Long-term Revegetation Success of Industry Reclamation Techniques for Native Mixedgrass Prairie

Cypress Uplands and Majorville Uplands Case Studies

Cypress Uplands—Early Seral Stage

Cypress Uplands—Mid-Seral Stage

Cypress Uplands—Late Seral Stage

Majorville Uplands Natural Recovery Site

Prepared For:

PTAC Petroleum Technology Alliance Canada

Prepared By:

Jane Lancaster, Marilyn Neville and Laura Hickman

May 2012

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Date: May 2012

FINAL

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Sponsorship

Alberta Upstream Petroleum Research Fund
Canadian Association of Petroleum Producers

Range Resource Management Program
Government of Alberta Sustainable Resource Development

Husky Energy

Cenovus Energy Inc.

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Acknowledgements

The authors would like to acknowledge a funding partnership for this research project from; the Alberta Upstream Petroleum Research Fund, administered through the Petroleum Technology Alliance Canada, Husky Energy, and Cenovus Energy Inc., and Alberta Sustainable Resource Development Range Resource Management Program. The authors would also like to acknowledge Barry Adams, Head Range Resource Management Program, ASRD and Kevin France, Range Management Specialist for the Grassland Natural Region, ASRD for providing guidance on research design and expertise during the review of the draft. Husky Energy and Bellatrix Exploration generously provided access to their infrastructure and safety support to conduct the field programs.

Executive Summary

The purpose of this research project is to provide industry and the government of Alberta regulatory agencies with results and key learnings regarding the long term recovery of native mixedgrass prairie from industrial disturbance. The project focuses on minimal disturbance pipeline construction and documents the long term outcome of three revegetation strategies commonly used in the Mixedgrass Natural Subregion of Alberta, including use of natural recovery, assisted natural recovery (agronomic cover crops) and native seed mixes.

Work that was done on the Husky Majorville Sweet Gas Gathering System (JWA 2008), Cypress Pipeline (AXYS et al. 2003) and Merry Flats Sweet Gas Gathering System (AXYS et al. 2004) projects can be considered a best case scenario for restoration of Mixedgrass rangelands; the pastures are large and in generally good range health with relatively few invasive species. The oil and gas developments were led and executed by responsible people who were committed to ensuring their projects met and exceeded guidelines for minimum disturbance.

The three projects are located in two different Ecodistricts in the Mixedgrass Natural Subregion. The Husky Majorville Sweet Gas Gathering System is located in the Majorville Uplands Ecodistrict. Monitoring data was collected four years after construction and seven years after construction in 2011. The Cypress Pipeline (AXYS et al. 2003) and Merry Flats Sweet Gas Gathering System (AXYS et al. 2004) are both located in the Cypress Uplands Ecodistrict. Monitoring in 2011 provided the opportunity to expand data sets collected one, two and three years' post-disturbance with data collected 11 and 12 years post-disturbance.

Minimal Disturbance Construction Techniques for Small Diameter Pipelines

Pipeline construction procedures designed to minimize the disturbance to the native grasslands were strictly adhered to throughout construction of the three projects. Disturbance to the native grasslands was minimized to the extent possible through the following procedures:

- Winter construction;
- Construction only during suitably dry and/or frozen ground conditions. Temporary shut-down in adverse weather conditions;
- Strict adherence to access and traffic control plans;
- Use of polypropylene pipe rather than welded steel pipe wherever possible;
- Reducing the timeframe between topsoil stripping, pipe installation, back fill and topsoil replacement to 48 hours where possible;
- Two strip gravelling of existing tracks to prevent erosion and to provide stable access.

Construction procedures that differed between the projects are:

- Use of rubber tracked side booms for stringing and pipe installation (Husky);
- Implementation of no-strip trenched pipe installation in native prairie on public lands (Husky);
- Topsoil stripping restricted to approximately one metre over trench line (Cypress & Merry Flats);
- "Partial sod salvage" over the trench to reduce impact to soils and vegetation (Cypress & Merry Flats).

Revegetation Strategies

Three revegetation strategies were used on the projects:

- An assisted natural recovery strategy, using an agronomic cover crop was implemented on the Alberta portion of the Cypress Pipeline. This strategy is designed to provide cover for the first two years and then die off. The seed mix is composed of two agricultural species: annual flax and fall rye (a biennial). A 1:1 mixture of each species was seeded at half a bushel to the acre for each species.
- Native grass seed mixes, including the dominant indicator species for the surrounding plant communities, were seeded on the Saskatchewan portion of the Cypress Pipeline and the Merry Flats Drilling Program, also located in Saskatchewan. The seed mix was applied at 12 kilograms (kgs) per hectare with a Kinsella Accuroller.
- Natural recovery of bare soils, relying on the soil seed and propagule bank and infill from surrounding grassland was the strategy implemented on the Husky Majorville Project.

The 2011 monitoring was conducted on upland ecological range sites where quantitative data had been collected in previous years for the Cypress, Merry Flats and Majorville projects. Data in 2011 is 12 year after construction of the Cypress project, 11 years after construction of the Merry Flats project and seven years after construction of the Majorville project.

A range health assessment was also conducted in 2011 on disturbed soils and adjacent undisturbed reference plots for the Cypress Upland Ecodistrict sites (including Cypress and Merry Flats Project areas) and Majorville Upland Ecodistrict monitoring projects, based on the current manual developed by Alberta Sustainable Resource Development (ASRD) *Rangeland Health Assessment for Grassland, Forest & Tame Pasture Field Workbook (*Adams et al 2009*)*. Range health assessment provides perspective on the ecological function of reclaiming communities. This technique also links current land use to the condition of the reclaiming grassland.

Data was interpreted in the context of new tools developed for classifying rangelands including; Grassland Vegetation Inventory (GVI) mapping of ecological range sites (ASRD and LandWise Inc. 2010) and the "*Mixedgrass Range Plant Community Guide*" (Adams et al. 2004), which links naturally occurring plant communities to ecological range sites. The Cypress Upland monitoring project is situated on shallow to gravel ecological ranges sites and the Majorville Upland project is situated on loamy and limey ecological range sites.

A series of disturbance plant communities that develop over time were identified for the Cypress Uplands monitoring data based on plant community ordination results.

Restoring Site Stability (Vegetation Cover, Litter and Bare Ground)

Cypress Uplands: Shallow to Gravel Ecological Range Sites

Indicators of site stability and function were compared for each of the revegetation treatments and compared to undisturbed grassland. The agronomic cover crop produced more live cover in the first two years compared to the native seed mixes. However, after 11 to 12 years, vegetation cover levels are similar between all the treatments and the undisturbed grassland, varying between 54% and 70% cover.

Litter accumulation reduces soil exposure and helps re-establish nutrient cycling in a disturbance plant community. Litter levels have slowly risen over time for all the revegetation treatments. For each of the monitoring years, litter levels were consistently 5% to 20% higher in the native seed mix treatments than in the assisted natural recovery treatment. However, differences in litter cover are not significant between the revegetation treatments and the undisturbed grassland after 11-12 years.

The agronomic cover crop established early and reduced exposure of bare ground more than the native seed mixes did in the first two years after seeding. However, all three native seed mix treatments resulted in less bare ground in the third year than the assisted natural recovery treatment. Eleven to twelve years after disturbance, exposure of bare ground on the assisted natural recovery treatment and the native seed treatment is still significantly higher than the 0.4% bare ground on the undisturbed grassland. Average soil exposure on the native seed mix sites is 4.6%. The assisted natural recovery sites averaged the most bare ground and had the greatest variability between sites, averaging 18.6% substrate exposure.

Majorville Uplands: Loamy and Limey Ecological Range Sites

On the natural recovery sites, bare soils exposure has decreased from 50% after four years to 7.6% after seven years recovery but is still greater than the 0.3% bare soil exposure on undisturbed grassland.

Litter accumulation is variable between sites and pastures, with litter being comparable to undisturbed grassland on several sites and less but increasing after four and seven years natural recovery on the majority of sites.

Restoring Range Health

Cypress Uplands: Shallow to Gravel Ecological Range Sites

Range health assessment (Adams et al. 2009) provides a measure of ecosystem function. In the Cypress Uplands study, disturbance plant communities, regardless of which revegetation strategy was used, scored in the "healthy with problems" range after 11 to 12 years of recovery. This indicates considerable progress towards restoration. The three measures that reduced the scores of the disturbance plant communities were the composition of the plant community, missing structural layers and the amount of litter accumulation.

Majorville Uplands: Loamy and Limey Ecological Range Sites

In the Majorville Uplands study, where natural recovery was the revegetation strategy, range health scores increased for all disturbance communities between four and seven years after construction, indicating that the process of infill is occurring. Exposure of bare ground decreased from 2008 to 2011 and total vegetation cover increased within the sample sites.

Restoring Plant Communities

Cypress Uplands: Shallow to Gravel Ecological Range Sites

Assisted Natural Recovery versus Native Seed Mixes: There are no traces of the agronomic cover crop species (common flax and fall rye) persisting after 12 years. The species present are all native and have established naturally from propagules, the seedbank or through infill. The composition of the plant community is very similar to the undisturbed grassland. The cover of rough fescue is still significantly higher on the undisturbed sites at 36% cover versus 14% cover on the disturbance. The early seral grass needle-and-thread and the disturbance forb pasture sagewort are more common on the disturbed site, but in general the cover values reflect what occurs naturally on these rangelands.

The primary differences between the composition and cover of native seed mix sites versus the undisturbed plant community or the assisted natural recovery sites is the presence of northern wheatgrass, slender wheatgrass and green needle grass cultivars at significantly higher cover than natural cover levels.

After 11 to 12 years, the cover of rough fescue is still significantly higher on the undisturbed sites than either the assisted natural recovery sites or the native seed mix sites. Both the assisted natural recovery sites and the native seed mix sites did produce rough fescue at similar average cover and similar levels of variability between sites.

Western porcupine grass, an important species in the Mixedgrass, is present at similar cover levels on seeded sites, assisted natural recovery sites and control sites.

Cover of the disturbance forb pasture sagewort is higher on both disturbance treatments compared to the undisturbed grassland.

Forb Infill on Revegetating Disturbances: Neither of the Cypress Upland revegetation strategies included introduction of native forbs to the disturbed soils. Both the assisted natural recovery and the native seed mixes resulted in some natural infill, particularly of pasture sage. A great number of forbs established on the disturbance over 11 to 12 years, about 77% of the number of species observed on undisturbed sites. None of the forbs provide much cover and very few occur with great constancy across the sites within each treatment. The most common species on the disturbances are golden bean, hairy golden aster and common yarrow.

Identifying Successional Disturbance Plant Communities: Plant community ordination identified four plant communities that developed over time on disturbances in healthy *Plains rough fescue –Western porcupine grass – Sedge* communities (MGA1(Adams et al. 2004)) on loamy and shallow to gravel range sites in the Cypress Upland. Key observations are as follows:

- Two early seral communities are identified, primarily in years two and three after seeding; one dominated by native seed mix components (Slender wheatgrass - Northern wheatgrass - Pasture sage); the other by species found naturally as well as in native seed mix 2 (Pasture sage - Northern wheatgrass - Western porcupine grass).
- The one mid seral community includes observations from both seed mixes and the cover crop treatments and observations span all years.
- The late seral plant community (Plains rough fescue - Pasture sage - Northern wheatgrass) includes observations primarily from 11 and 12 years post-seeding and includes all treatments. Both cover crop and native seed mix strategies are resulting in this community over time.
- Two of the disturbed sites seeded to a cover crop and one site seeded to a native seed mix are clustering with the reference community observations, indicating good recovery over 11 to 12 years.

Over time, 11 and 12 years after disturbance, species relationships in the revegetating Cypress Uplands grasslands are becoming more similar to each other and to the undisturbed sites. A desirable successional trend is occurring for both the cover crop revegetation strategy and the native seed mix strategies.

Majorville Uplands: Loamy and Limey Ecological Range Sites

Natural Recovery: In the initial years of natural recovery, western wheatgrass, northern wheatgrass, green needle grass and sedge species play an important role in colonizing bare soils in the Mixedgrass. Pasture and prairie sagewort play an important role in providing initial cover and shade for emerging graminoids, catching snow and conserving moisture. Over time the western and northern wheatgrasses increase in cover, stabilizing the soils with their ability to produce a network of rhizomes within the soil. Green needle grass also increases in cover as it is well adapted to disturbance. As the colonizing species provide initial structure over the soil surface, needle-and-thread grass seed rain from the adjacent undisturbed grassland is trapped within the bare soil spaces. Pasture sagewort continues to play an important role in the forb component of the plant community. Other disturbance related forbs continue to provide infill and the species composition can vary over time depending on available moisture and site conditions in the area surrounding the disturbance.

Data Gaps and Further Research Required

Data gaps include Sandy, Sands, Choppy Sandhills, and Blowout ecological range sites. The range sites were not represented in this study.

Further research is required to assess revegetation strategies and recovery trends on large disturbed areas such as full strip well sites, or large diameter pipelines in the Mixedgrass.

Research is required to determine long term recovery trends on sites where invasive non-native species such as crested wheatgrass, smooth brome, Kentucky bluegrass and sweet clover are present in the area surrounding the disturbed soils.

Further research is required to determine the most appropriate revegetation strategy (natural recovery, assisted natural recovery or native seed mixes) for disturbances located in areas with unhealthy range health scores and which of the range health indicators are most likely to affect recovery.

