
Des Moines	winter rye or winter wheat @ 3-4 bu/ac	sorghum or piper sudangrass	winter rye or winter wheat @ 3-4 bu/ac
Fayette	oats	sorghum and red clover (for poor soil)	oats
Franklin	oats and annual rye	not specified	oats and annual rye
Greene	not specified	not specified	oats
Hardin	oats @ 2.5 bu/ac, timothy and annual rye 3 lbs/ac each	oats @ 1.5 bu/ac, timothy and annual rye 3 lbs/ac each ( for summer and fall plantings)	
Henry	oats @ 1 bu/ac and winter wheat @ 1 bu/ac	not specified	oats @ 1 bu/ac
Iowa	oats @ 2 bu/ac	not specified	winter rye @ 1-1.5 bu/ac
Jasper	winter rye 8-10 lbs/ac, red clover 1 lb/ac for erosive sites	winter rye 8-10 lbs/ac, red clover 1 lb/ac for erosive sites	winter rye 8-10 lbs/ac, red clover 1 lb/ac for erosive sites
Jefferson	use what is available from the COOP	use what is available from the COOP	use what is available from the COOP
Johnson	oats @ 3 bu/ac	winter wheat or winter rye @ 2 bu/ac (from August to October)	
Jones	oats, timothy, and annual rye @ 120 lbs/ac	winter wheat, timothy and hairy vetch @ 200 lbs/ac (after July 01)	
Lee	annual rye (for cool soils) or oats (for warm soils)	not specified	annual rye (for cool soils) or oats (for warm soils)
Linn	oats, annual rye, and timothy( Jan 01-July 01)	winter wheat, slender wheatgrass, and hairy vetch (July 02-December 31)	
Mahaska	oats @ 1.5 bu/ac	oats @ 1.5 bu/ac	annual rye @ 30 lbs/ac and winter wheat @ 1 bu/ac
Marion	oats @ 1.5 bu/ac	oats @ 1.5 bu/ac	annual rye @ 50 lbs/ac or winter rye @ 1 bu/ac
Mitchell	oats @ 1 bu/ac	not specified	oats @ 1 bu/ac
Montgomery	not specified	oats @ 3 - 5 bu/ac	not specified
Muscatine	oats @ 1.5 bu/ac	winter rye @ 1.5 bu/ac	winter rye @ 1.5 bu/ac
Page	oats @ 1-2 bu/ac	not specified	winter rye @ 0.75 - 1 bu/ac
Palo Alto	oats and timothy	oats and timothy	oats and timothy
Pocahontas	oats @ 1.5 bu/ac	not specified	oats @ 1.5 bu/ac
Polk	annual rye @ 50 lbs/ac	annual rye @ 50 lbs/ac	annual rye @ 50 lbs/ac
Pottawattamie	oats 2.25 bu/ac	not specified	winter wheat of winter rye @ 2.25 bu/ac
Poweshiek	Not used	Not used	Not used
Sac	oats @ 1.5 bu/ac	oats @ 1.5 bu/ac	oats @ 1.5 bu/ac
Shelby	oats @ 0.75 bu/ac	not specified	winter rye @ 0.5 bu/ac
Story	annual rye	Japanese millet (cover crop)	winter rye
Washington	oats	not specified	annual rye and winter rye
Webster	Not used	Not used	Not used
Winnebago	annual rye @ 70 lbs/ac	annual rye @ 70 lbs/ac	annual rye @ 70 lbs/ac

Appendix 8. Likes and dislikes of mulch blends used by IRVM counties that hydroseed.

# Counties	Mulch Type&Blends	Mulch Comments
14	100% recycled paper	<p><b>Likes</b> - creates solid mat, can apply a thin coat, covers well, local vendor, inexpensive, vendor stores the mulch, easy to handle, plastic wrapped, easy to use and transport, doesn't plug, seed sticks to mulch better, carries over in tank till the next day, has dye to see coverage, holds moisture, stays on site well, mixes well.</p> <p><b>Dislikes</b> - if it runs it will keep running, applied too thick soffocates seed, plastic contaminants doesn't hold as well, dusty when mixing, bales get hard if they sit around, plastic pieces plug pump and nozzle.</p>
9	70:30 wood:paper	<p><b>Likes</b> - no fish-eyes, blends well, reasonably priced, dye goes away fast, flows through the machine good, bales are easy to break apart when mixing, better coverage and spray distance than cheap paper mulches, helps stand establishment, easy to see where sprayed, holds better through rain.</p> <p><b>Dislikes</b> - dusty, auger won't chew it up if added too fast, bales are hard and may have to be broken by hand, Flexterra is expensive, can clog the pump, slurry needs to be agitated longer, more expensive than 100% recycled paper.</p>
5	100% wood	<p><b>Likes</b> - dissolves in slurry easy, forms a dense mat, sticks better than paper, no chunking or pump plugging, mixes easy.</p> <p><b>Dislikes</b> - dusty when mixing, dye coats your hands, Flexterra is expensive,</p>
5	50:50 wood:paper	<p><b>Likes</b> - Sticks better and mat lasts longer than 100% recycled paper, mixes easy, good coverage easy to see where applied, works well.</p> <p><b>Dislikes</b> - hard to mix, mulch bales get hard if they get wet, nozzle can plug from wood chunks, bales get hard over winter, difficult to keep in place on slopes.</p>
3	100% corn stover	<p><b>Likes</b> - local vendor, good coverage, easy to use, holds moisture near seed, easy to break apart when mixing.</p> <p><b>Dislikes</b> - dusty, hard to clean out of the machine,</p>
2	80:20 wood:paper	<p><b>Likes</b> - covers nicely, easy to break apart when mixing, affordable, chops up well when mixing</p> <p><b>Dislikes</b> - expensive, color fades quickly.</p>
1	80:20 corn stover:paper	<p><b>Likes</b> - local vendor, low cost, keeps moisture on the seed.</p> <p><b>Dislikes</b> - sometimes doesn't mix well and can plug the nozzle.</p>
1	70:30 corn stover:paper	<p><b>Likes</b> - mat stays longer than 100% recycled newspaper.</p> <p><b>Dislikes</b> - needs longer agitation so material can go through the pump.</p>



Appendix 9. Hydroseeding methods that incorporate straw or erosion blankets that IRVM counties use to reduce soil erosion in the ROW.

County	Hydroseeding Method
Allamakee	installs erosion blankets after hydroseeding with the 1-step or 2-step method
Audubon	1st step - broadcast seed natives&nurse crop seed; 2nd step - install erosion blanket; 3rd step - water, some native&nurse crop seed, mulch, tack
Black Hawk	1st step - water, native&nurse crop seed; 2nd step - apply straw to the site; 3rd step - water, mulch, tack
Clayton	1st step - water, native&nurse crop seed, mulch; 2nd step - apply straw to site
Clinton	installs erosion blankets after hydroseeding with the 1-step or 2-step method
Des Moines	1st step - broadcast seed natives&nurse crop seed; 2nd step-install erosion blankets; 3rd step - water, native&nurse crop seed, mulch, tack
Des Moines	1st step - broadcast only forbs; 2nd step - water, grass&nurse crop seed,mulch, tack; 3rd step - apply straw to the site
Fayette	installs erosion blankets after hydroseeding with the 1-step or 2-step method
Hardin	1st step - water, native&nurse crop seed, some mulch; 2nd step - apply straw to the site; 3rd step - water, mulch, tack
Hardin	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site
Henry	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site
Jefferson	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site and crimp (on wet ditch bottoms)
Johnson	applies straw on the site or installs erosion blankets after hydroseeding with the 1-step or 2-step method
Jones	applies straw on sites with surface water present after hydroseeding with the 1-step or 2-step method
Lee	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site
Linn	1st step - water, native&nurse crop seed; 2nd step - apply straw to the site; 3rd step - water, mulch, tack
Mahaska	1st step - broadcast seed natives&nurse crop seed; 2nd step - apply straw to the site; 3rd step - water, tack
Page	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site or install erosion blankets
Palo Alto	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - install erosion blankets
Polk	1st step - water, native&nurse crop seed, fertilizer; 2nd step - apply straw to the site or install erosion blankets
Pottawattamie	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - apply straw to the site
Shelby	1st step - water, native&nurse crop seed, mulch, tack; 2nd step - install erosion blankets
Story	1st step - broadcast seed natives&nurse crop seed; 2nd step - install erosion blankets; 3rd step - water, native&nurse crop seed, mulch, tack
Washington	1st step - water, native&nurse crop seed, tack; 2nd step - apply strawto the site or install erosion blankets

Appendix 10. Hydroseeding methods of 10 IRVM counties selected for site visits in June 2012.