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

The purpose of this research project is to provide industry and the government of Alberta regulatory agencies with results and key learnings regarding the long term recovery of native mixedgrass prairie from industrial disturbance. The project focuses on minimal disturbance pipeline construction. The project documents the long term outcome of three revegetation strategies commonly used in the Mixedgrass Natural Subregion of Alberta (Natural Regions Committee 2006), including use of natural recovery, assisted natural recovery (agronomic cover crops) and native seed mixes. Previous monitoring data collected from the Husky Majorville Sweet Gas Gathering System (JWA 2008), the Cypress Pipeline (AXYS et al. 2003) and Merry Flats Sweet Gas Gathering System (AXYS et al. 2004) provided the opportunity to expand existing data sets with monitoring data collected during the 2011 growing season.

This project incorporates and builds on Mixedgrass data collected from similar long term monitoring conducted on Kinder Morgan Canada's Express Pipeline 14 years post-construction. The subsequent report entitled '*Long Term Recovery of Native Prairie from Industrial Disturbance: Express Pipeline Monitoring Project 2010'* (Kestrel Research Inc. et al 2011), documents the long term performance of native seed mixes and natural recovery as revegetation strategies in four Natural Subregions of Alberta, including the Mixedgrass.

The goal of this research project is to promote industry stewardship on increasingly pressured native prairie landscapes.

2 BACKGROUND

2.1 Cypress Pipeline and Merry Flats Project

The Cypress Pipeline and Merry Flats Drilling Program (Cypress Upland Projects) are currently owned and operated by Bellatrix Exploration. The application process and subsequent construction was implemented by the former owners, AEC Suffield Gas Pipeline Inc., a subsidiary of AEC Oil and Gas Company Ltd. The Cypress project is located south of Medicine Hat, Alberta on the southern and eastern slopes of the Cypress Hills. The Cypress Pipeline is a 6.2 kilometre natural gas pipeline extending from the East Cypress Compressor Station located in LSD 8-3-7-1 W4M in Alberta to a TransGas pipeline receipt point located in LSD 9-32-6-30 W3M in Saskatchewan. The pipeline transports sweet natural gas from the East Cypress gas field on the Alberta side of the border, into Saskatchewan to connect with the gathering system of producing wells in the area referred to as Merry Flats.

2.1.1 Setting and Regulatory History

The Cypress Pipeline project is located in the Cypress Upland Ecodistrict of the Mixedgrass Natural Subregion of Alberta. The Merry Flats Drilling program is located in the Cypress Hills Landscape Area of the Cypress Upland Ecoregion of Saskatchewan. Soils and native vegetation are typical of high elevation Mixedgrass prairie with Orthic Dark Brown soils and plains rough fescue plant communities. These native grasslands are large, contiguous blocks of intact grasslands that have not been subject to cultivation. Land use is primarily for grazing livestock, in conjunction with petroleum exploration and development.

The Cypress Pipeline is regulated by the National Energy Board (NEB) as it crosses a provincial boundary. The Merry Flats Drilling program is regulated by Saskatchewan Environmental Resource Management (SERM). Both projects were subject to a detailed application process which included environmental assessment and environmental protection planning. Subsequently the conditions of approval for both the Cypress Pipeline and the Merry Flats Drilling Program required three years of post-construction reclamation monitoring. The Cypress Pipeline was approved and constructed during December of 1999. The Merry Flats Drilling program and flow line construction was approved and implemented during the late winter of year 2000 and completed in the early spring of 2001.

2.1.2 Construction and Reclamation Methods

Pipeline construction procedures designed to minimize the disturbance to the native grasslands were strictly adhered to throughout both projects. Disturbance to the native grasslands was minimized to the extent possible through the following procedures:

- Winter construction;
- Construction only during suitably dry and/or frozen ground conditions. Temporary shut-down in adverse weather conditions;
- Strict adherence to access and traffic control plans;
- The use of polypropylene pipe rather than welded steel pipe wherever possible;
- Topsoil stripping restricted to approximately one metre over trench line;

- Reduced impact to soils and vegetation through "partial sod salvage[1]" over the trench;
- Timeframe between topsoil stripping, pipe installation, back fill and topsoil replacement reduced to 48 hours where possible;
- Two strip gravelling of existing tracks to prevent erosion and to provide stable access.

Two revegetation strategies were employed on the Cypress pipeline RoW. In Alberta, regulators request the trial of a non-native seed mix designed to provide initial cover and then die out of the stand. The seed mix is composed of two agricultural species: annual flax and fall rye. A 1:1 mixture of each species was seeded at half a bushel to the acre for each species.

On the Saskatchewan portion of the Cypress pipeline, regulators approved the use of a native grass seed mix composed of rough fescue (50%), awned wheatgrass (10%), northern wheat grass (10%), June grass (5%), green needle grass (10%), tufted hair grass (5%) and western porcupine grass (10%). The seed mix was applied at 12 kilograms (kgs) per hectare with a Kinsella Accuroller.

Three native seed mixes were approved by the Saskatchewan regulatory authorities for the Merry Flats Drilling Program. Three mixes were required due to the variability of elevation, soils, landforms and native plant communities adjacent to the RoW. Refer to Appendix A for a copy of the native seed mixes used. Seed mixes were applied at 12 kgs per hectare with a Kinsella Accuroller.

2.2 Husky Majorville Project

The Husky Majorville Sweet Gas Gathering System (the Majorville project), owned and operated by Husky Energy, is a gathering and pipeline delivery system located in the Majorville area, east of Vulcan, Alberta. The system delivers natural gas from approximately 75 shallow sweet natural gas wells to the Husky Majorville Compressor Station located in section 25-18-20 W4M.

2.2.1 Setting and Regulatory History

The Majorville project well sites and rights of way traverse native grasslands located on Crown lease land, in the Majorville Upland Ecodistrict within the Mixedgrass Natural Subregion. The Majorville Upland is a broad plain with undulating to hummocky topography, lying to the east of Lake McGregor and extending to the valley breaks of the Bow River. Soils and native vegetation are typical of the Mixedgrass with Orthic Dark Brown soils and northern and western wheat grass, needle-and-thread grass and June grass plant communities.

These native grasslands are a large, contiguous block of relatively intact grasslands that have not been subject to cultivation. Land use is primarily for grazing livestock, in conjunction with petroleum exploration and development.

The Class 1[2] pipeline gathering system required a Conservation and Reclamation (C&R) approval under the Environmental Protection and Enhancement Act (EPEA). The C&R application, submitted by Husky (Application No. 001-210452) was approved by AENV (Approval No: 210452-00-00) on Sept. 24, 2004. The approval included a number of conditions, including the requirement for three years of post-construction reclamation monitoring. The pipeline was constructed during the late fall of 2004 and completed late March of 2005.

[1]Partial sod salvage: the topsoil with the sod relatively intact was stripped with the 1 meter wide bucket of a track hoe. Sod was stored adjacent to trench during pipe installation, backfill and cleanup. Sod was replaced over trench as intact as possible within 48 hours.

[2]Class 1 pipelines are those lines with an "index" of 2690 or greater (diameter in millimeters X length in kilometers).

2.2.2 Construction and Reclamation Methods

Pipeline construction procedures designed to minimize the disturbance to the native grasslands were strictly adhered to throughout the project as detailed in the Application for Conservation and Reclamation Approval (AXYS 2004). Disturbance to the native grasslands was minimized to the extent possible through the following procedures:

- Winter construction;
- Strict adherence to access and traffic control plans;
- Construction only during suitably dry and/or frozen ground conditions. Temporary shut-down in adverse weather conditions;
- The use of composite and polypropylene pipe rather than welded steel pipe wherever possible;
- The use of rubber tracked side booms for stringing and pipe installation;
- The implementation of no-strip trenched pipe installation in native prairie on public lands;
- Reduced timeframe between trenching, backfill and final cleanup;
- Natural recovery as the revegetation strategy;
- Two strip gravelling of existing tracks to prevent erosion and to provide stable access.

3 MONITORING AND ASSESSMENT METHODS

The historic monitoring requirements for the Majorville project and the Cypress projects were different, as different regulatory authorities were involved. However the monitoring conducted in 2011 was standardized for both projects.

3.1 Historic Monitoring Methods: Cypress Project

The monitoring methods used for the Cypress Pipeline and the Merry Flats Drilling Program (the Cypress project) were consistent. The development of methods, field work, data analysis and reporting was conducted by AXYS Environmental Consulting. The Cypress Pipeline was monitored for three growing seasons. The Merry Flats Drilling Program was monitored for two years, with one drought year skipped. The general post-construction monitoring program for each project included a qualitative component which assessed and addressed issues of possible erosion, weeds and construction issues such as subsidence over the trench. The quantitative revegetation monitoring programs assessed the progress of revegetation over the disturbed soils of the trenchline. The final reports were provided to Encana Oil and Gas Co. Ltd. (formerly AEC Oil and Gas Co. Ltd.), and the appropriate regulatory authorities (AXYS January 2003 and AXYS April 2003).

Six vegetation monitoring sites were established on the Cypress Pipeline RoW: four in Alberta and two in Saskatchewan. As well, six vegetation monitoring sites were established on the Merry Flats Drilling Program: two sites in seasonal drainages, two in rough fescue dominated sites and two in western porcupine dominated sites. Vegetation sampling occurred over the trenchline (the area of soil disturbance) and at an off right of way control within the same ecological range site. The sites were chosen to represent a variety of slope and aspect positions.

Sample site locations were permanently marked on the edge of the stripped trench line with orange-coloured range pins pounded flush with the ground. The coordinates of each site were recorded using a hand held GPS in order to relocate the sites in future years.

Photographs were taken at each site, each year of monitoring to provide a visual record of the progress of revegetation over time. A one metre square frame was placed directly over the trenchline with the range pin at the northwest corner of the frame and a photograph was taken looking directly down on the frame. A second photo was taken at the control with the southwest corner of the frame one metre north of the range pin in undisturbed vegetation. This photograph was also taken looking directly down on the frame. A third photo was taken standing over the trench line looking east along the RoW with the frame in the foreground.

Micro-plot sampling for species composition and canopy cover was done using randomly tossed 1/10 metre Daubenmire frames. Ten frames were inventoried for each site on the trench line. Ten frames were inventoried off RoW in the control to compare vegetation cover to adjacent undisturbed vegetation. Percentage canopy cover estimates of all vascular vegetation, clubmoss, moss and lichen (combined), litter and bare ground were recorded.

Field observations of species cover and frequency were used to calculate a percentage cover value and a prominence value for each species present in the micro-plot frames.

3.2 Historic Monitoring Methods: Majorville Project

The terms and conditions of the AENV approval required a weed control program, the submission of a Post-Construction Reclamation Assessment Plan (Plan) to AENV for approval and the implementation of the Plan for a minimum of three growing seasons. The Plan was prepared by Jacques Whitford AXYS (JWA 2006) and submitted to Husky and AENV in July of 2006. The final report that provides a summary of the three years of monitoring was prepared and submitted to AENV and ARSD Public Lands Division (JWA 2008).

Monitoring methods during the growing season of 2006 included:

- Documenting occurrences of weeds and invasive non-native agronomic species such as crested wheatgrass and implementing appropriate control measures;
- Monitoring the rights of way (RoW) for erosion over the trenchline and the general recovery of the native vegetation on the spoil storage and traffic lane portions of the RoW; and
- The installation of permanent monitoring/photo reference sites in native rangeland at 13 randomly selected ecological range sites evaluated during the baseline pre-construction vegetation assessment.

Metal range pins flush with the ground at the edge of the trenchline permanently marked each monitoring site. GPS coordinates allowed the sites to be easily relocated. At each site Permanent Photo Reference Points were installed to provide a visual record of the progress of vegetation recovery over time. A one metre square frame was placed directly over the trenchline and a photo was taken with the view above the frame. A second photo was taken at the control with the view above the metre square frame. A third photo was taken standing over the trenchline with the direction of the view recorded to duplicate the photo in subsequent years. Photos were labelled and submitted to Husky with the annual monitoring report.

Monitoring was repeated in 2007 using the same methods.

In 2008, two vegetation inventory and Range Health Assessments were conducted at each permanent monitoring site; the first assessment was focused on the trenchline and the second located off right of way (the control) within the same ecological range site polygon. Soil characterization gathered for the C&R application was used to verify the ecological range site classification.

The assessment team followed the protocol established by ASRD Public Lands Rangeland Management Branch, entitled '*Rangeland Health Assessment for Grassland, Forest and Tame Pasture*' (Adams et al. 2005) and used the Range Plant Community Guide for the Mixedgrass Natural Subregion of Alberta, (Adams et al. 2005) to characterize the plant communities.

For each assessment (trench line and control), a 30 metre long transect comprised of ten micro-plots was installed to record vegetation species diversity and foliar cover estimates using a 20 cm x 50 cm Daubenmire frame. The trench line transect was installed over the trenchline (the area of soil disturbance). The control transect was located off right of way in the same ecological range site. Data was recorded using the standard Public Lands MF5 form. The transects provide an accurate description of the percentage foliar cover of the dominant species, exposed soil, and the total live vegetation including the moss and lichen component. Litter values were estimated at three standardized locations along each transect with a quarter metre frame and compared to litter thresholds (lbs/ac) established by SRD for the appropriate Natural Subregion and range site (Adams et al. 2005). The density and distribution of weeds within each range site were recorded using the tables provided in the Rangeland Health Assessment for Grassland, Forest and Tame Pasture (Adams et al. 2005). This information was then used to complete the Range Health Assessments for both the control and on RoW sampling sites.

Data analysis consisted of a comparison of the range health scores on RoW and at the control. Specific comparisons included: plant community type, dominant species, average percent total live vegetation including moss and lichen, and average percent exposed soil.

This project was one of the first projects to use range health assessment for an industrial application. Advice on monitoring methods, design and analysis was provided by Barry Adams, Head Range Resource Development Program, ASRD.