Summary of hydroseeding methods of 10 IRVM Counties in Iowa.			
County	Hydro Method	Hydroseeding (steps and ingredients)	Rate (gal.)
Buchanan	1-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (8 bales/ac.), No Tack	1,250
Buchanan	2-Step*	1st Step - Water, Native&Nurse Crop Seed; 2nd Step - Water, Mulch (8 bales/ac), No Tack	2,500
Cerro Gordo	1-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (28 bales/ac.), Tack	3,200
Cerro Gordo	2-Step*	1st Step - Water, Native&Nurse Crop Seed; 2nd Step - Water, Mulch (28 bales/ac.), Tack	6,400
Des Moines	1-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (24-40 bales/ac.), Fertilizer (on poor soils), Tack (in mulch)	2,700-3,600
Des Moines	2-Step*	1st Step - Broadcast forbs; 2nd Step - Water, Native Grasses&Nurse Crop Seed, Mulch (24-40 bales/ac.), Tack (in mulch)	2,700-3,600
Fayette	1-Step	1st step - Water, Native&Nurse Crop Seed, Mulch (8-12 bales/ac), Tack	1,200-1,500
Fayette	2-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (2 bales/ac.); 2nd Step - Water, Mulch (8-12 bales/ac.), Tack	2,400-3,000
Hardin	1-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (18 bales/ac.) + Tackifier	2,400
Hardin	3-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (9 bales/ac); 2nd Step - Apply Straw (2000lbs/ac); 3rd Step - Water, Mulch (18 bales/ac.), Tack	4,800
Mitchell	1-Step*	1st Step - Water, Native&Nurse Crop Seed, No Mulch and No Tack	278
Montgomery	1-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (32 bales/ac.), Tack	3,200
Pocahontas	1-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (32 bales/ac.), No Tack	4,000
Sac	1-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (10 bales/ac.), No Tack	3,400
Story	1-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (36 bales/ac.), Tack	4,500
Story	2-Step	1st Step - Water, Native&Nurse Crop Seed, Mulch (4 bales/ac.); 2nd Step - Water, Some Native&Nurse Seed, Mulch (32 bales/ac.), Tack	9,000
Story	3-Step*	1st Step - Water, Native&Nurse Crop Seed, Mulch (4 bales/ac.); 2nd Step - Cultipack; 3rd Step - Water, Mulch (32 bales/ac.), Tack	9,000
* Hydroseeding method chosen for site assessment			

Appendix 11. Locations of assessed hydroseeded plantings in 10 IRVM counties visited in June 2012.

ROW locations of hydroseeded plantings assessed in June 2012.		
County	Site 1 Location (quadrat sampled, walking survey)	Site 2 Location (walking plant survey only)
Buchanan	N&S ROW on 240th Ave west of V71	N&S ROW on 180th, west of 187
Cerro Gordo	S ROW on 263rd west of Kingbird	N ROW on 260th Ave east of Ulmus Ave
Des Moines	N ROW on Hwy. 99 at Strawberry Point	Corner of 158th & south Prairie Grove Rd.
Fayette	N&S ROW on Spruce Rd. north of 250th	E&W ROW on M Ave. north of 170th
Hardin	E&W ROW on V Ave. north of 270th St.	NW corner of 160th & Hwy S56
Mitchell	E&W ROW on Cameo Ave. north of 390th	S ROW on 370th east of Cameo Ave.
Montgomery	S ROW on 155th west of Spruce	N&S ROW on 210th east of Hwy 71
Pocahontas	N&S ROW on 580th east of 270th	E ROW on 250th Ave. south of 590th
Sac	E ROW on Shasta Ave across from cemetery	Location not recorded
Story	E&W ROW on 580th north of Hwy 30	N&S ROW on 640th Ave east of 272nd St.

Appendix 12. Plant inventory of twenty hydroseeded sites in 10 Iowa IRVM counties conducted in late June 2012.

**Grasses/Sedges/Rushes**

**Common**

Western wheatgrass  
 Big bluestem  
 Side-oats grama  
 Bluejoint  
 Plains oval sedge  
 Davis' sedge  
 Heavy sedge  
 Porcupine sedge  
 Troublesome sedge  
 Wooley sedge  
 Fox sedge  
 Yellow nutgrass  
 Spike-rush sp.  
 Canada wildrye  
 Virginia wildrye  
 Scouring rush  
 Dudley's rush  
 Path rush  
 Torrey's rush  
 Switchgrass  
 Little bluestem  
 Dark green bulrush  
 Woolgrass  
 Nut-rush  
 Indiangrass  
 Prairie cordgrass  
 Tall dropseed  
 Prairie dropseed  
 Porcupine grass

**Legumes**

Leadplant  
 Hog peanut  
 Canada milkvetch  
 Partridge pea  
 White prairie clover  
 Purple prairie clover  
 Illinois bundleflower

**Scientific**

*Agropyron smithii*  
*Andropogon gerardii*  
*Bouteloua curtipendula*  
*Calamagrostis canadensis*  
*Carex brevior*  
*Carex davisii*  
*Carex gravida*  
*Carex hystericina*  
*Carex molesta*  
*Carex pellita*  
*Carex vulpinoidea*  
*Cyperus esculentus*  
*Eleocharis spp.*  
*Elymus canadensis*  
*Elymus virginicus*  
*Equisetum hyemale*  
*Juncus dudleyii*  
*Juncus tenuis*  
*Juncus torreyii*  
*Panicum virgatum*  
*Schizachyrium scoparium*  
*Scirpus atrovirens*  
*Scirpus cyperinus*  
*Scleria spp.*  
*Sorghastrum nutans*  
*Spartina pectinata*  
*Sporobolis asper*  
*Sporobolis heterolepis*  
*Stipa spartea*  
  
*Amorpha canescens*  
*Amphicarpaea bracteata*  
*Astragalus canadensis*  
*Chamaecrista fasciculata*  
*Dalea candida*  
*Dalea purpurea*  
*Desmanthus illinoensis*

**Forbs**

**Common**

Common yarrow  
 Common ragweed  
 Giant ragweed  
 Canada anemone  
 Thimbleweed  
 Dogbane  
 Prairie sage  
 Swamp milkweed  
 Common milkweed  
 Butterfly milkweed  
 Whorled milkweed  
 Sky blue aster  
 Heath aster  
 Smooth blue aster  
 New England Aster  
 Frost aster  
 Redstem aster  
 White wild indigo  
 False boneset  
 Field thistle  
 Tickseed coreopsis  
 Plains coreopsis  
 Pale purple coneflower  
 Purple coneflower  
 Daisy fleabane  
 Rattlesnake master  
 Flowering spurge  
 Northern bedstraw  
 Cream gentian  
 Sneezeweed  
  
 Saw-tooth sunflower  
 Maximilian sunflower  
 Prairie sunflower  
 Ox-eye sunflower  
 Mare's tail  
 Prairie blazingstar  
 Great blue lobelia