3.3 Current Monitoring Methods: Cypress and Majorville Projects

Monitoring was conducted on a subset of sites where data had been collected in previous years for both the Cypress (Figure 3-1) and Majorville projects (Figure 3-2). Sites were selected primarily in upland ecological range sites that are dominant features of the landscape. Quantitative methods for vegetation inventory remained the same with the following changes:

- Foliar cover estimates were used instead of canopy cover estimates; and
- Five microplot frames were assessed rather than 10 in previous years due to budget constraints.

Several additional sites were established on the Cypress project to provide sufficient data for plant community ordination analysis for the "shallow to gravel" range site (Figure 3-1).

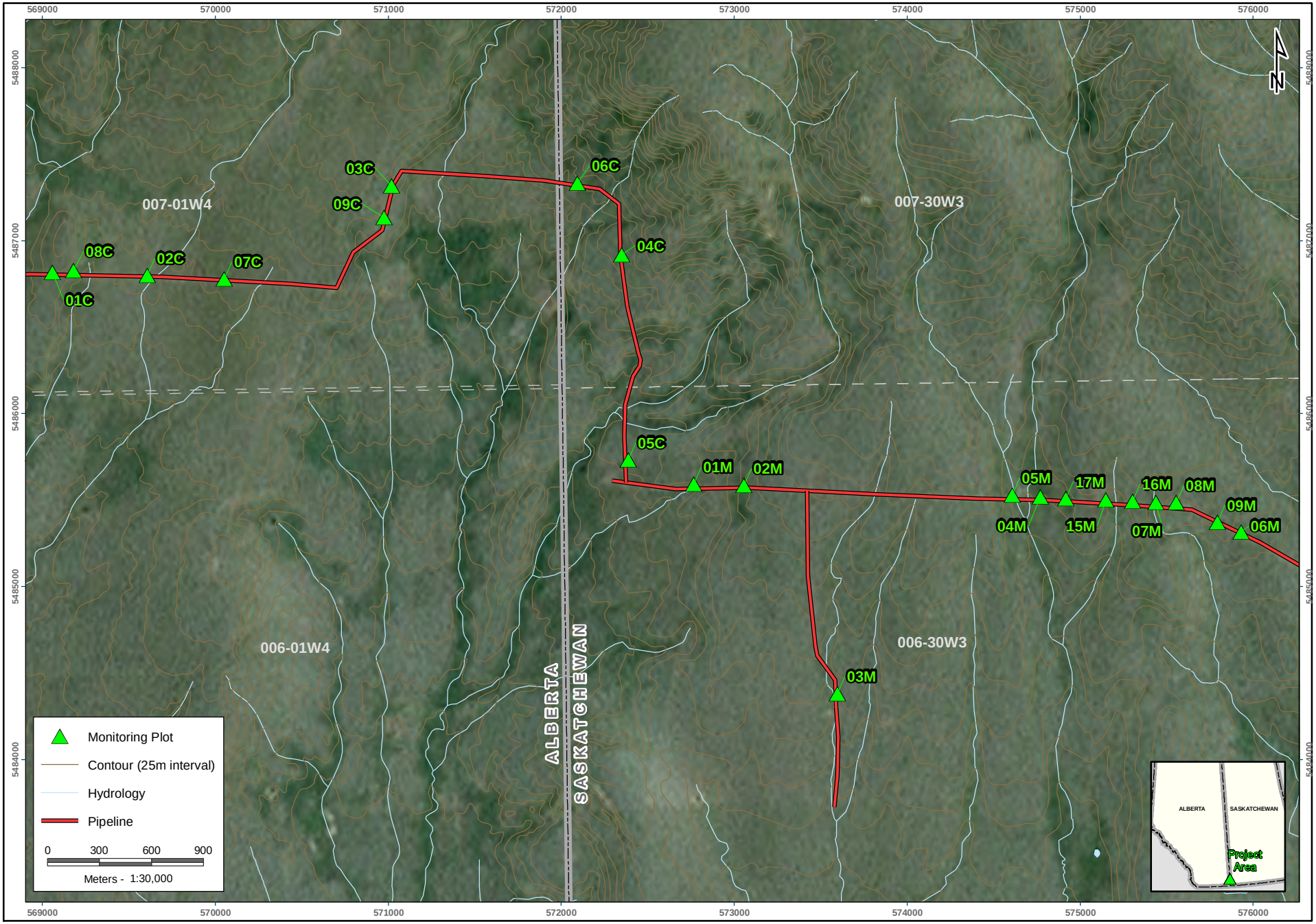
A range health assessment was also conducted on disturbed soils and undisturbed reference plots for both projects, based on the current manual developed by ASRD and LandWise Inc. (2010). Range health assessment provides perspective on the range capability of reclaiming communities. This technique also links current land use to the condition of the reclaiming grassland.

3.4 Data Analysis and Interpretation

Data was interpreted in the context of new tools developed for classifying rangelands including; Grassland Vegetation Inventory (GVI) mapping of ecological range sites (ASRD and LandWise Inc. 2010) and the "*Mixedgrass Range Plant Community Guide*" (Adams et al. 2004), which links naturally occurring plant communities to ecological range sites.

For the Cypress Uplands data on shallow to gravel range sites, a cluster analysis of data from all monitoring years was performed using hierarchical methods to identify vegetation communities by characteristic species combinations (McCune and Grace 2002). The vegetation community group identification was also supported by the following complimentary analyses: Nonmetric multidimensional scaling (NMS) ordination methods were used to align observations in a pattern along multiple axes (dimensions) (McCune and Grace 2002); and indicator species analysis was used to support and describe species groups. For details on the data analysis methods see Appendix B.

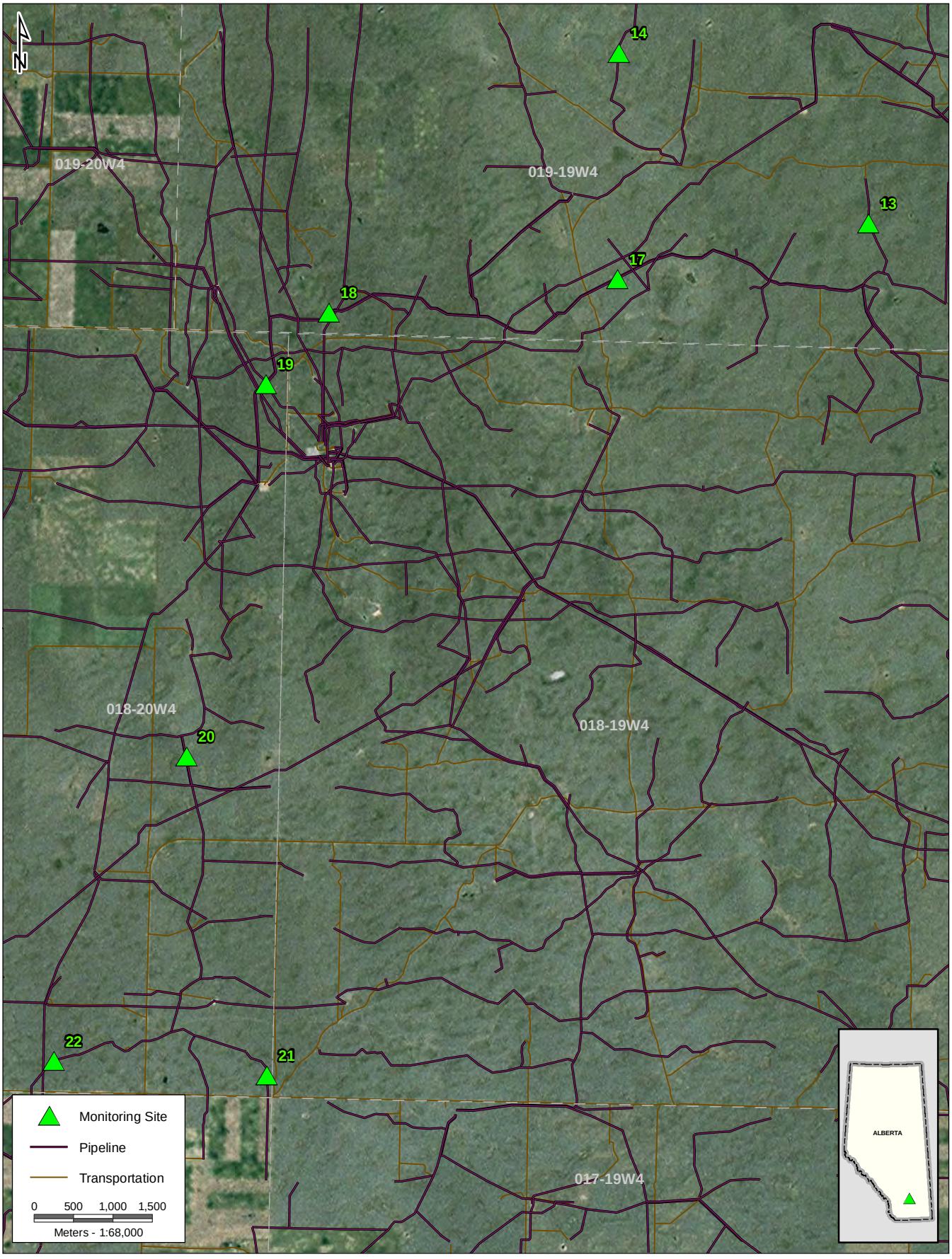
A seral stage was then assigned to the resulting community groups based on professional judgement and the plant communities described in the "*Mixedgrass Range Plant Community Guide*" (Adams et al. 2004). Definitions of seral stages for disturbance plant communities are presented in Appendix C.



Location of Cypress Uplands Monitoring Plots

FIGURE NO. 3-1

References: Base data provided by the Government of Alberta and the Goverment of Saskatchewan; Imagery provided by 2009 ESRI, i-cubed, GeoEye



Location of Majorville Uplands Monitoring Plots

FIGURE NO. **3-2**

References: Base data provided by the Government of Alberta and IHS Inc.; Imagery provided by 2009 ESRI, i-cubed, GeoEye

4 PERFORMANCE OF REVEGETATION STRATEGIES OVER TIME

4.1 Cypress Uplands – Assisted Natural Recovery and Native Seed Mixes

The quantitative revegetation monitoring data for the Cypress Uplands ecodistrict includes observations from years 1, 2, 3, 11 and 12 post-construction (Appendix D). The monitoring sites assessed are on shallow to gravel or thin loamy ecological range sites on the south-facing upper slopes of the Cypress Hills. Revegetation treatments include assisted natural recovery through use of an agronomic cover crop and seeding to three different native seed mixes (refer to Appendix A).

4.1.1 Restoring Site Stability

Indicators of site stability and function were compared for each of the revegetation treatments and the adjacent undisturbed grassland (Figures 4-1 and 4-2). The agronomic cover crop produced more live cover in the first two years compared to the Cypress native seed mix (Figure 4-2). However, after 11 to 12 years, vegetation cover levels are similar between all the treatments and the undisturbed grassland, varying between 54% and 70% cover.

Both the agronomic cover crop and the Cypress native seed mix established early and were able to reduce exposure of bare ground on the disturbance by 13% in the first year and by a total of 54% in the second year after seeding. However, all three native seed mix treatments resulted in less bare ground in the third year after seeding than the assisted natural recovery treatment. Average soil exposure on the assisted natural recovery sites rose to 70%. Eleven to twelve years after disturbance, exposure of bare ground is still significantly higher on the disturbed RoW than the 0.4% bare ground on the undisturbed grassland (Figure 4-1). Soil exposure on the native seed mix sites is 4.6%. The assisted natural recovery sites averaged the most bare ground and had the greatest variability between sites (Figure 4-1), averaging 18.6% substrate exposure.

Litter accumulation reduces soil exposure and helps re-establish nutrient cycling in a disturbance plant community. Litter levels have slowly risen over time for all the revegetation treatments. For each of the monitoring years, litter levels were consistently 5% to 20% higher in the native seed mix treatments than in the assisted natural recovery treatment. However, differences in litter cover were not significant between the revegetation treatments and the undisturbed grassland after 11-12 years. In years 11 to 12, average litter levels were as follows; undisturbed grassland 48%, assisted natural recovery 28%, Merry Flats native seed mix 1 at 49% and Merry Flats native seed mix 2 at 49%. Litter levels in the undisturbed grassland were reduced considerably in 2011 compared to previous observations. This may be a reflection of grazing pressure, a legacy from the droughts in 2000 and 2001 or a difference in measurement technique.

Figure 4-1 **Indicators of Litter, Bare Ground and Vegetation Cover after 11 to 12 Years for Assisted Natural Recovery and Native Seed Mix Revegetation Strategies**

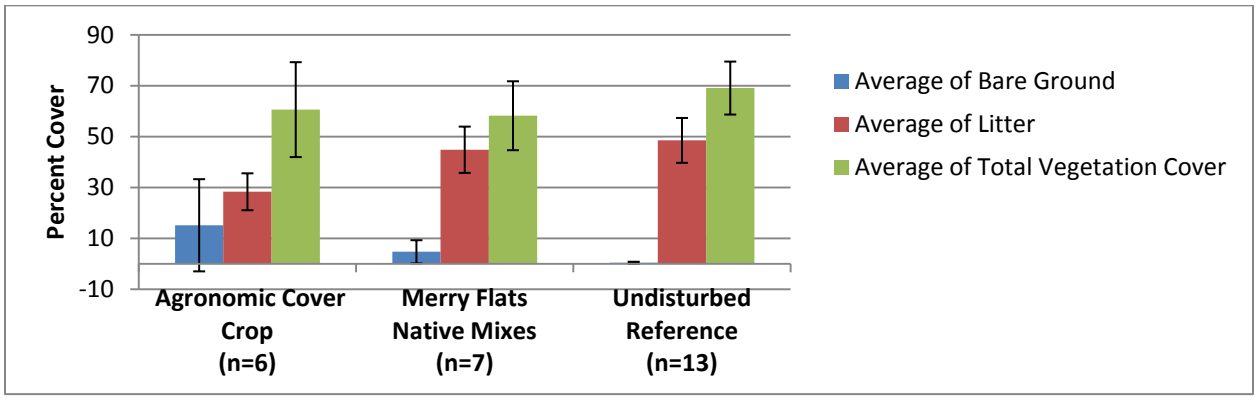
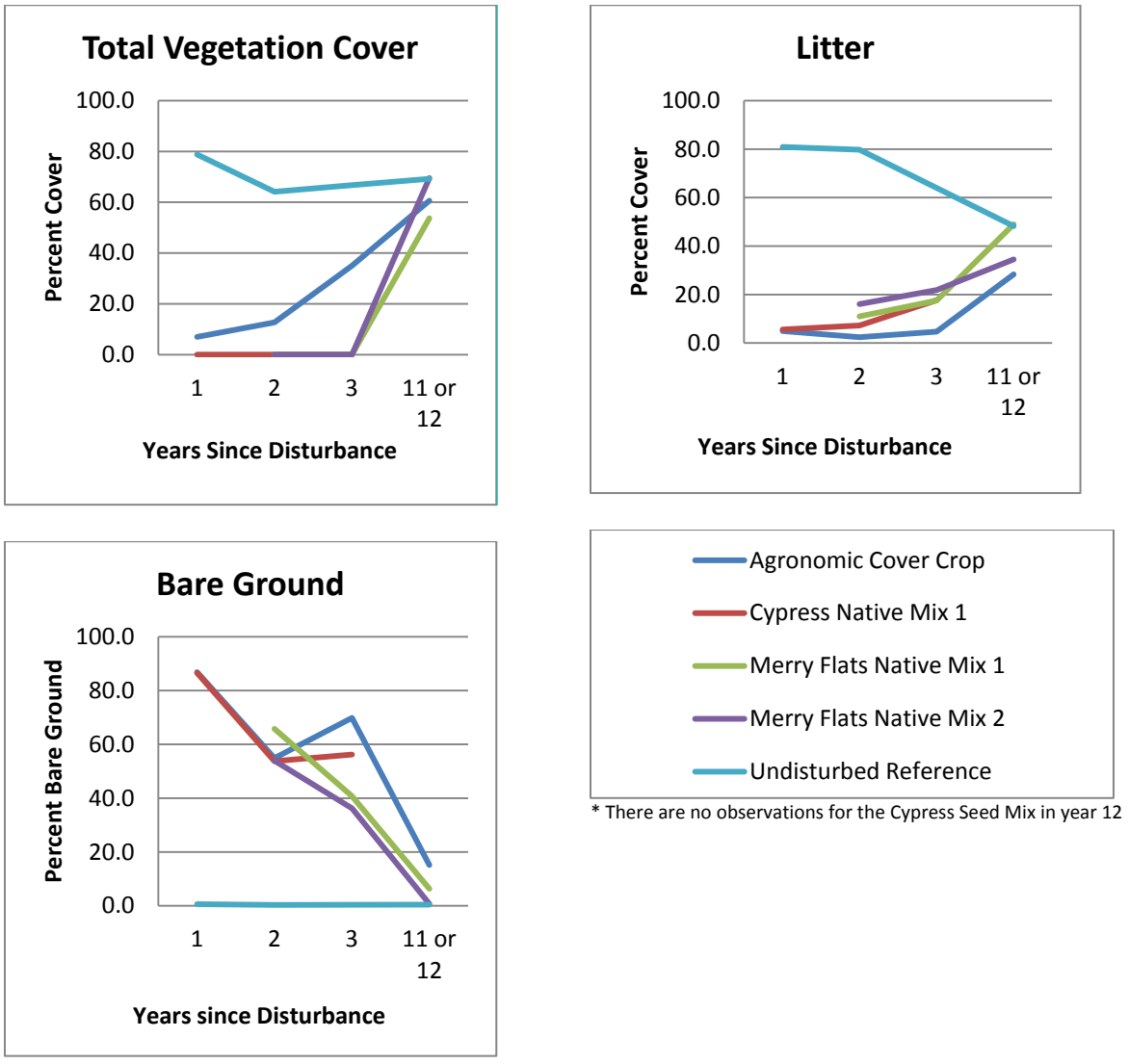


Figure 4-2 **A Comparison of Indicators of Site Stability and Function after 11 to 12 Years for Assisted Natural Recovery and Native Seed Mix Revegetation Strategies**



* There are no observations for the Cypress Seed Mix in year 12

4.1.2 Range Health

Range health assessment (Adams et al. 2009) provides a measure of ecosystem function. Twelve of the 14 undisturbed Cypress Upland grassland controls had healthy range scores and two controls had "healthy with problems" scores (Appendix D). All 13 disturbance plant communities, regardless of which revegetation strategy was used, scored in the "healthy with problems" range after 11 to 12 years of recovery. This indicates considerable progress towards restoration. The three measures that reduced the scores of the disturbance plant communities were the composition of the plant community, missing structural layers and the amount of litter accumulation.

4.1.3 Restoring Plant Communities

The vegetation cover and composition of the disturbance plant communities was compared for each revegetation treatment and the undisturbed adjacent grassland (Figure 4-3). The chart includes all seeded species and the species providing most cover on the undisturbed grassland after 11 to 12 years.

Assisted Natural Recovery

There are no traces of the agronomic cover crop species (common flax and fall rye) persisting after 12 years. The species present are all native and have established naturally from propagules, the seedbank or through infill. The composition of the plant community is very similar to the undisturbed grassland. The cover of rough fescue is still significantly higher on the undisturbed sites at 36% cover versus 14% cover on the disturbance. The early seral grass needle-and-thread and the disturbance forb pasture sagewort are more common on the disturbed site, but in general the cover values reflect what occurs naturally on these rangelands.

Native Seed Mixes

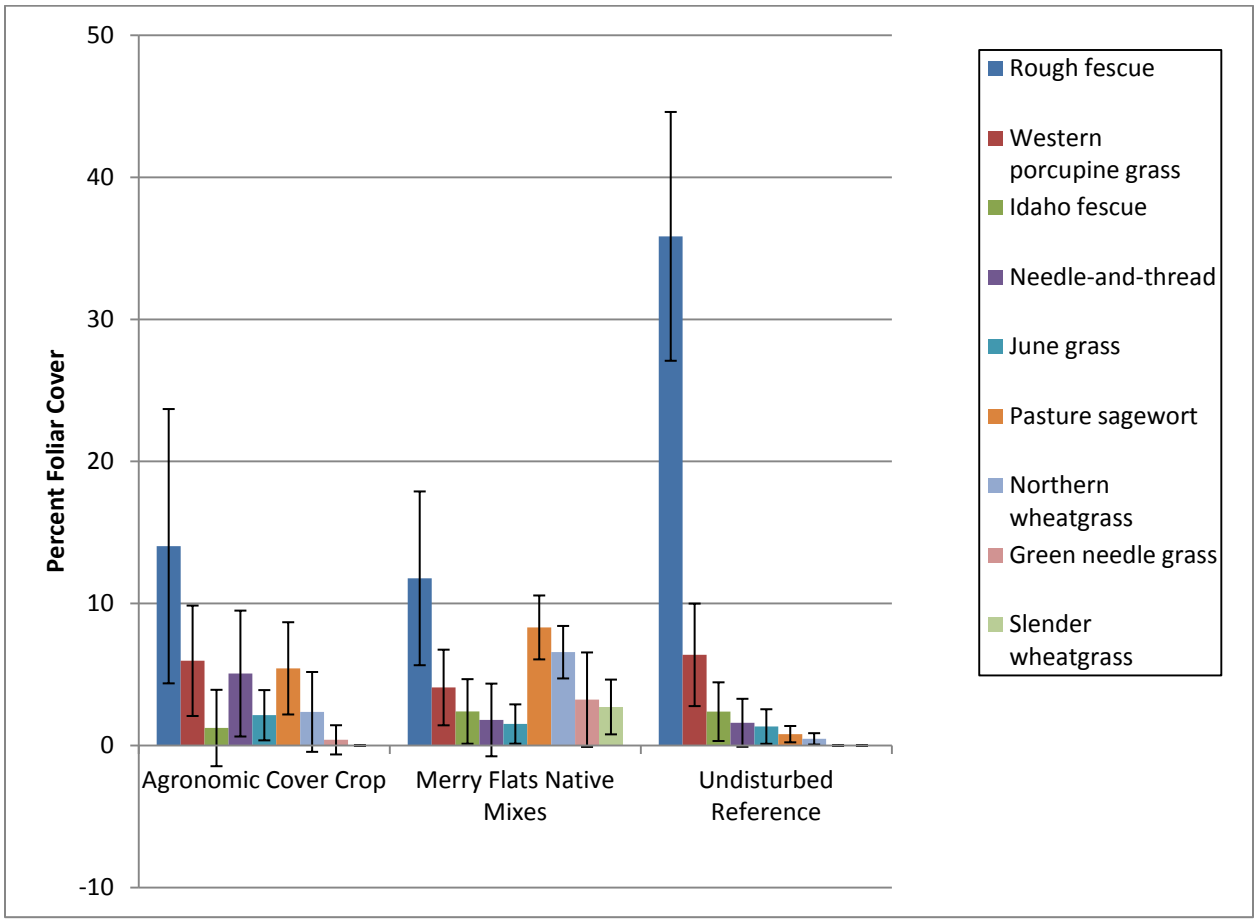
Two very similar native seed mixes were used on the Merry Flats portion of the Cypress project (see Appendix A). The species composition of both mixes is the same; the primary difference being the proportions of wild-harvested rough fescue and western porcupine grass. Merry Flats Native Mix 1 included 50% rough fescue and 15% western porcupine grass. Merry Flats Native Mix 2 included 25% rough fescue and 40% western porcupine grass. The other seed mix components were northern wheatgrass (15% and 10%), slender wheatgrass (10%) and green needle grass (10%). Both mixes resulted in similar expression of species despite the large difference in the percentage of rough fescue and western porcupine grass in each mix. Monitoring sites for both seed mixes were grouped for the comparison of native seed mix results versus assisted natural recovery (Figure 4-3).

After 11 to 12 years, the cover of rough fescue is still significantly higher on the undisturbed sites than either the assisted natural recovery sites or the native seed mix sites (Figure 4-3). Both the assisted natural recovery sites and the native seed mix sites produced similar average cover of rough fescue with similar levels of variability between sites.

Western porcupine grass, an important species in the Mixedgrass, is present at similar cover levels on seeded sites, assisted natural recovery sites and control sites.

The primary differences between the composition and cover of native seed mix sites versus the undisturbed plant community or the assisted natural recovery sites is the presence of northern wheatgrass, slender wheatgrass and green needle grass cultivars at significantly higher cover than natural cover levels (Figure 4-3). Cover of the disturbance forb pasture sagewort is higher on both disturbance treatments compared to the undisturbed grassland.

Figure 4-3 Comparison of Average Species Cover after 11 to 12 Years for Assisted Natural Recovery and Native Seed Mix Revegetation Strategies



4.1.4 Forb Infill on Revegetating Disturbances

Neither of the Cypress Upland revegetation strategies included introduction of native forbs to the disturbed soils. Both the assisted natural recovery and the native seed mixes resulted in some natural infill, particularly of pasture sage (Figure 4-3; Table 4-1). A great number of forbs established on the disturbance over 11 to 12 years, about 77% of the number of species observed on undisturbed sites (although there are twice as many observations for undisturbed sites). None of the forbs provide much cover and very few occur with great constancy across the sites within each treatment. Table 4-1 compares the number of forbs and identifies those observed on more than 50% of the monitoring sites and providing more than 1% cover. There are notably few invasive weeds. No noxious forb species were observed on either the disturbed or undisturbed grassland on the monitoring plots. Trace quantities of Canada thistle were hand pulled in the first year post-construction.

Table 4-1 Forb infill after 11 to 12 Years on for Different Revegetation Strategies

Revegetation Strategy	Number of Monitoring Plots	Number of Forb Species	Forbs with >50% Constancy	Forbs with >50% Constancy and >1% Cover	Forb Species	Constancy	% Cover
Agronomic Cover Crop	6	25	6	4	Pasture sage	100.0	5.4
					Golden bean	83.3	2.6
					Hairy golden aster	66.7	2.5
					Common yarrow	66.7	2.3
Native Seed Mixes	7	23	4	3	Pasture sage	100.0	8.3
					Common yarrow	100.0	3.1
					Golden bean	71.4	2.1
Undisturbed Reference	13	31	6	3	Golden bean	69.2	3.5
					Three-flowered avens	53.8	3.3
					Felwort	53.8	1.0

4.1.5 Succession of Disturbance Plant Communities over Time

Plant community ordination identifies groupings of similar species combinations. The analysis conducted on the Cypress Upland data set identified four plant communities that developed over time on the disturbance as well as the reference plant community present in undisturbed control plots (see Appendix B for the full analysis). The time series data was analyzed first including the undisturbed control observations and observations on the revegetating sites to investigate the relationship between revegetating pipeline disturbances and adjacent native prairie control sites. Next, the data was analyzed without native prairie control sites to identify disturbance communities. The two data sets produced very similar species cover combinations for the disturbance communities.