**Scientific**

*Achillea millefolium*  
*Ambrosia artemisiifolia*  
*Ambrosia trifida*  
*Anemone canadensis*  
*Anemone cylindrica*  
*Apocynum spp.*  
*Artemisia ludoviciana*  
*Asclepias incarta*  
*Asclepias syriaca*  
*Asclepias tuberosa*  
*Asclepias verticillata*  
*Aster azureus*  
*Aster ericoides*  
*Aster laevis*  
*Aster novae-angliae*  
*Aster pilosus*  
*Aster puniceus*  
*Baptisia alba*  
*Brickellia eupatorioides*  
*Cirsium discolor*  
*Coreopsis lanceolata*  
*Coreopsis tinctoria*  
*Echinacea pallida*  
*Echinacea purpurea*  
*Erigeron strigosus*  
*Eryngium yuccifolium*  
*Euphorbia corollata*  
*Galium boreale*  
*Gentiana alba*  
*Helenium autumnale*  
*Helianthus grosseserratus*  
*Helianthus maximiliani*  
*Helianthus rigidus*  
*Heliopsis helianthoides*  
*Hippuris vulgaris*  
*Liatris pycnostachya*  
*Lobelia siphilitica*

Showy tick trefoil	<i>Desmodium canadense</i>	Fringed loosestrife	<i>Lysimachia ciliata</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Winged-angled loosestrife	<i>Lythrum alatum</i>
American vetch	<i>Vicia americana</i>	Wild bergamot	<i>Monarda fistulosa</i>
<b>Trees/Shrubs/Vines</b>		Common evening primrose	<i>Oenothera laciniata</i>
Boxelder	<i>Acer negundo</i>	Stiff goldenrod	<i>Oligonueron rigidum</i>
Silver maple	<i>Acer saccharinum</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
			<i>Parthenium</i>
Gray dogwood	<i>Cornus racemosa</i>	Wild quinine	<i>integrifolium</i>
Red-osier dogwood	<i>Cornus stolonifera</i>	Lousewort	<i>Pedicularis canadensis</i>
Green ash	<i>Fraxinus lanceolata</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
Red cedar	<i>Juniperus virginiana</i>	Large flower beardtongue	<i>Penstemon grandiflorus</i>
Red mulberry	<i>Morus rubra</i>	Clammy ground cherry	<i>Physalis pubescens</i>
	<i>Parthenocissus</i>		
Virginia creeper	<i>quinquefolia</i>	Virginia ground cherry	<i>Physalis virginiana</i>
Cottonwood	<i>Populus deltoides</i>	Plantain	<i>Plantago spp.</i>
Choke cherry	<i>Prunus virginiana</i>	Solomans seal	<i>Polygonatum biflorum</i>
Oak	<i>Quercus spp.</i>	Smartweed	<i>Polygonum spp.</i>
Sumac	<i>Rhus spp.</i>	Prairie cinquefoil	<i>Potentilla arguta</i>
Black locust	<i>Robinia pseudoacacia</i>	Self heal	<i>Prunella lanceolata</i>
Wild rose	<i>Rosa spp.</i>	Hairy mountin mint	<i>Pycnanthemum pilosum</i>
			<i>Pycnanthemum</i>
Black raspberry	<i>Rubus occidentalis</i>	Common mountain mint	<i>virginianum</i>
Willow	<i>Salix spp.</i>	Long-headed coneflower	<i>Ratibida columnifera</i>
Elderberry	<i>Sambucus canadensis</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Poison ivy	<i>Toxicodendron negundo</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Slippery elm	<i>Ulmus rubra</i>	Sweet coneflower	<i>Rudbeckia subtomentosa</i>
Wild grape	<i>Vitis spp.</i>	Rosinweed	<i>Silphium integrifolium</i>
<b>Exotics (Non-Native)</b>	<b>Scientific</b>	Compass plant	<i>Silphium laciniatum</i>
Redtop	<i>Agrostis gigantea</i>	Cup plant	<i>Silphium perfoliatum</i>
Common burdock	<i>Arctium minus</i>	False solomn's seal	<i>Smilacina racemosa</i>
Smooth brome	<i>Bromus inermis</i>	Black nightshade	<i>Solanum americanum</i>
Japanese brome	<i>Bromus japonicus</i>	Horse nettle	<i>Solanum carolinense</i>
Marijuana	<i>Cannabis sativa</i>	Canada goldenrod	<i>Solidago canadensis</i>
Musk thistle	<i>Carduus nutans</i>	Germander	<i>Teucrium canadense</i>
Lamb's quarters	<i>Chenopodium album</i>	Meadow-rue	<i>Thalictrum dasycarpum</i>
Canada thistle	<i>Cirsium arvense</i>	Prairie spiderwort	<i>Tradescantia bracteata</i>
Bull thistle	<i>Cirsium vulgare</i>	Ohio spiderwort	<i>Tradescantia ohiensis</i>
Field bindweed	<i>Convolvulus arvensis</i>	Cattail	<i>Typha latifolia</i>
Orchardgrass	<i>Dactylis glomerata</i>	Blue vervain	<i>Verbina hastata</i>
Queen Anne's lace	<i>Daucus carota</i>	Hoary vervain	<i>Verbina stricta</i>
Teasel	<i>Dipsacus sylvestris</i>	White vervain	<i>Verbina urticifolia</i>
Tall fescue	<i>Festuca arundinacea</i>	Ironweed	<i>Vernonia fasciculata</i>
			<i>Veronicastrum</i>
Day lily	<i>Hemerocallis fulva</i>	Culver's root	<i>virginicum</i>
Common St John's wort	<i>Hypericum perforatum</i>	Common violet	<i>Viola pratincola</i>
Peppergrass	<i>Lepidium spp.</i>	Golden alexanders	<i>Zizia aurea</i>
Chinese bushclover	<i>Lespedeza cuneata</i>		
Shasta daisy	<i>Leucanhemum superbum</i>		
Perennial rye	<i>Lolium perenne</i>		
Honeysuckle	<i>Lonicera tatarica</i>		

Birdsfoot trefoil	<i>Lotus corniculatus</i>
Black medic	<i>Medicago lupulina</i>
Alfalfa	<i>Medicago sativa</i>
White sweet clover	<i>Melilotus alba</i>
Yellow sweet clover	<i>Melilotus officinalis</i>
Sweet clover	<i>Melilotus spp.</i>
Catnip	<i>Nepeta cataria</i>
Wild parsnip	<i>Pastinaca sativa</i>
Reed canarygrass	<i>Phalaris arundinacea</i>
Timothy	<i>Phleum pratense</i>
Kentucky bluegrass	<i>Poa pratensis</i>
Multiflora rose	<i>Rosa multiflora</i>
Curly dock	<i>Rumex crispus</i>
Bouncing bet	<i>Saponaria officinalis</i>
Foxtail	<i>Setaria spp.</i>
Sow thistle	<i>Sonchus asper</i>
Johnson grass	<i>Sorghum halepense</i>
Dandelion	<i>Taraxacum officinale</i>
Goat's-beard	<i>Tragopogon dubias</i>
Alsike clover	<i>Trifolium hybridum</i>
Red clover	<i>Trifolium pratense</i>
Siberian elm	<i>Ulmus pumila</i>
Common mullein	<i>Verbascum thapsus</i>
Hairy vetch	<i>Vicia villosa</i>

Appendix 13. Sedges and rushes detected in 20 hydroseeded ROW plantings in 10 IRVM counties sampled in July 2012.

Scientific	Common	Counties found in	Included in Seed Mix
<i>Carex brevior</i>	shortbeak sedge	Cerro Gordo, Des Moines, Mitchell, Montgomery, Sac ,Story	NO
<i>Carex davisii</i>	Davis' sedge	Sac	NO
<i>Carex gravida</i>	heavy sedge	Buchanan, Cerro Gordo, Fayette, Mitchell, Story	NO
<i>Carex hystericina</i>	porcupine sedge	Buchanan	NO
<i>Carex molesta</i>	troublesome sedge	Buchanan, Hardin	NO
<i>Carex pellita</i>	woolly sedge	Fayette, Sac, Story	NO
<i>Carex vulpinoidea</i>	fox sedge	Buchanan, Hardin, Mitchell	YES
<i>Cyperus esculentus</i>	yellow nutgrass	Montgomery	NO
<i>Eleocharis spp.</i>	spike-rush spp.	Montgomery	NO
<i>Juncus dudleyii</i>	Dudley's rush	Buchanan, Hardin, Story	NO
<i>Juncus tenuis</i>	path rush	Cerro Gordo, Mitchell, Sac	NO
<i>Juncus torreyii</i>	Torrey's rush	Hardin, Montgomery	NO
<i>Scleria spp.</i>	nut-rush spp.	Montgomery	NO
<i>Scirpus atrovirens</i>	dark-green bulrush	Buchanan, Cerro Gordo, Des Moines, Mitchell, Montgomery	YES
<i>Scirpus cyperinus</i>	woolgrass	Buchanan	NO

Appendix 14. Vegetation sampling results of one hydroseeded ROW planting in each of 10 Iowa IRVM counties conducted in July 2012.

County	Hydro Method	Total Species Detected		Mean Cover (%)		Mean Species Richness (#/0.25m <sup>2</sup> )		Cover Class (%) for Entire Site
		Natives	Exotics	Natives	Exotics	Natives	Exotics	
Mitchell	1-Step (no mulch, no tack)	46	17	75%	16%	5.4	1.9	50% - 75%
Sac	1-Step (low mulch, no tack)	36	10	90%	10%	5.0	1.5	> 75%
Pocahontas	1-Step (high mulch, no tack)	38	13	78%	18%	5.4	2.9	50% - 75%
Montgomery	1-Step (high mulch, tack)	36	22	84%	14%	5.2	2.3	50% - 75%
Buchanan	2-Step (low mulch, no tack)	43	11	70%	16%	4.8	2.7	50% - 75%
Fayette	2-Step (low mulch, tack)	39	13	102%	8%	6.1	1.8	> 75%
Cerro Gordo	2-Step (high mulch, tack)	30	15	64%	22%	4.3	2.7	50% - 75%
Des Moines	2-Step (high mulch, tack, broadcast forbs)	30	7	68%	11%	1.8	0.9	50% - 75%
Hardin	3-Step (high mulch, tack, straw)	36	15	60%	38%	4.6	2.7	< 50%
Story	3-Step (high mulch, tack, cultipack)	55	12	94%	6%	7.0	1.1	> 75%



Appendix 15. Plant inventory of 2 hydroseeded plantings in Mitchell County sampled in June 2012.

Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Giant ragweed	<i>Ambrosia trifida</i>
Plains oval sedge	<i>Carex brevior</i>	Prairie sage	<i>Artemisia ludoviciana</i>
Heavy sedge	<i>Carex gravida</i>	Swamp milkweed	<i>Asclepias incarta</i>
Fox sedge	<i>Carex vulpinoidea</i>	Common milkweed	<i>Asclepias syriaca</i>
Canada wildrye	<i>Elymus canadensis</i>	Butterfly milkweed	<i>Asclepias tuberosa</i>
Scouring rush	<i>Equisetum hyemale</i>	Whorled milkweed	<i>Asclepias verticillata</i>
Path rush	<i>Juncus tenuis</i>	Smooth blue aster	<i>Aster laevis</i>
Switchgrass	<i>Panicum virgatum</i>	New England Aster	<i>Aster novae-angliae</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Northern bedstraw	<i>Galium boreale</i>
Indiangrass	<i>Sorghastrum nutans</i>	Prairie sunflower	<i>Helianthus rigidus</i>
Tall dropseed	<i>Sporobolus asper</i>	Ox-eye sunflower	<i>Helipopsis helianthoides</i>
Prairie dropseed	<i>Sporobolus heterolepis</i>	Mare's tail	<i>Hippuris vulgaris</i>
Porcupine grass	<i>Stipa spartea</i>	Wild bergamot	<i>Monarda fistulosa</i>
<b>Legumes</b>		Stiff goldenrod	<i>Oligoneuron rigidum</i>
Leadplant	<i>Amorpha canescens</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Lousewort	<i>Pedicularis canadensis</i>
White prairie clover	<i>Dalea candida</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
Purple prairie clover	<i>Dalea purpurea</i>	Large flower beardtongue	<i>Penstemon grandiflorus</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Clammy ground cherry	<i>Physalis pubescens</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Virginia ground cherry	<i>Physalis virginiana</i>
American vetch	<i>Vicia americana</i>	Smartweed	<i>Polygonum spp.</i>
<b>Trees/Shrubs/Vines</b>		Yellow coneflower	<i>Ratibida pinnata</i>
Boxelder	<i>Acer negundo</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Red cedar	<i>Juniperus virginiana</i>	Sweet coneflower	<i>Rudbeckia subtomentosa</i>
Red mulberry	<i>Morus rubra</i>	Rosinweed	<i>Silphium integrifolium</i>
Cottonwood	<i>Populus deltoides</i>	Black nightshade	<i>Solanum americanum</i>
Wild rose	<i>Rosa spp.</i>	Canada goldenrod	<i>Solidago canadensis</i>
Black raspberry	<i>Rubus occidentalis</i>	Germander	<i>Teucrium canadense</i>
Poison ivy	<i>Toxicodendron negundo</i>	Ohio spiderwort	<i>Tradescantia ohiensis</i>
<b>Exotics (Non-Native)</b>		Culver's root	<i>Veronicastrum virginicum</i>
Smooth brome	<i>Bromus inermis</i>	Common violet	<i>Viola pratensis</i>
Canada thistle	<i>Cirsium arvense</i>		
Field bindweed	<i>Convolvulus arvensis</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Peppergrass	<i>Lepidium spp.</i>		
Perennial rye	<i>Lolium perenne</i>		
Black medic	<i>Medicago lupulina</i>		
Alfalfa	<i>Medicago sativa</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Wild parsnip	<i>Pastinaca sativa</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Timothy	<i>Phleum pratense</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Bouncing bet	<i>Saponaria officinalis</i>		
Sow thistle	<i>Sonchus asper</i>		
Dandelion	<i>Taraxacum officinale</i>		
Goatsbeard	<i>Tragopogon dubius</i>		
Red clover	<i>Trifolium pratense</i>		
Siberian elm	<i>Ulmus pumila</i>		
Common mullein	<i>Verbascum thapsus</i>		

Appendix 16. Plant inventory of 2 hydroseeded plantings in Montgomery County sampled in June 2012.

<b>Grasses/Sedges/Rushes</b>		<b>Forbs</b>	
<b>Common</b>	<b>Scientific</b>	<b>Common</b>	<b>Scientific</b>
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Dogbane	<i>Apocynum spp.</i>
Bluejoint	<i>Calamagrostis canadensis</i>	Common milkweed	<i>Asclepias syriaca</i>
Plains oval sedge	<i>Carex brevior</i>	Frost aster	<i>Aster pilosus</i>
Yellow nutgrass	<i>Cyperus esculentus</i>	False boneset	<i>Brickellia eupatorioides</i>
Spike-rush sp.	<i>Eleocharis spp.</i>	Field thistle	<i>Cirsium discolor</i>
Canada wildrye	<i>Elymus canadensis</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Scouring rush	<i>Equisetum hyemale</i>	Daisy fleabane	<i>Erigeron strigosus</i>
Path rush	<i>Juncus tenuis</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Torrey's rush	<i>Juncus torreyi</i>	Saw-tooth sunflower	<i>Helianthus grosseserratus</i>
Switchgrass	<i>Panicum virgatum</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Mare's tail	<i>Hippuris vulgaris</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Wild bergamot	<i>Monarda fistulosa</i>
Nut-rush	<i>Scleria spp.</i>	Common evening primrose	<i>Oenothera laciniata</i>
Indiangrass	<i>Sorghastrum nutans</i>	Virginia ground cherry	<i>Physalis virginiana</i>
Prairie cordgrass	<i>Spartina pectinata</i>	Plantain	<i>Plantago spp.</i>
Tall dropsced	<i>Sporobolus asper</i>	Long-headed coneflower	<i>Ratibida columnifera</i>
<b>Legumes</b>		Yellow coneflower	<i>Ratibida pinnata</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Horse nettle	<i>Solanum carolinense</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Canada goldenrod	<i>Solidago canadensis</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Germander	<i>Teucrium canadense</i>
<b>Trees/Shrubs/Vines</b>		Cattail	<i>Typha latifolia</i>
Red mulberry	<i>Morus rubra</i>	Hoary vervain	<i>Verbina stricta</i>
Virginia creeper	<i>Parthenocissus quinquefolia</i>	Ironweed	<i>Vernonia fasciculata</i>
Choke cherry	<i>Prunus virginiana</i>	Golden alexanders	<i>Zizia aurea</i>
Sumac	<i>Rhus spp.</i>		
Willow	<i>Salix spp.</i>		
Slippery elm	<i>Ulmus rubra</i>		
Wild grape	<i>Vitis spp.</i>		
<b>Exotics (Non-Native)</b>			
Redtop	<i>Agrostis gigantea</i>		
Smooth brome	<i>Bromus inermis</i>		
Japanese brome	<i>Bromus japonicus</i>		
Musk thistle	<i>Carduus nutans</i>		
Lamb's quarters	<i>Chenopodium album</i>		
Canada thistle	<i>Cirsium arvense</i>		
Field bindweed	<i>Convolvulus arvensis</i>		
Orchardgrass	<i>Dactylis glomerata</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Tall fescue	<i>Festuca arundinacea</i>		
Chinese bushclover	<i>Lespedeza cuneata</i>		
Birdsfoot trefoil	<i>Lotus corniculatus</i>		
Black medic	<i>Medicago lupulina</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Wild parsnip	<i>Pastinaca sativa</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Bouncing bet	<i>Saponaria officinalis</i>		
Sow thistle	<i>Sonchus asper</i>		
Dandelion	<i>Taraxacum officinale</i>		
Red clover	<i>Trifolium pratense</i>		
Siberian elm	<i>Ulmus pumila</i>		