Table 4-2 illustrates the seral stage of the five communities identified in the analysis that included the undisturbed areas. Key observations are as follows:

- Twenty-four of the 25 observations of undisturbed control sites are associated with the reference plant community for loamy and shallow to gravel range sites in the Cypress Upland, which is *Plains rough fescue - Western porcupine grass - Sedge MGA1*(Adams et al. 2004). This indicates the pastures are in good range health.
- Two early seral communities are identified; one dominated by native seed mix components (Slender wheatgrass - Northern wheatgrass - Pasture sage); the other by species found naturally as well as in native seed mix 2 (Pasture sage - Northern wheatgrass - Western porcupine grass). These communities were observed primarily in years two and three after seeding.
- The one mid seral community includes observations from both seed mixes and the cover crop treatments and observations span all years.
- The late seral plant community (Plains rough fescue - Pasture sage - Northern wheatgrass) includes observations primarily from 11 and 12 years post-seeding and includes all treatments. Both cover crop and native seed mix strategies are resulting in this community over time.
- Two of the disturbed sites seeded to a cover crop and one site seeded to a native seed mix are clustering with the reference community observations, indicating good recovery over 11 to 12 years. The two observations of a first year disturbance clustering with the reference plant community observations is likely due to chunks of intact sod that were replaced right side up on the trench as possible during final clean up.

Table 4-2 Succession of Reclaiming Plant Communities

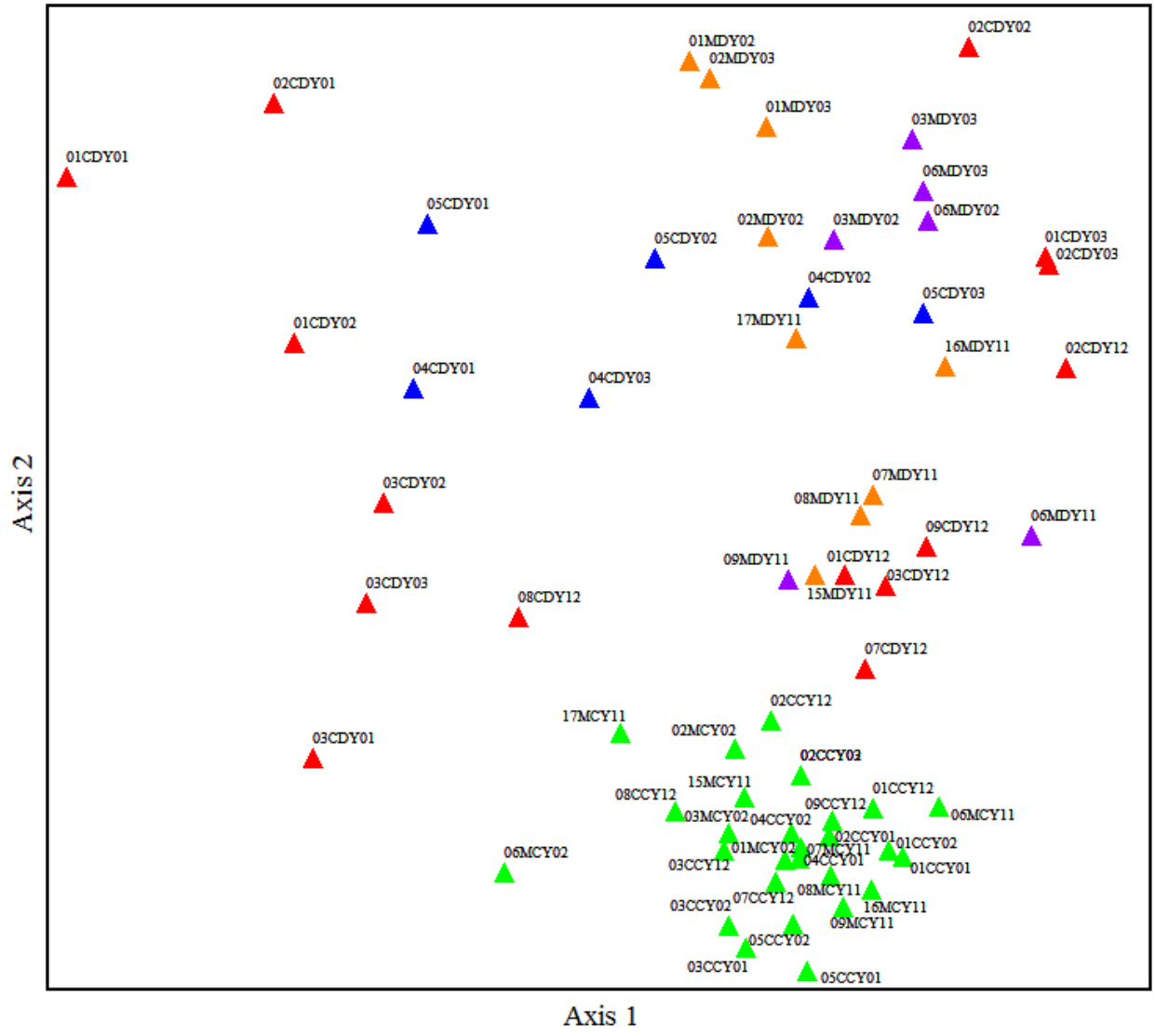
Seral Stage	Plant Community Groups	Cover Crop *	Native Mix 1 *	Native Mix 2 *	Native Mix 3 *	Control *
Early Seral	Pasture sage - Northern wheatgrass - Western porcupine grass	2, 3, 3		2, 3, 3	1, 2, 2	
Early Seral	Slender wheatgrass - Northern wheatgrass - Pasture sage		2, 2, 3, 3, 11	2		
Mid-seral	Western porcupine grass - Plains rough fescue - Low sedge	2, 3, 12	11	2	3	
Late Seral	Plains rough fescue - Pasture sage - Northern wheatgrass	1, 1, 2, 12, 12, 12	11, 11, 11	11, 11		2
Reference	Plains rough fescue - Western porcupine grass - Selaginella	1, 12, 12	11		1	24 obs, all years

*Each number is an observation that references the number of years since seeding at one site.

Another way to look at the succession of vegetation on the disturbance is to graphically display the relationships between the observations produced by nonmetric multidimensional scaling (NMS) ordination. The details of the analysis are presented in Appendix B. Each symbol in Figure 4-4 represents an observation at a site in a particular year. The more widely separated the symbols are from one another, the less similar the observations are. The site label for each symbol indicates the number of years since construction. Things to note are:

- The green symbols are all observations from undisturbed grassland. They cluster together reflecting their similar species composition.
- The other symbol colours represent the different seed treatments on disturbed soils. In the first few years after disturbance, the variability between treatment observations is high and the distance from the undisturbed site observations is high.
- Over time, 11 and 12 years after disturbance, species relationships in the revegetating grasslands are becoming more similar to each other and to the undisturbed sites. The distance between the disturbance observations and the reference observations is decreasing, indicating that a desirable successional trend is occurring.
- The desirable successional trend is occurring for both the cover crop revegetation strategy and the native seed mix strategies.

Figure 4-4 An Illustration of Succession from NMS Analysis of Control and Treatment Data



Cover Crop: Annual Flax/Fall Rye	1	
Undisturbed Control	2	
Cypress Native Seed Mix	3	
Merry flats Native Seed Mix 1	4	
Merry Flats Native Seed Mix 2	5	

4.2 Majorville Upland - Natural Recovery of Native Plant Communities

Minimal disturbance construction procedures accompanied by natural recovery as the revegetation strategy is commonly used for narrow linear disturbances in the Mixedgrass Natural Subregion. The Husky Majorville project did not have enough replicate time series data sets or similarity between sites to conduct plant community ordination analyses. However, this project was one of the earliest to conduct range health assessments on recovering grasslands. Range health data exists four years after disturbance and another data set was collected seven years after disturbance. Comparison of the range health assessments conducted on loamy and limey ecological range sites on the Husky Majorville Sweet Gas Gathering System provides interesting insight into the progress of natural recovery over time. Indicator species analysis identifies the graminoid and forb species that are infilling naturally on the disturbed soils. A summary of the range health assessment scoring for 2008 and 2011 is presented in Table 4-3. Supporting micro-plot data is included in Appendix E.

Range health is rated for a site by scoring a series of questions that reflect key indicators of range health and their importance (Adams et al 2009). A summary of the Husky Majorville 2011 data and observations has been correlated and presented for each of the questions.

4.2.1 Range Health of the Natural Recovery Disturbance Plant Communities

4.2.1.1 Question 1 Integrity and Ecological Status

What kinds of plants are on the site? What is the plant community?

Plant species composition is a key indicator of grassland health. It strongly influences a site's ability to perform important ecological functions. The plant community composition within the assessed site is compared to the reference plant community. The reference plant community is the potential natural community for the ecological range site under light grazing disturbance (Adams et al. 2009).

Table 4-3 Integrity and Ecological Status Component of the Range Health Scores on the Majorville Uplands Monitoring Sites after Seven Years Recovery in 2011

Monitoring Site Number	2011 Plant Community on Undisturbed Control	Ecological Status Score Control	2011 Plant Community on RoW (7 Yrs recovery)	Ecological Status Score on RoW
Site #13 Loamy	Wheatgrass – Needle-and-thread MGA 21	27	Wheatgrass – Needle-and-thread MGA 21	27
Site #14 Loamy	Needle-and-Thread-June Grass MGA 22	27	Wheatgrass – Needle-and-thread MGA 21	27
Site #17 Loamy	Wheatgrass – Needle-and-thread MGA 21	27	Wheatgrass – Needle-and-thread MGA 21	15
Site #18 Loamy	Wheatgrass – Needle-and-thread MGA 21	27	Wheatgrass – Needle-and-thread MGA 21	27
Site #19 Sub-irrigated	Snowberry / Low Sedge – Northern Wheatgrass MGC5	27	Snowberry / Low Sedge – Northern Wheatgrass MGC5	15
Site #20 Loamy	Wheatgrass – Needle-and-thread MGA 21	27	Needle-and-Thread-June Grass MGA 22	27
Site #21 Loamy	Wheatgrass – Needle-and-thread MGA 21	27	Wheatgrass – Needle-and-thread MGA 21	27
Site #22 Limey	Wheatgrass – Needle-and-thread MGA 21	27	Needle-and-Thread-June Grass MGA 22	40

Results:

On three sites, (Sites 13, 18 and 21) the plant communities on the RoW and at the control were comparable to the reference plant community for loamy ecological range sites: Wheatgrass – Needle-and-thread MGA 21. The scoring for integrity and ecological status rated equally on the RoW and the control micro-plot inventory.

At site 14 the control was comparable to the mid-seral plant community for loamy ecological range sites, Needle-and-Thread - June Grass MGA 22, due to the percent cover of blue grama grass in the micro-plots. However the recovering disturbance plant community was comparable to the reference plant community MGA 21 as the cover of the native wheat grasses was significantly higher than at the control. The increase in percent cover of western and northern wheatgrass may be due to disturbance to the soil profile resulting in increased nitrogen content in the soil.

At site 17 the control and the recovering disturbance plant community were compared to the reference plant community MGA 21. The lower score on the recovering plant community was due to the absence of needle-and-thread grass in the micro-plots and low diversity of species. Micro-plots were dominated by rhizomatous western and northern wheatgrass. The trenchline was also slightly depressed and possibly used as a cattle trail.

Site 19 is a Sub-irrigated ecological range site in close proximity to a Class 3 wetland. The closest fit to control at this site is the mid-seral plant community Snowberry / Low Sedge-Northern Wheatgrass MGC5. The lower score on the trenchline was due to the percent cover of foxtail barley and the low percent cover of sedge species. It was observed that the trenchline was depressed and used as a cattle trail. This could be influencing the species composition in the recovering plant community.

On two sites (Sites 20 and 22) the controls were compared to the reference plant community MGA 21. The recovering disturbance plant community was compared to the mid-seral plant community for loamy ecological range sites: Needle-and-Thread - June Grass MGA 22 due to the decrease in percent cover of wheat grasses and the presence of blue grama in the micro-plots compared to MGA 21.

4.2.1.2 Question 2 Plant Community Structure

Are the expected layers present?

This question addresses the diversity of plants that vary in size, height and rooting depth and their ability to use sunlight, soil nutrients and water from different zones of the canopy. Community structure is important for efficient nutrient cycling, energy flow, forage production and wildlife habitat (Adams et al. 2009).

Table 4-4 Plant Community Structure Component of the Range Health Scores on the Majorville Uplands Monitoring Sites after Seven Years Recovery in 2011

Monitoring Site Number	2011 Plant Community Structure Scores on Undisturbed Controls	Comments on Control Scoring	2011 Plant Community Structure Scores on RoW after 7 Years Recovery	Comments on RoW Scoring
Site #13 Loamy	10 (full score)	All layers are present	10	All layers are present Moss and lichen is present at 3%
Site #14 Loamy	10	All layers are present	7	Ground cover layer is absent
Site #17 Loamy	10	All layers are present	3	Ground cover layer and low graminoids and forbs are missing
Site #18 Loamy	10	All layers are present	7	Ground cover is missing
Site #19 Sub-irrigated	7	Tall grasses significantly reduced	7	Ground cover is missing
Site #20 Loamy	10	All layers are present	7	Ground cover significantly reduced
Site #21 Loamy	10	All layers are present	7	Ground cover significantly reduced
Site #22 Limey	10	All layers are present	7	Ground cover is missing

Results:

The ground cover layer is absent or significantly reduced in six of the eight assessments located over the trenchline. The ground cover layer is composed of low stature graminoids and forbs, moss and lichen. Of interest in the trenchline micro-plots is the percent cover of moss and lichen. It remains on the low end of the range described for the reference plant community. However, the percent cover has increased from 2008 to 2011 on all but one site (site 14) where it decreased from 0.90% to 0.40%.

4.2.1.3 Hydrologic Function and Nutrient Cycling

Does the site retain moisture? Is the expected amount of litter present?

This question evaluates the ability of a site to retain moisture based on amounts of organic residue (litter) produced by the plant community.