Appendix 17. Plant inventory of 2 hydroseeded plantings in Pocahontas County sampled in June 2012.

<b>Grasses/Sedges/Rushes</b>		<b>Forbs</b>	
<b>Common</b>	<b>Scientific</b>	<b>Common</b>	<b>Scientific</b>
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Giant ragweed	<i>Ambrosia trifida</i>
Canada wildrye	<i>Elymus canadensis</i>	Swamp milkweed	<i>Asclepias incarta</i>
Scouring rush	<i>Equisetum hyemale</i>	Common milkweed	<i>Asclepias syriaca</i>
Switchgrass	<i>Panicum virgatum</i>	New England Aster	<i>Aster novae-angliae</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Indiangrass	<i>Sorghastrum nutans</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Prairie cordgrass	<i>Spartina pectinata</i>	Winged-angled loosestrife	<i>Lythrum alatum</i>
Tall dropseed	<i>Sporobolus asper</i>	Wild bergamot	<i>Monarda fistulosa</i>
<b>Legumes</b>		Stiff goldenrod	<i>Oligoneron rigidum</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
Purple prairie clover	<i>Dalea purpurea</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Clammy ground cherry	<i>Physalis pubescens</i>
American vetch	<i>Vicia americana</i>	Virginia ground cherry	<i>Physalis virginiana</i>
<b>Trees/Shrubs/Vines</b>		Smartweed	<i>Polygonum spp.</i>
Red-osier dogwood	<i>Cornus stolonifera</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Red cedar	<i>Juniperus virginiana</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Red mulberry	<i>Morus rubra</i>	Rosinweed	<i>Silphium integrifolium</i>
Wild rose	<i>Rosa spp.</i>	Compass plant	<i>Silphium laciniatum</i>
Willow	<i>Salix spp.</i>	Hoary vervain	<i>Verbina stricta</i>
Slippery elm	<i>Ulmus rubra</i>	Common violet	<i>Viola pratincola</i>
<b>Exotics (Non-Native)</b>		Golden alexanders	<i>Zizia aurea</i>
Smooth brome	<i>Bromus inermis</i>		
Japanese brome	<i>Bromus japonicus</i>		
Lamb's quarters	<i>Chenopodium album</i>		
Canada thistle	<i>Cirsium arvense</i>		
Field bindweed	<i>Convolvulus arvensis</i>		
Perennial rye	<i>Lolium perenne</i>		
Black medic	<i>Medicago lupulina</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Catnip	<i>Nepeta cataria</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Foxtail	<i>Setaria spp.</i>		
Sow thistle	<i>Sonchus asper</i>		
Dandelion	<i>Taraxacum officinale</i>		
Red clover	<i>Trifolium pratense</i>		

Appendix 18. Plant inventory of 2 hydroseeded plantings in Sac County sampled in June 2012.

<b>Grasses/Sedges/Rushes</b>		<b>Forbs</b>	
<b>Common</b>	<b>Scientific</b>	<b>Common</b>	<b>Scientific</b>
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Giant ragweed	<i>Ambrosia trifida</i>
Plains oval sedge	<i>Carex brevior</i>	Common milkweed	<i>Asclepias syriaca</i>
Davis' sedge	<i>Carex davisii</i>	Butterfly milkweed	<i>Asclepias tuberosa</i>
Heavy sedge	<i>Carex gravida</i>	Frost aster	<i>Aster pilosus</i>
Wooley sedge	<i>Carex pellita</i>	Redstem aster	<i>Aster puniceus</i>
Canada wildrye	<i>Elymus canadensis</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Virginia wildrye	<i>Elymus virginicus</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Scouring rush	<i>Equisetum hyemale</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Path rush	<i>Juncus tenuis</i>	Prairie blazingstar	<i>Liatris pycnostachya</i>
Switchgrass	<i>Panicum virgatum</i>	Wild bergamot	<i>Monarda fistulosa</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Common evening primrose	<i>Oenothera laciniata</i>
Indiangrass	<i>Sorghastrum nutans</i>	Stiff goldenrod	<i>Oligonueron rigidum</i>
Tall dropseed	<i>Sporobolis asper</i>	Virginia ground cherry	<i>Physalis virginiana</i>
<b>Legumes</b>		Plantain	<i>Plantago spp.</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Compass plant	<i>Silphium laciniatum</i>
Purple prairie clover	<i>Dalea purpurea</i>	Canada goldenrod	<i>Solidago canadensis</i>
<b>Trees/Shrubs/Vines</b>		Golden alexanders	<i>Zizia aurea</i>
Silver maple	<i>Acer saccharinum</i>		
Choke cherry	<i>Prunus virginiana</i>		
Wild rose	<i>Rosa spp.</i>		
Willow	<i>Salix spp.</i>		
Slippery elm	<i>Ulmus rubra</i>		
<b>Exotics (Non-Native)</b>			
Smooth brome	<i>Bromus inermis</i>		
Marijuana	<i>Cannabis sativa</i>		
Canada thistle	<i>Cirsium arvense</i>		
Bull thistle	<i>Cirsium vulgare</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Tall fescue	<i>Festuca arundinacea</i>		
Day lily	<i>Hemerocallis fulva</i>		
Honeysuckle	<i>Lonicera tatarica</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Johnson grass	<i>Sorghum halepense</i>		
Dandelion	<i>Taraxacum officinale</i>		
Goatsbeard	<i>Tragopogon dubias</i>		
Red clover	<i>Trifolium pratense</i>		

Appendix 19. Plant inventory of 2 hydroseeded plantings in Buchanan County sampled in June 2012.