Table 4-5 Hydrologic Function and Nutrient Cycling Component of the Range Health Scores on the Majorville Uplands Monitoring Sites after Seven Years Recovery in 2011

Monitoring Site Number	2011 Control scoring for Hydrologic Function and Nutrient Cycling	Comments on control scoring	2011 Hydrologic Function and Nutrient Cycling Scores on RoW after 7 Years Recovery	Comments on RoW scoring Measurement is over Trenchline
Site #13 Loamy	25 (full score)	Litter values within the expected threshold	13	Decreased litter values due to cattle using the trench as a trail
Site #14 Loamy	25	Litter values within the expected threshold	25	Litter values within the expected threshold
Site #17 Loamy	13	Litter values have decreased since 2008 assessment	13	Litter values have increased since 2008
Site #18 Loamy	25	Litter values within the expected threshold	13	Litter values consistent with 2008, bare soil is reduced from 2008 values
Site #19 Sub-irrigated	25	Litter values within the expected threshold	25	Litter values within the expected threshold
Site #20 Loamy	25	Litter values within the expected threshold	0	Litter value very low, Bare soil is decreasing since 2008.
Site #21 Loamy	25	Litter values within the expected threshold	13	Litter value consistent with 2008. Bare soil decreasing from 2008
Site #22 Limey	25	Litter values within the expected threshold	0	Litter value very low, Bare soil is decreasing since 2008. Cattle utilizing trench as a trail to water.

Results:

At sites 14 and 19 litter values are within expected threshold at both the control and over the trenchline.

A slight depression over the trench has led to reduced litter values from the expected threshold at site 13 and site 22. In both cases the trenchline has been utilized as a cattle trail.

At site 17 litter values have decreased on the control and increased on the trenchline from 2008 assessed values.

At sites 18 and 21 litter values are within the expected threshold on the controls. On the trenchline, litter values are reduced and consistent with 2008 assessed values. However bare soil is decreasing from the 2008 assessment.

At site 20 litter values are within the expected threshold on the control and very low on the trenchline. However bare soil has been significantly reduced over the trenchline since the 2008 assessment.

4.2.1.4 Question 4: Site Stability

Is the site subject to accelerated erosion? Is there human-caused bare ground?

This question assesses whether the site is subject to accelerated erosion above what is considered normal for the ecological range site classification. Indicators of accelerated erosion include: evidence of soil movement, plant pedestalling, flow patterns or hoof shearing (Adams et al. 2009).

The assessment also considers bare soil values at the site compared to the range of bare soil values for the comparable ecological range site and plant community description in the range plant community guide.

Table 4-6 % Bare Soil Component of the Range Health Scores on the Majorville Uplands Monitoring Sites

Monitoring Site Number	2008 Undisturbed Control % bare soil	2011 Undisturbed Control % bare soil	2008 On RoW % bare soil over the trenchline (4 years recovery)	2011 On RoW % bare soil over the trenchline (7 years recovery)
Site #13 Loamy	3%	0%	6%	0%
Site #14 Loamy	1%	0%	42%	8%
Site #17 Loamy	0%	0%	82%	23%
Site #18 Loamy	0%	0%	65%	11%
Site #19 Sub-irrigated	0%	0%	15%	1%
Site #20 Loamy	0%	0%	67%	5%
Site #21 Loamy	5%	1%	50%	5%
Site #22 Limey	0%	1%	76%	8%
Averages	1.1%	0.3%	50.4%	7.6%

Results:

All of the sites have been assessed as stable with no accelerated erosion observed within the control or in the RoW transect located over the trenchline.

In the 2011 assessment, the estimated percent cover of bare soil on the control micro-plots has remained the same or decreased in value compared to the 2008 assessment. The exception is site 22 where there was a 1% increase in estimated bare soil. This increase is not considered significant.

There has been a positive trend in the reduction of bare soil over the trenchline on all of the sites in 2011 as compared to 2008.

On the natural recovery sites, bare soils exposure has decreased from 50% after four years to 7.6% after seven years recovery, but is still greater than the 0.3% bare soil exposure on undisturbed grassland.

4.2.1.5 Question 5 Noxious Weeds

Are noxious weeds present on the site?

This question deals with the presence of noxious weeds as listed and rated in the Range Health Assessment Field Workbook (Adams et al. 2009).

Table 4-7 Noxious Weed Component of the Range Health Scores on the Majorville Uplands Monitoring Sites

Monitoring Site Number	2008 Control	2011 Control	2008 On RoW	2011 On RoW
Site #13 Loamy	None noted	None noted	None noted	None noted
Site #14 Loamy	None noted	None noted	None noted	None noted
Site #17 Loamy	None noted	None noted	None noted	None noted
Site #18 Loamy	None noted Kentucky bluegrass noted at 3%	None noted	None noted	None noted Kentucky bluegrass noted at 1%
Site #19 Sub-irrigated	None noted	None noted	Perennial sow thistle noted	Canada thistle noted
Site #20 Loamy	None noted	None noted	None noted	None noted
Site #21 Loamy	None noted	None noted	Canada thistle noted	Perennial sow thistle noted
Site #22 Limey	None noted	None noted	None noted	None noted

Results:

Documented Occurrences of Restricted Noxious or Noxious Weeds:

Of the eight monitoring sites, Site 19 had a small patch of perennial sow thistle (*Sonchus arvensis*), documented in 2008 within the right of way. It was not observed in 2011, however a small patch of Canada thistle (*Cirsium arvense*) was recorded on the right of way. Both species are regulated as noxious weeds under the Alberta Weed Control Act (Government of Alberta, 2010).

Site 21 had a small patch of Canada thistle documented within the right of way in 2008. It was not observed during the 2011 assessment. However perennial sow thistle was documented on the right-of-way in 2011. Husky Energy does have an ongoing weed control program that appears to be effective over time for targeted species.

Documented occurrences of disturbance related invasive plants:

Kentucky bluegrass was observed on one of the eight monitoring sites assessed in 2011 (Site 18). Kentucky bluegrass is an unregulated, disturbance-caused, undesirable herbaceous species that may influence restoration potential. It was noted in 2008 at 3% cover in the control microplots. It was not recorded in the control in 2011. However, it was recorded in the on trenchline micro-plots in 2011 at 1% cover. The change in cover values is likely due to grazing and does not present a serious management concern.

4.2.2 Summary of the Majorville Range Health Assessment Scores

Table 4-8 Comparison of Range Health Assessments conducted in 2008 and 2011 on the Husky Majorville project

Monitoring Site Number	2008 Range Health Score on Undisturbed Control	Range Health Score on RoW after 4 Years Recovery - 2008	2011 Range Health Score on Undisturbed Control	Range Health Score on RoW after 7 Years Recovery - 2011
Site #13 Loamy	83%	66%	87%	75%
Site #14 Loamy	70%	53%	87%	82%
Site #17 Loamy	87%	10%	76%	48%
Site #18 Loamy	73%	51%	83%	67%
Site #19 Sub-irrigated	87%	61%	84%	63%
Site #20 Loamy	87%	50%	87%	59%
Site #21 Loamy	66%	36%	87%	68%
Site #22 Limey	58%	40%	87%	72%

Scoring ranges as per Adams et al. 2009 include: Healthy 75 to 100%, Healthy with Problems 50 to 74%, and Unhealthy a score less than 50%.

General observations that can be drawn from the comparison of the range health data include:

Range health scores have increased on all on RoW sites from 2008 to 2011 indicating that the process of infill is occurring. Exposure of bare ground has decreased from 2008 to 2011 and total vegetation has increased within the sample sites. Appendix E-3 provides the compiled transect micro-plot data for both 2008 and 2011 at each site.

Range health scores have increased on control sites from 2008 to 2011, with the exception of sites 17 and 19. The increase in score from 2008 to 2011 on the majority of the sites may be due to increased soil moisture in 2010 and 2011.

4.2.3 Discussion of Pioneer and Infill Species on the Trenchline

The Husky Majorville project did not have enough replicate time series data sets or similarity between sites to conduct plant community ordination analyses. However, to capture what species were colonizing the bare ground disturbance in the early years of recovery (year 4 - 2008) and what infill species were contributing to recovery in the long term (year 7 - 2011), an indicator species analysis of the data set was performed. The dominant graminoid species and the dominant forb species were identified from the 2008 data set. These species represent the early colonizing species. Similarly, the dominant graminoid species and the dominant forb species were identified from the 2011 data set. These species represent the dominant species that are providing infill and reducing the amount of bare ground over the long term. Results are presented in Figures 4-5 to 4-8.

In the initial years of natural recovery, western wheatgrass, northern wheatgrass, green needle grass and sedge species play an important role in colonizing the bare soil. Prairie sagewort (*Artemesia frigida)* plays an important role in providing initial cover and shade for emerging graminoids. Over time, the western and northern wheatgrasses increase in percent cover, stabilizing the soils with their ability to produce a network of rhizomes within the soil. Green needle grass also increases in cover as it is well adapted to disturbance. As the colonizing species provide initial structure over the soil surface, needle-and-thread grass seed rain from the adjacent undisturbed grassland is trapped within the bare soil spaces enabling the uniquely adapted seed to germinate, emerge and increase in cover over time.

Figure 4-5 Dominant Infill Graminoids after Four Years Natural Recovery (2008)

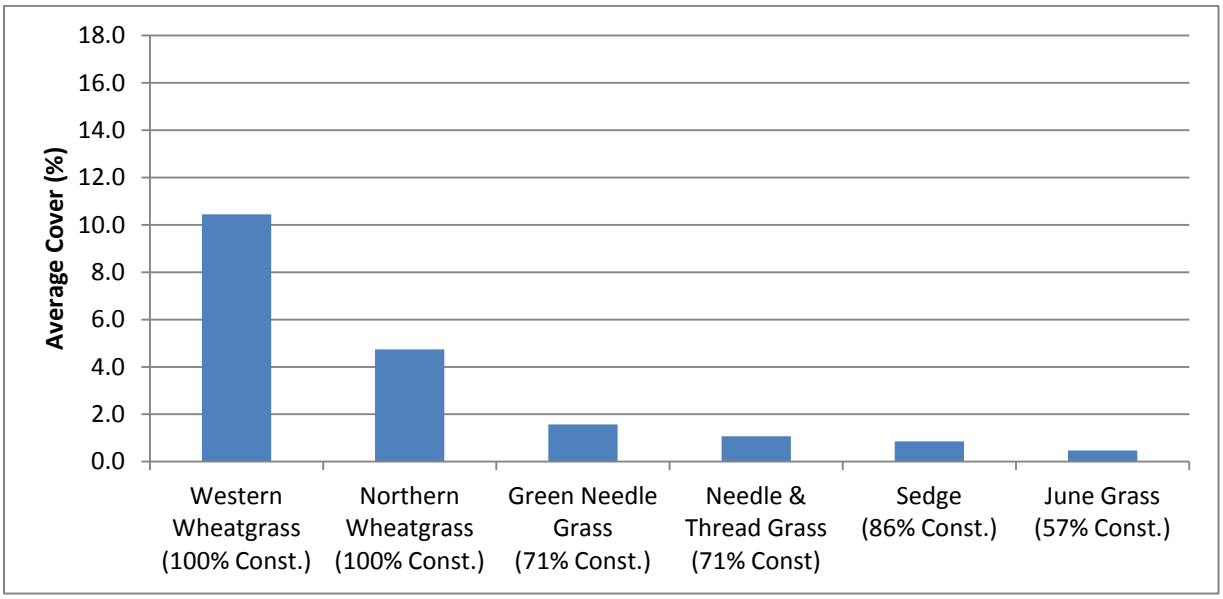
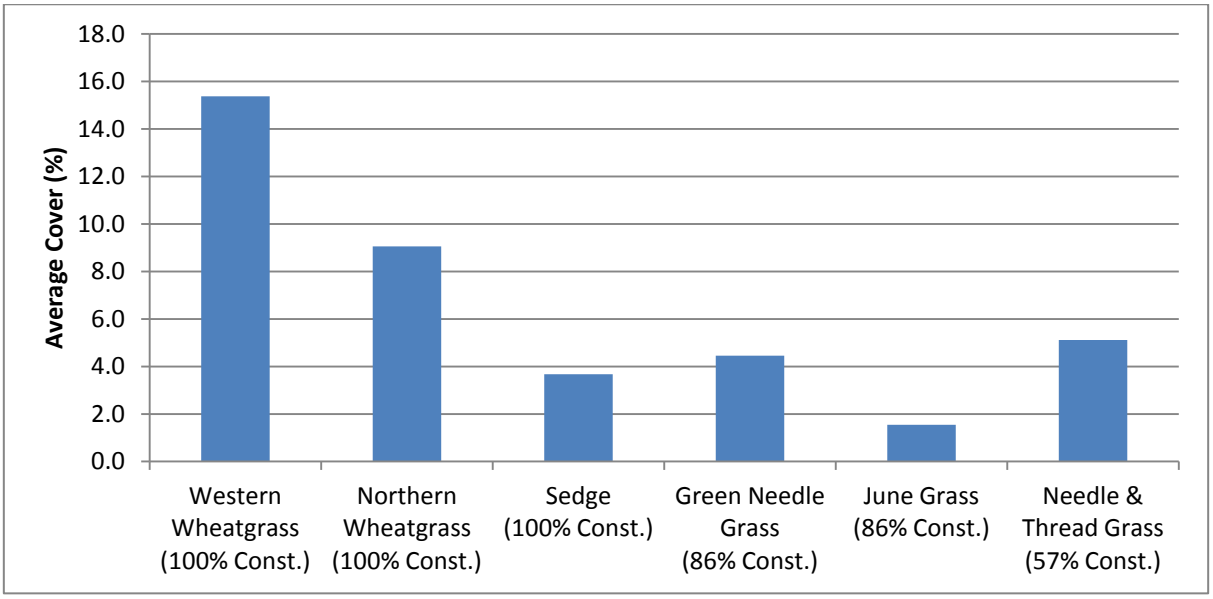


Figure 4-6 Dominant Infill Graminoids after Seven Years Natural Recovery (2011)



Pasture sagewort continues to play an important role in the forb component of the plant community but decreases in cover over time (Figure 4-7 and 4-8).

Other disturbance related forbs continue to provide infill and the species composition varies over time depending on available moisture and site conditions in the area surrounding the disturbance. Several undesirable species such as dandelion and common goatsbeard have established from seed sources in the surrounding grassland and are likely to persist and fluctuate in prominence with seasonal moisture conditions.

Figure 4-7 Dominant Infill Forbs after Four Years Natural Recovery (2008)

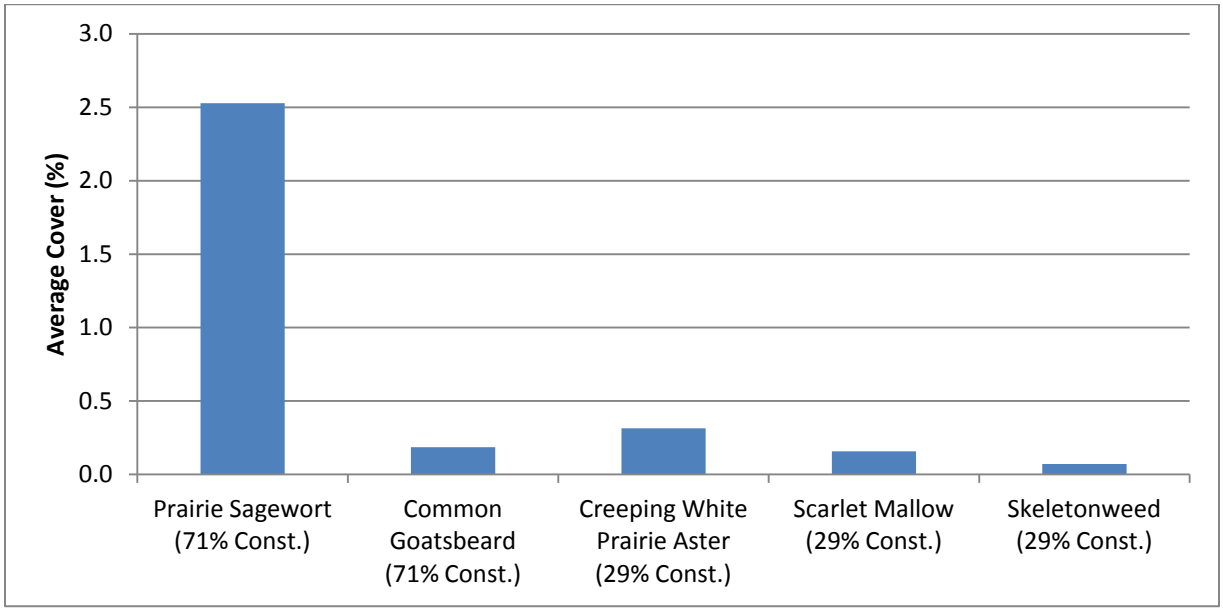
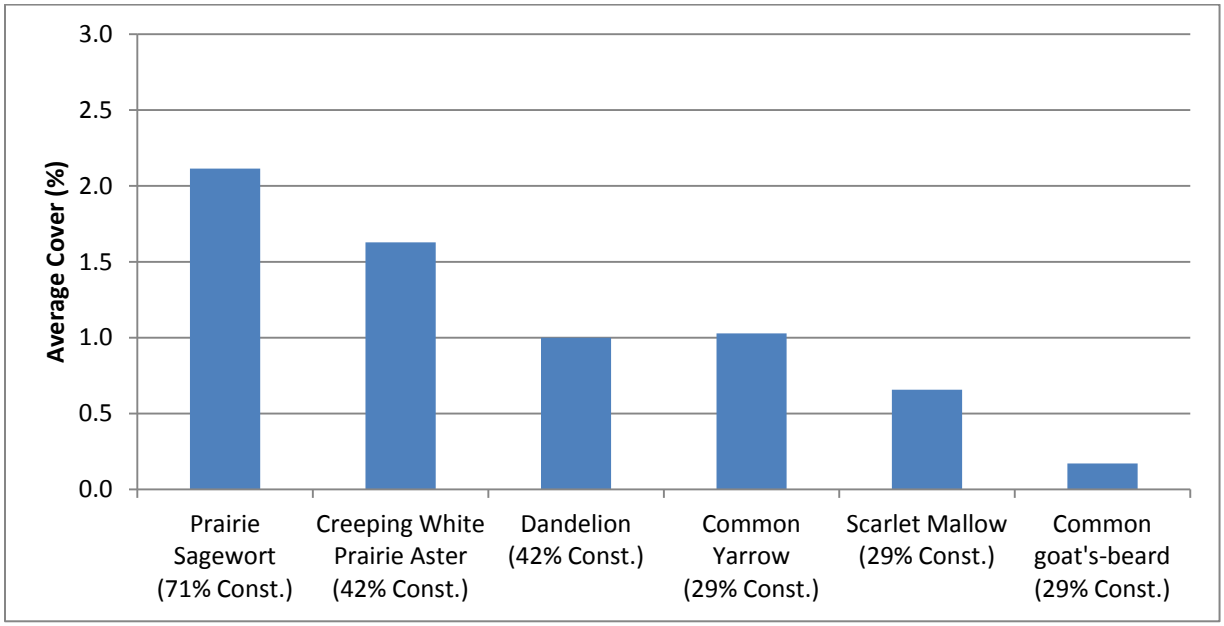


Figure 4-8 Dominant Infill Forbs after Seven Years Natural Recovery (2011)



5 LEARNINGS – LONG TERM RECOVERY OF MIXEDGRASS PRAIRIE

Construction on Native Prairie

The most important common factor which influenced the long term recovery of each of the three projects was the implementation of minimal disturbance pipeline construction procedures. Each project was constructed during the winter months with strict adherence to adverse weather shut down criteria. The soil disturbance was minimized to the extent possible while maintaining safe working conditions. In all cases there was a positive working relationship between company representative, environmental inspector and pipeline contractor. Local, well trained pipeline contractors who understand the issues of industrial disturbance in native prairie were critical to the success of each project.

Recovery on Mixedgrass Native Prairie

Each project was constructed in large pasture management units with few invasive non-native species of concern in the Mixedgrass such as crested wheatgrass, smooth brome and Kentucky bluegrass. The relative absence of invasive species and post-construction management of invasive species establishment is important for the success of natural recovery and assisted natural recovery as revegetation strategies.

The process of recovery takes time in the Mixedgrass. All three strategies produced a positive successional trend, however more than five growing seasons were required to establish the trend.

Performance of Assisted Natural Recovery and Native Seed Mixes on Shallow to Gravel Ecological Range Sites in the Mixedgrass

Use of assisted natural recovery or compatible native seed mix revegetation strategies for narrow linear disturbances on shallow to gravel ecological ranges sites produced similar results over 11 to 12 years. Litter cover levels were similar between treatments. Both treatments resulted in the establishment of dominant grasses found naturally on undisturbed grassland. The main long-term differences observed were; the persistence of seeded northern wheatgrass, slender wheatgrass and green needle grass cultivars from the native seed mix, and more soil exposure and more variability in the exposure of bare soils on assisted natural recovery sites.

Both strategies have resulted in a positive successional trend towards the undisturbed adjacent plant communities, with notable differences being the lack of groundcover structure and reduced cover of rough fescue.

Both the assisted natural recovery and the native seed mixes resulted in “healthy with problems” range health scores after 11 to 12 years of recovery, indicating considerable progress towards restoration of “healthy” rangeland. The three measures that reduced the range health scores of the disturbance plant communities were the composition of the plant community, missing structural layers and the amount of litter accumulation.

Performance of Natural Recovery on Loamy and Limey Ecological Range Sites in the Mixedgrass

Use of natural recovery as the strategy for narrow linear disturbances on loamy and limey ecological range sites in the Majorville Upland resulted in a positive successional trend towards the recovery of the disturbance over the trenchline. Range health scores have increased on all trenchline monitoring sites from 2008 to 2011 indicating that the process of infill is occurring. Exposure of bare ground over the trenchline has decreased from 2008 to 2011 and total vegetation has increased within the sample sites.

In the initial years of natural recovery (4 growing seasons post-construction) western wheatgrass, northern wheatgrass, green needle grass and sedge species play an important role in colonizing the bare soil. Prairie sagewort (*Artemesia frigida*) plays an important role in providing initial cover and shade for emerging graminoids.

Over the long term (11 years post-construction) western and northern wheatgrasses increase in percent cover, stabilizing the soils with their ability to produce a network of rhizomes within the soil. Green needle grass also increases in cover as it is well adapted to disturbance. As the colonizing species provide initial structure over the soil surface, needle-and-thread grass seed rain from the adjacent undisturbed grassland is trapped within the bare soil spaces enabling the uniquely adapted seed to germinate, emerge and increase in cover over time. Pasture sagewort continues to play an important role in the forb component of the plant community but decreases in cover over time. Other disturbance related forbs continue to provide infill and the species composition varies over time depending on available moisture and site conditions in the area surrounding the disturbance.

6 DATA GAPS AND RECOMMENDED RESEARCH

Further research is required to assess the long term recovery from industrial disturbance in Sandy, Sands, Choppy Sandhills, and Blowout ecological range sites. The range sites were not represented in this study.

Further research is required to assess revegetation strategies and recovery trends on large disturbed areas such as full strip well sites, or large diameter pipelines in the Mixedgrass.

Research is required to determine long term recovery trends on sites where invasive non-native species such as crested wheatgrass, smooth brome, Kentucky bluegrass and sweet clover are present in the area surrounding the disturbed soils.

Further research is required to determine the most appropriate revegetation strategy (natural recovery, assisted natural recovery or native seed mixes) for disturbances located in areas with unhealthy range health scores to understand which of the range health indicators are most likely to affect recovery.

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Appendix A Cypress Uplands Project Seed Mixes

Cypress Pipeline Seed Mixes

Annual Cover Crop				Seeding Rate
Fall rye	*Secalecereale*			1/1 @ ½
Common flax	*Linum usitatissimum*			bushel/acre

Native Seed Mix		Source		Seeding Rate
Rough fescue	*Festuca campestris*	wild harvested	50%	
Western porcupine grass	*Stipa curtiseta*	wild harvested	10%	
Awned wheat grass	*Agropyron dasystachyum*		10%	
Northern wheatgrass	*Agropyron trachycaulum*		10%	
Green needle grass	*Stipa viridula*		10%	
June grass	*Koeleria macrantha*		5%	
Tufted hair grass	*Deschampsiacespitosa*		5%	
				12 kg/ha

Merry Flats Drilling Program Seed Mixes

Seed Mix 1 Upland Rough Fescue Dominated Sites		Source		Seeding Rate
Rough fescue	*Festuca campestris*	wild harvested	50%	
Western porcupine grass	*Stipa curtiseta*	wild harvested	15%	
Northern wheatgrass	*Agropyron dasystachyum*		15%	
Slender wheatgrass	*Agropyron trachycaulum*		10%	
Green needle grass	*Stipa viridula*		10%	12 kg/ha

Seed Mix 2 Lower Slope and Valley Floor Sites				Seeding Rate
Western porcupine grass	*Stipa curtiseta*	wild harvested	40%	
Rough fescue	*Festuca campestris*	wild harvested	25%	
Northern wheatgrass	*Agropyron dasystachyum*		10%	
Slender wheatgrass	*Agropyron trachycaulum*		10%	
Green needle grass	*Stipa viridula*		10%	12 kg/ha

Seed Mix 3 Seasonal Drainage Channels			Seeding Rate
Fowl bluegrass	*Poa palustris*	40%	
Tufted hairgrass	*Deschampsia cespitosa*	30%	
Western wheatgrass	*Agropyron smithii*	30%	12 kg/ha

Cluster Analysis, Non-metric Multidimensional Scaling Ordination and Indicator Species Analyses for the Shallow to Gravel Ecological Range Site in the Cypress Uplands Ecodistrict of the Dry Mixedgrass

Laura Hickman and Jane Lancaster

Background

Revegetation monitoring programs for the Cypress Pipeline and the Merry Flats Drilling Program (the Cypress project) collected quantitative data over a twelve year period to assess the progress of revegetation over the disturbed soils. Micro-plot sampling for species composition and cover was done using randomly placed 1/10 meter Daubenmire frames both on the disturbance and on an adjacent undisturbed control site. Field observations of species cover and frequency were used to calculate a percentage cover value and a prominence value for each species present in the micro-plot frames. Sites selected for plant community ordination assessment were located on shallow to gravel ecological range sites in the Cypress Uplands Ecodistrict. Control sites were primarily in healthy range and supported the reference plant community for the range site (Plains rough fescue – Western porcupine grass - Sedge MGA1). Table 1 presents the timing of data collections.