Walking inventory of two hydroseeded sites in Buchanan County, Iowa conducted in late June 2012			
Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Big bluestem	<i>Andropogon gerardii</i>	Giant ragweed	<i>Ambrosia trifida</i>
Heavy sedge	<i>Carex gravida</i>	Dogbane	<i>Apocynum spp.</i>
Porcupine sedge	<i>Carex hystericina</i>	Swamp milkweed	<i>Asclepias incarta</i>
Troublesome sedge	<i>Carex molesta</i>	Common milkweed	<i>Asclepias syriaca</i>
Fox sedge	<i>Carex vulpinoidea</i>	Frost aster	<i>Aster pilosus</i>
Canada wildrye	<i>Elymus canadensis</i>	White wild indigo	<i>Baptisia alba</i>
Scouring rush	<i>Equisetum hyemale</i>	Field thistle	<i>Cirsium discolor</i>
Dudley's rush	<i>Juncus dudleyi</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Switchgrass	<i>Panicum virgatum</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Prairie blazingstar	<i>Liatris pycnostachya</i>
Woolgrass	<i>Scirpus cyperinus</i>	Wild bergamot	<i>Monarda fistulosa</i>
Indiangrass	<i>Sorghastrum nutans</i>	Stiff goldenrod	<i>Oligoneuron rigidum</i>
Prairie cordgrass	<i>Spartina pectinata</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
Tall dropseed	<i>Sporobolus asper</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
<b>Legumes</b>		Clammy ground cherry	<i>Physalis pubescens</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Smartweed	<i>Polygonum spp.</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Purple prairie clover	<i>Dalea purpurea</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Sweet coneflower	<i>Rudbeckia subtomentosa</i>
<b>Trees/Shrubs/Vines</b>		Compass plant	<i>Silphium laciniatum</i>
Red-osier dogwood	<i>Cornus stolonifera</i>	Cup plant	<i>Silphium perfoliatum</i>
Red mulberry	<i>Morus rubra</i>	False solomn's seal	<i>Smilacina racemosa</i>
Wild rose	<i>Rosa spp.</i>	Canada goldenrod	<i>Solidago canadensis</i>
Black raspberry	<i>Rubus occidentalis</i>	Germander	<i>Teucrium canadense</i>
Elderberry	<i>Sambucus canadensis</i>	Meadow-rue	<i>Thalictrum dasycarpum</i>
Wild grape	<i>Vitis spp.</i>	Ohio spiderwort	<i>Tradescantia ohioensis</i>
<b>Exotics (Non-Native)</b>		Blue vervain	<i>Verbena hastata</i>
Smooth brome	<i>Bromus inermis</i>	Hoary vervain	<i>Verbena stricta</i>
Canada thistle	<i>Cirsium arvense</i>	Culver's root	<i>Veronicastrum virginicum</i>
Field bindweed	<i>Convolvulus arvensis</i>	Common violet	<i>Viola pratensis</i>
Orchardgrass	<i>Dactylis glomerata</i>	Golden alexanders	<i>Zizia aurea</i>
Queen Anne's lace	<i>Daucus carota</i>		
Common St John's wort	<i>Hypericum perforatum</i>		
Perennial rye	<i>Lolium perenne</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Catnip	<i>Nepeta cataria</i>		
Wild parsnip	<i>Pastinaca sativa</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Timothy	<i>Phleum pratense</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Dandelion	<i>Taraxacum officinale</i>		
Red clover	<i>Trifolium pratense</i>		

Appendix 20. Plant inventory of 2 hydroseeded plantings in Cerro Gordo County sampled in June 2012.

Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Big bluestem	<i>Andropogon gerardii</i>	Common yarrow	<i>Achillea millefolium</i>
Plains oval sedge	<i>Carex brevior</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Heavy sedge	<i>Carex gravida</i>	Giant ragweed	<i>Ambrosia trifida</i>
Scouring rush	<i>Equisetum hyemale</i>	Prairie sage	<i>Artemisia ludoviciana</i>
Path rush	<i>Juncus tenuis</i>	Swamp milkweed	<i>Asclepias incarta</i>
Switchgrass	<i>Panicum virgatum</i>	Common milkweed	<i>Asclepias syriaca</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Sky blue aster	<i>Aster azureus</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	New England Aster	<i>Aster novae-angliae</i>
Indiangrass	<i>Sorghastrum nutans</i>	Frost aster	<i>Aster pilosus</i>
Prairie cordgrass	<i>Spartina pectinata</i>	Redstem aster	<i>Aster puniceus</i>
Tall dropseed	<i>Sporobolus asper</i>	White wild indigo	<i>Baptisia alba</i>
<b>Legumes</b>		Pale purple coneflower	<i>Echinacea pallida</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Northern bedstraw	<i>Galium boreale</i>
White prairie clover	<i>Dalea candida</i>	Cream gentian	<i>Gentiana alba</i>
Purple prairie clover	<i>Dalea purpurea</i>	Sneezeweed	<i>Helenium autumnale</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Saw-tooth sunflower	<i>Helianthus grosseserratus</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
<b>Trees/Shrubs/Vines</b>		Mare's tail	<i>Hippuris vulgaris</i>
Cottonwood	<i>Populus deltoides</i>	Prairie blazingstar	<i>Liatris pycnostachya</i>
Choke cherry	<i>Prunus virginiana</i>	Wild bergamot	<i>Monarda fistulosa</i>
Wild rose	<i>Rosa spp.</i>	Stiff goldenrod	<i>Oligonueron rigidum</i>
Black raspberry	<i>Rubus occidentalis</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
Wild grape	<i>Vitis spp.</i>	Large flower beardtongue	<i>Penstemon grandiflorus</i>
<b>Exotics (Non-Native)</b>		Clammy ground cherry	<i>Physalis pubescens</i>
Smooth brome	<i>Bromus inermis</i>	Virginia ground cherry	<i>Physalis virginiana</i>
Canada thistle	<i>Cirsium arvense</i>	Common mountain mint	<i>Pycnanthemum virginianum</i>
Queen Anne's lace	<i>Daucus carota</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Tall fescue	<i>Festuca arundinacea</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Shasta daisy	<i>Leucanhemum superbum</i>	Rosinweed	<i>Silphium integrifolium</i>
Black medic	<i>Medicago lupulina</i>	Compass plant	<i>Silphium laciniatum</i>
Alfalfa	<i>Medicago sativa</i>	Canada goldenrod	<i>Solidago canadensis</i>
White sweet clover	<i>Melilotus alba</i>	Ohio spiderwort	<i>Tradescantia ohioensis</i>
Yellow sweet clover	<i>Melilotus officinalis</i>	Cattail	<i>Typha latifolia</i>
Wild parsnip	<i>Pastinaca sativa</i>	Blue vervain	<i>Verbina hastata</i>
Reed canarygrass	<i>Phalaris arundinacea</i>	Golden alexanders	<i>Zizia aurea</i>
Timothy	<i>Phleum pratense</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Dandelion	<i>Taraxacum officinale</i>		
Red clover	<i>Trifolium pratense</i>		
Siberian elm	<i>Ulmus pumila</i>		

Appendix 21. Plant inventory of 2 hydroseeded plantings in Des Moines County sampled in June 2012.

Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Dogbane	<i>Apocynum spp.</i>
Plains oval sedge	<i>Carex brevior</i>	Common milkweed	<i>Asclepias syriaca</i>
Wooley sedge	<i>Carex pellita</i>	Butterfly milkweed	<i>Asclepias tuberosa</i>
Canada wildrye	<i>Elymus canadensis</i>	Sky blue aster	<i>Aster azureus</i>
Scouring rush	<i>Equisetum hyemale</i>	Heath aster	<i>Aster ericoides</i>
Switchgrass	<i>Panicum virgatum</i>	New England Aster	<i>Aster novae-angliae</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Frost aster	<i>Aster pilosus</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Tickseed coreopsis	<i>Coreopsis lanceolata</i>
Indiangrass	<i>Sorghastrum nutans</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Tall dropseed	<i>Sporobolus asper</i>	Daisy fleabane	<i>Erigeron strigosus</i>
<b>Legumes</b>		Maximilian sunflower	<i>Helianthus maximiliani</i>
Leadplant	<i>Amorpha canescens</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Hog peanut	<i>Amphicarpaea bracteata</i>	Mare's tail	<i>Hippuris vulgaris</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Wild bergamot	<i>Monarda fistulosa</i>
Purple prairie clover	<i>Dalea purpurea</i>	Stiff goldenrod	<i>Oligonueron rigidum</i>
Illinois bundleflower	<i>Desmanthus illinoensis</i>	Shell leaf penstemon	<i>Penstemon digitalis</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Clammy ground cherry	<i>Physalis pubescens</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Self heal	<i>Prunella lanceolata</i>
<b>Trees/Shrubs/Vines</b>		Hairy mountain mint	<i>Pycnanthemum pilosum</i>
Silver maple	<i>Acer saccharinum</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Gray dogwood	<i>Cornus racemosa</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Red cedar	<i>Juniperus virginiana</i>	Rosinweed	<i>Silphium integrifolium</i>
Cottonwood	<i>Populus deltoides</i>	Compass plant	<i>Silphium laciniatum</i>
Oak	<i>Quercus spp.</i>	Canada goldenrod	<i>Solidago canadensis</i>
Black locust	<i>Robinia pseudoacacia</i>	Ohio spiderwort	<i>Tradescantia ohioensis</i>
Wild rose	<i>Rosa spp.</i>	Cattail	<i>Typha latifolia</i>
Poison ivy	<i>Toxicodendron negundo</i>	Blue vervain	<i>Verbena hastata</i>
Slippery elm	<i>Ulmus rubra</i>	Hoary vervain	<i>Verbena stricta</i>
<b>Exotics (Non-Native)</b>		White vervain	<i>Verbena urticifolia</i>
Smooth brome	<i>Bromus inermis</i>		
Musk thistle	<i>Carduus nutans</i>		
Bull thistle	<i>Cirsium vulgare</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Tall fescue	<i>Festuca arundinacea</i>		
Birdsfoot trefoil	<i>Lotus corniculatus</i>		
Sweet clover	<i>Melilotus spp.</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Red clover	<i>Trifolium pratense</i>		
Common mullein	<i>Verbascum thapsus</i>		

Appendix 22. Plant inventory of 2 hydroseeded plantings in Fayette County sampled in June 2012.

<b>Grasses/Sedges/Rushes</b>		<b>Forbs</b>	
<b>Common</b>	<b>Scientific</b>	<b>Common</b>	<b>Scientific</b>
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Giant ragweed	<i>Ambrosia trifida</i>
Heavy sedge	<i>Carex gravida</i>	Canada anemone	<i>Anemone canadensis</i>
Wooley sedge	<i>Carex pellita</i>	Dogbane	<i>Apocynum spp.</i>
Canada wildrye	<i>Elymus canadensis</i>	Prairie sage	<i>Artemisia ludoviciana</i>
Scouring rush	<i>Equisetum hyemale</i>	Swamp milkweed	<i>Asclepias incarta</i>
Switchgrass	<i>Panicum virgatum</i>	Common milkweed	<i>Asclepias syriaca</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Butterfly milkweed	<i>Asclepias tuberosa</i>
Indiangrass	<i>Sorghastrum nutans</i>	Whorled milkweed	<i>Asclepias verticillata</i>
Tall dropseed	<i>Sporobolus asper</i>	New England Aster	<i>Aster novae-angliae</i>
Prairie dropseed	<i>Sporobolus heterolepis</i>	Frost aster	<i>Aster pilosus</i>
<b>Legumes</b>		Redstem aster	<i>Aster puniceus</i>
Leadplant	<i>Amorpha canescens</i>	White wild indigo	<i>Baptisia alba</i>
Canada milkvetch	<i>Astragalus canadensis</i>	False boneset	<i>Brickellia eupatorioides</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Field thistle	<i>Cirsium discolor</i>
White prairie clover	<i>Dalea candida</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Purple prairie clover	<i>Dalea purpurea</i>	Daisy fleabane	<i>Erigeron strigosus</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Flowering spurge	<i>Euphorbia corollata</i>
<b>Trees/Shrubs/Vines</b>		Northern bedstraw	<i>Galium boreale</i>
Boxelder	<i>Acer negundo</i>	Saw-tooth sunflower	<i>Helianthus grosseserratus</i>
Silver maple	<i>Acer saccharinum</i>	Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Red mulberry	<i>Morus rubra</i>	Mare's tail	<i>Hippuris vulgaris</i>
Virginia creeper	<i>Parthenocissus quinquefolia</i>	Wild bergamot	<i>Monarda fistulosa</i>
Cottonwood	<i>Populus deltoides</i>	Common evening primrose	<i>Oenothera laciniata</i>
Sumac	<i>Rhus spp.</i>	Stiff goldenrod	<i>Oligoneuron rigidum</i>
Wild rose	<i>Rosa spp.</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
Black raspberry	<i>Rubus occidentalis</i>	Wild quinine	<i>Parthenium integrifolium</i>
Elderberry	<i>Sambucus canadensis</i>	Large flower beardtongue	<i>Penstemon grandiflorus</i>
Slippery elm	<i>Ulmus rubra</i>	Clammy ground cherry	<i>Physalis pubescens</i>
Wild grape	<i>Vitis spp.</i>	Virginia ground cherry	<i>Physalis virginiana</i>
<b>Exotics (Non-Native)</b>		Plantain	<i>Plantago spp.</i>
Smooth brome	<i>Bromus inermis</i>	Solomans seal	<i>Polygonatum biflorum</i>
Canada thistle	<i>Cirsium arvense</i>	Common mountain mint	<i>Pycnanthemum virginianum</i>
Field bindweed	<i>Convolvulus arvensis</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Queen Anne's lace	<i>Daucus carota</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Tall fescue	<i>Festuca arundinacea</i>	Rosinweed	<i>Silphium integrifolium</i>
Peppergrass	<i>Lepidium spp.</i>	Compass plant	<i>Silphium laciniatum</i>
Perennial rye	<i>Lolium perenne</i>	Canada goldenrod	<i>Solidago canadensis</i>
Birdsfoot trefoil	<i>Lotus corniculatus</i>	Poison ivy	<i>Toxicodendron negundo</i>
Black medic	<i>Medicago lupulina</i>	Ohio spiderwort	<i>Tradescantia ohioensis</i>
Alfalfa	<i>Medicago sativa</i>	Hoary vervain	<i>Verbena stricta</i>
White sweet clover	<i>Melilotus alba</i>	Golden alexanders	<i>Zizia aurea</i>
Wild parsnip	<i>Pastinaca sativa</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Timothy	<i>Phleum pratense</i>		
Multiflora rose	<i>Rosa multiflora</i>		
Curly dock	<i>Rumex crispus</i>		
Sow thistle	<i>Sonchus asper</i>		
Dandelion	<i>Taraxacum officinale</i>		
Goat's-beard	<i>Tragopogon dubias</i>		
Alsike clover	<i>Trifolium hybridum</i>		
Red clover	<i>Trifolium pratense</i>		
Common mullein	<i>Verbascum thapsus</i>		



Appendix 23. Plant inventory of 2 hydroseeded plantings in Hardin County sampled in June 2012.

Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Western wheatgrass	<i>Agropyron smithii</i>	Common yarrow	<i>Achillea millefolium</i>
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Side-oats grama	<i>Bouteloua curtipendula</i>	Giant ragweed	<i>Ambrosia trifida</i>
Troublesome sedge	<i>Carex molesta</i>	Common milkweed	<i>Asclepias syriaca</i>
Fox sedge	<i>Carex vulpinoidea</i>	New England Aster	<i>Aster novae-angliae</i>
Canada wildrye	<i>Elymus canadensis</i>	Frost aster	<i>Aster pilosus</i>
Scouring rush	<i>Equisetum hyemale</i>	White wild indigo	<i>Baptisia alba</i>
Dudley's rush	<i>Juncus dudleyii</i>	Field thistle	<i>Cirsium discolor</i>
Torrey's rush	<i>Juncus torreyii</i>	Tickseed coreopsis	<i>Coreopsis lanceolata</i>
Switchgrass	<i>Panicum virgatum</i>	Plains coreopsis	<i>Coreopsis tinctoria</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Indiangrass	<i>Sorghastrum nutans</i>	Daisy fleabane	<i>Erigeron strigosus</i>
Tall dropseed	<i>Sporobolus asper</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
<b>Legumes</b>		Ox-eye sunflower	<i>Heliopsis helianthoides</i>
Canada milkvetch	<i>Astragalus canadensis</i>	Mare's tail	<i>Hippuris vulgaris</i>
Partridge pea	<i>Chamaecrista fasciculata</i>	Great blue lobelia	<i>Lobelia siphilitica</i>
Purple prairie clover	<i>Dalea purpurea</i>	Fringed loosestrife	<i>Lysimachia ciliata</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Winged-angled loosestrife	<i>Lythrum alatum</i>
<b>Trees/Shrubs/Vines</b>		Wild bergamot	<i>Monarda fistulosa</i>
Green ash	<i>Fraxinus lanceolata</i>	Common evening primrose	<i>Oenothera laciniata</i>
Red mulberry	<i>Morus rubra</i>	Stiff goldenrod	<i>Oligonueron rigidum</i>
Cottonwood	<i>Populus deltoides</i>	Yellow wood sorrel	<i>Oxalis stricta</i>
Sumac	<i>Rhus spp.</i>	Smartweed	<i>Polygonum spp.</i>
Black locust	<i>Robinia pseudoacacia</i>	Common mountain mint	<i>Pycnanthemum virginianum</i>
Wild rose	<i>Rosa spp.</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Black raspberry	<i>Rubus occidentalis</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Willow	<i>Salix spp.</i>	Compass plant	<i>Silphium laciniatum</i>
Slippery elm	<i>Ulmus rubra</i>	Canada goldenrod	<i>Solidago canadensis</i>
Wild grape	<i>Vitis spp.</i>	Germander	<i>Teucrium canadense</i>
<b>Exotics (Non-Native)</b>		Cattail	<i>Typha latifolia</i>
Redtop	<i>Agrostis gigantea</i>	Blue vervain	<i>Verbena hastata</i>
Smooth brome	<i>Bromus inermis</i>	Hoary vervain	<i>Verbena stricta</i>
Lamb's quarters	<i>Chenopodium album</i>	Golden alexanders	<i>Zizia aurea</i>
Canada thistle	<i>Cirsium arvense</i>		
Orchardgrass	<i>Dactylis glomerata</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Tall fescue	<i>Festuca arundinacea</i>		
Day lily	<i>Hemerocallis fulva</i>		
Common St John's wort	<i>Hypericum perforatum</i>		
Perennial rye	<i>Lolium perenne</i>		
Honeysuckle	<i>Lonicera tatarica</i>		
White sweet clover	<i>Melilotus alba</i>		
Yellow sweet clover	<i>Melilotus officinalis</i>		
Catnip	<i>Nepeta cataria</i>		
Wild parsnip	<i>Pastinaca sativa</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Timothy	<i>Phleum pratense</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Dandelion	<i>Taraxacum officinale</i>		
Goat's-beard	<i>Tragopogon dubias</i>		
Red clover	<i>Trifolium pratense</i>		
Siberian elm	<i>Ulmus pumila</i>		
Common mullein	<i>Verbascum thapsus</i>		
Hairy vetch	<i>Vicia villosa</i>		

Appendix 24. Plant inventory of 2 hydroseeded plantings in Story County sampled in June 2012.

Grasses/Sedges/Rushes		Forbs	
Common	Scientific	Common	Scientific
Big bluestem	<i>Andropogon gerardii</i>	Common ragweed	<i>Ambrosia artemisiifolia</i>
Plains oval sedge	<i>Carex brevior</i>	Giant ragweed	<i>Ambrosia trifida</i>
Heavy sedge	<i>Carex gravida</i>	Thimbleweed	<i>Anemone cylindrica</i>
Wooley sedge	<i>Carex pellita</i>	Dogbane	<i>Apocynum spp.</i>
Canada wildrye	<i>Elymus canadensis</i>	Common milkweed	<i>Asclepias syriaca</i>
Scouring rush	<i>Equisetum hyemale</i>	Butterfly milkweed	<i>Asclepias tuberosa</i>
Dudley's rush	<i>Juncus dudleyi</i>	Heath aster	<i>Aster ericoides</i>
Switchgrass	<i>Panicum virgatum</i>	Smooth blue aster	<i>Aster laevis</i>
Little bluestem	<i>Schizachyrium scoparium</i>	Frost aster	<i>Aster pilosus</i>
Dark green bulrush	<i>Scirpus atrovirens</i>	Redstem aster	<i>Aster puniceus</i>
Indiangrass	<i>Sorghastrum nutans</i>	Field thistle	<i>Cirsium discolor</i>
Prairie cordgrass	<i>Spartina pectinata</i>	Pale purple coneflower	<i>Echinacea pallida</i>
Tall dropseed	<i>Sporobolus asper</i>	Rattlesnake master	<i>Eryngium yuccifolium</i>
Prairie dropseed	<i>Sporobolus heterolepis</i>	Saw-tooth sunflower	<i>Helianthus grosseserratus</i>
<b>Legumes</b>		Maximilian sunflower	<i>Helianthus maximiliani</i>
Purple prairie clover	<i>Dalea purpurea</i>	Prairie sunflower	<i>Helianthus rigidus</i>
Illinois bundleflower	<i>Desmanthus illinoensis</i>	Ox-eye sunflower	<i>Helopsis helianthoides</i>
Showy tick trefoil	<i>Desmodium canadense</i>	Mare's tail	<i>Hippuris vulgaris</i>
Round-headed bush clover	<i>Lespedeza capitata</i>	Prairie blazingstar	<i>Liatris pycnostachya</i>
<b>Trees/Shrubs/Vines</b>		Wild bergamot	<i>Monarda fistulosa</i>
Gray dogwood	<i>Cornus racemosa</i>	Common evening primrose	<i>Oenothera lacinata</i>
Green ash	<i>Fraxinus lanceolata</i>	Stiff goldenrod	<i>Oligoneuron rigidum</i>
Red cedar	<i>Juniperus virginiana</i>	Clammy ground cherry	<i>Physalis pubescens</i>
Red mulberry	<i>Morus rubra</i>	Virginia ground cherry	<i>Physalis virginiana</i>
Choke cherry	<i>Prunus virginiana</i>	Plantain	<i>Plantago spp.</i>
Wild rose	<i>Rosa spp.</i>	Solomans seal	<i>Polygonatum biflorum</i>
Slippery elm	<i>Ulmus rubra</i>	Smartweed	<i>Polygonum spp.</i>
Wild grape	<i>Vitis spp.</i>	Prairie cinquefoil	<i>Potentilla arguta</i>
<b>Exotics (Non-Native)</b>		Common mountain mint	<i>Pycnanthemum virginianum</i>
Smooth brome	<i>Bromus inermis</i>	Yellow coneflower	<i>Ratibida pinnata</i>
Canada thistle	<i>Cirsium arvense</i>	Black-eyed susan	<i>Rudbeckia hirta</i>
Field bindweed	<i>Convolvulus arvensis</i>	Compass plant	<i>Silphium laciniatum</i>
Orchardgrass	<i>Dactylis glomerata</i>	Cup plant	<i>Silphium perfoliatum</i>
Queen Anne's lace	<i>Daucus carota</i>	Canada goldenrod	<i>Solidago canadensis</i>
Tall fescue	<i>Festuca arundinacea</i>	Prairie spiderwort	<i>Tradescantia bracteata</i>
Birdsfoot trefoil	<i>Lotus corniculatus</i>	Ohio spiderwort	<i>Tradescantia ohioensis</i>
Black medic	<i>Medicago lupulina</i>	Hoary vervain	<i>Verbina stricta</i>
White sweet clover	<i>Melilotus alba</i>	Common violet	<i>Viola pratensis</i>
Sweet clover	<i>Melilotus spp.</i>	Golden alexanders	<i>Zizia aurea</i>
Wild parsnip	<i>Pastinaca sativa</i>		
Reed canarygrass	<i>Phalaris arundinacea</i>		
Timothy	<i>Phleum pratense</i>		
Kentucky bluegrass	<i>Poa pratensis</i>		
Curly dock	<i>Rumex crispus</i>		
Bouncing bet	<i>Saponaria officinalis</i>		
Foxtail	<i>Setaria spp.</i>		
Sow thistle	<i>Sonchus asper</i>		
Dandelion	<i>Taraxacum officinale</i>		
Goatsbeard	<i>Tragopogon dubias</i>		
Red clover	<i>Trifolium pratense</i>		
Common mullein	<i>Verbascum thapsus</i>		