Site Label	Seed Mix	Years Data was Collected on the Disturbed RoW	Years Data was Collected on the Undisturbed Controls
01C	Cover Crop: Rye/Flax	2000,01,02,11	2000,01,02,11
02C	Cover Crop: Rye/Flax	2000,01,02,11	2000,01,02,11
03C	Cover Crop: Rye/Flax	2000,01,02,11	2000,01,02,11
04C	Cypress Native Seed Mix	2000,01,02	2000,01,02
05C	Cypress Native Seed Mix	2000,01,02	2000,01,02
07C	Cover Crop: Rye/Flax	2011	2011
08C	Cover Crop: Rye/Flax	2011	2011
09C	Cover Crop: Rye/Flax	2011	2011
01M	MF Native Seed Mix 1	2002,03	2002
02M	MF Native Seed Mix 1	2002,03	2002
03M	MF Native Seed Mix 2	2002,03	2002
06M	MF Native Seed Mix 2	2002,03,11	2002,11
07M	MF Native Seed Mix 1	2011	2011
08M	MF Native Seed Mix 1	2011	2011
09M	MF Native Seed Mix 2	2011	2011
15M	MF Native Seed Mix 1	2011	2011
16M	MF Native Seed Mix 1	2011	2011
17M	MF Native Seed Mix 1	2011	2011

Methods

The cluster analysis performed was a hierarchical, agglomerative clustering method in PCORD used for initial vegetation community group classification. This method of community group classification identifies vegetation communities by characteristic species combinations (Jongman et al. 1995). Hierarchical methods find groups that are composed of subgroups and produce dendrograms where the axis is measured in percent information remaining; agglomerative methods build groups from the bottom to a single top group composed of all sample units (McCune and Grace 2002). Cluster analyses were performed using Ward's group linkage method and the relative Euclidean distance measure (McCune and Grace 2002).

Dendrograms are presented below to illustrate the community groups interpreted from the data. Dendrogram branches were subjectively trimmed for community group identification based on ecological interpretation of sample unit (dis)similarity within and among clusters at different levels of percent information remaining (Kent and Coker 1992). The community group identification within each ecological range type was also supported by the complimentary analyses described below.

Ordination methods graphically summarize complex species relationships among observations by aligning observations in a pattern along multiple axes (dimensions) (McCune and Grace 2002). Nonmetric multidimensional scaling (NMS) is "currently one of the most defensible techniques" (McCune and Grace 2002) and is favoured for its increased computational power over other ordination methods such as principal components analysis and detrended correspondence analysis. The Sorenson (Bray-Curtis) distance measure was and ordination parameters utilized included two to three axes, random starting configurations, 250 runs with real data, 500 iterations, a stability criterion of 0.00001, and solution selection based on low stress (<15) and the stability criterion (examination of a plot of stress vs. iteration number; McCune and Grace 2002).

Indicator species analysis (ISA; Dufrene and Legendre 1997) also supported dendrogram pruning decisions. ISA evaluates the faithfulness (i.e. is the species present at every sample unit within the group?) and exclusivity (i.e. does the species occur only within the group and not at sample units within other groups?) of each species, producing an indicator value (IV) for each species in each group (McCune and Grace 2002). Statistical significance was evaluated by a Monte Carlo method (1000 randomized runs) with the null hypothesis being that the maximum IV is no larger than would be expected by chance. The number of significant indicators (species with $p \leq 0.05$) and the average of all species' p-values were then each plotted against the number of clusters (i.e. how far left or right the cluster analysis dendrogram is pruned), with the ideal number of dendrogram clusters corresponding to high total and average significance.

Presented below are the final dendrogram figures, illustrating the community groups identified based on control and treatment observation data. NMS diagrams are included to illustrate the strength of community grouping based on various treatment categories (such as time since construction). Indicator

species analysis plots described above are provided to illustrate support for the number of community groups identified for each ecological range site.

The data was analyzed first with all control and treatment observations combined in order to investigate the relationship between pipeline disturbances that were under reclamation and adjacent native prairie control sites. Next, the data was analyzed with control observations excluded. This allows a focussed investigation of disturbances under reclamation in order to identify succession patterns.

All Data including Revegetation Treatments and Undisturbed Controls

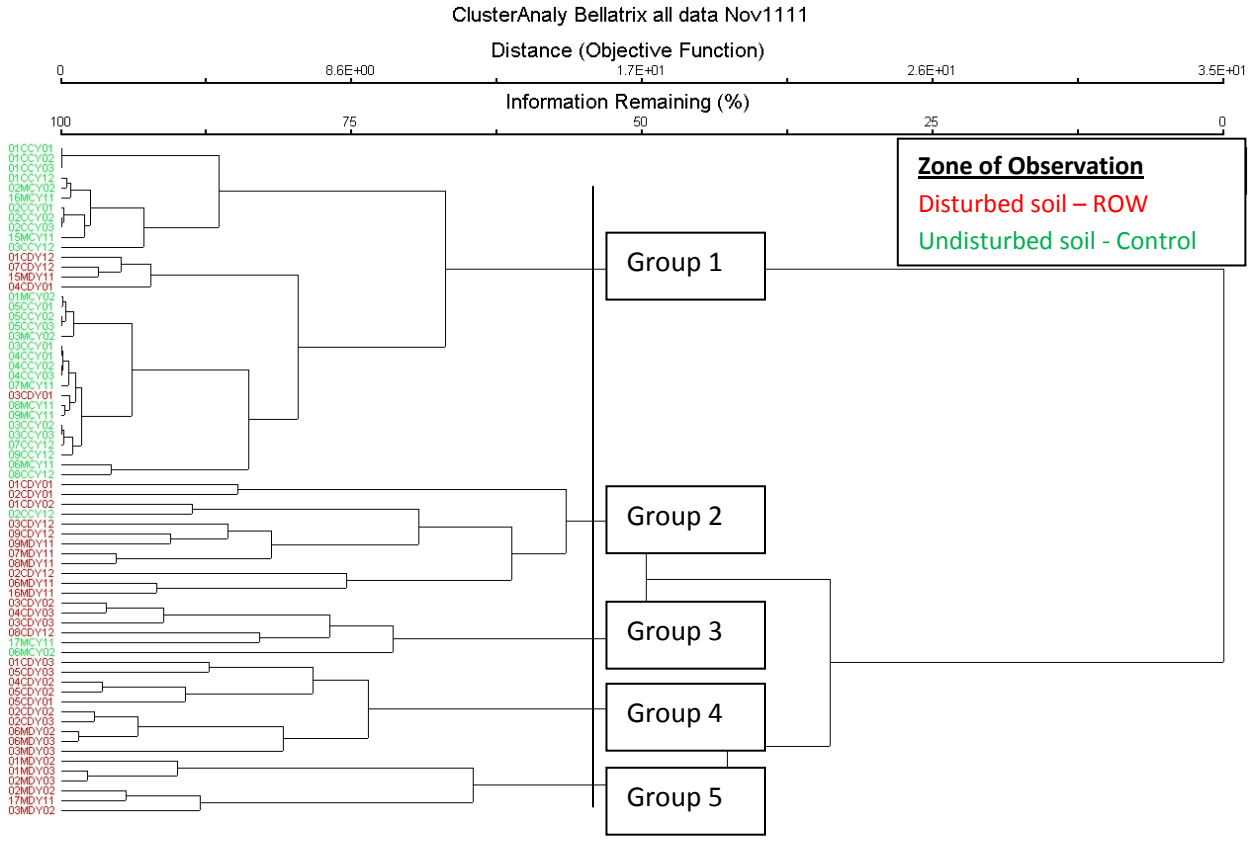
n=68

All Data Cluster Analysis

Percent chaining is 2.49%, which is very good (ideal is <10%). This means there were a number of distinct groups to further investigate.

From observation of the cluster analysis, 13 groups are distinguished at the 75% information remaining level. However, given the size of the data set (n=68), and the fact that at this level, some of the community groups are composed of single sites or groups of less than three, a higher level of grouping is likely more meaningful for interpretation in the field. There is an obvious natural group comprised of a majority of control sites (Group 1). To identify this group and avoid groups with less than three members, five community groups can be identified as shown below.

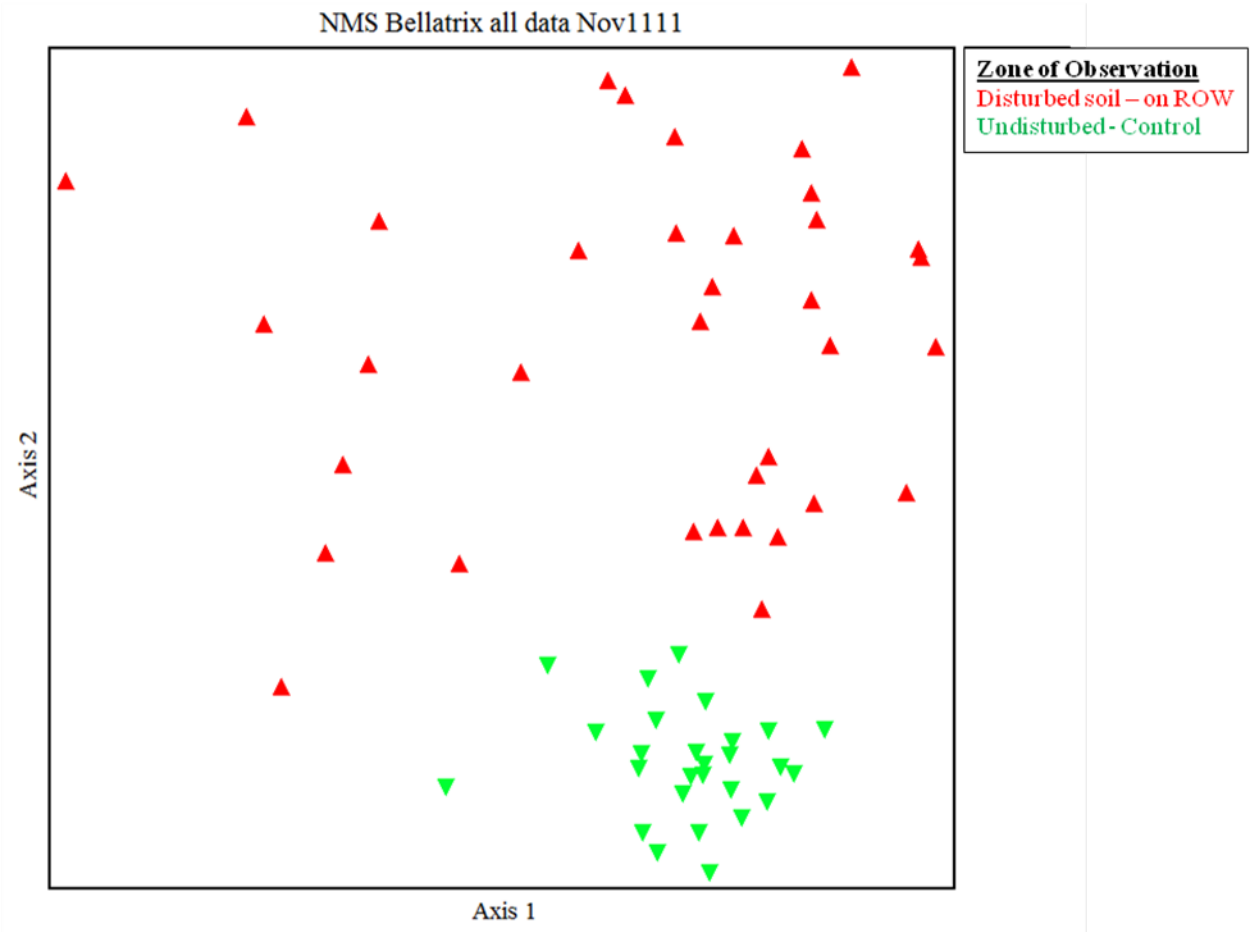
Figure 1 Cypress Upland Cluster Analysis Diagram – All Data including Controls



All Data NMS Ordination

Nonmetric multidimensional scaling (NMS) results were useful but not strong. Stress was 16.1 (<10 is ideal, but 10-20 produces useable results if interpreted with caution). A 2D solution was recommended, indicating that additional dimensions were not required to explain the complexity of the data. For the 2D solution, 82.8% of the overall variation was accounted for, which is quite good. Axis 2 was the strongest (55.6%). The distinction between control and disturbed sites is visualized to an even greater degree than in the above cluster analysis.

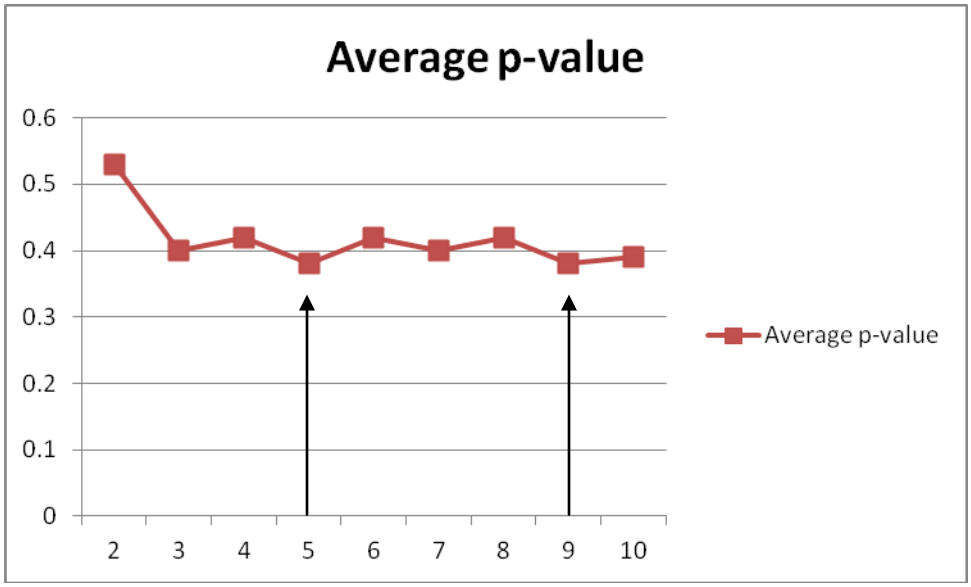
Figure 2 Cypress Upland Nonmetric Multidimensional Scaling Diagram – All Data including Controls

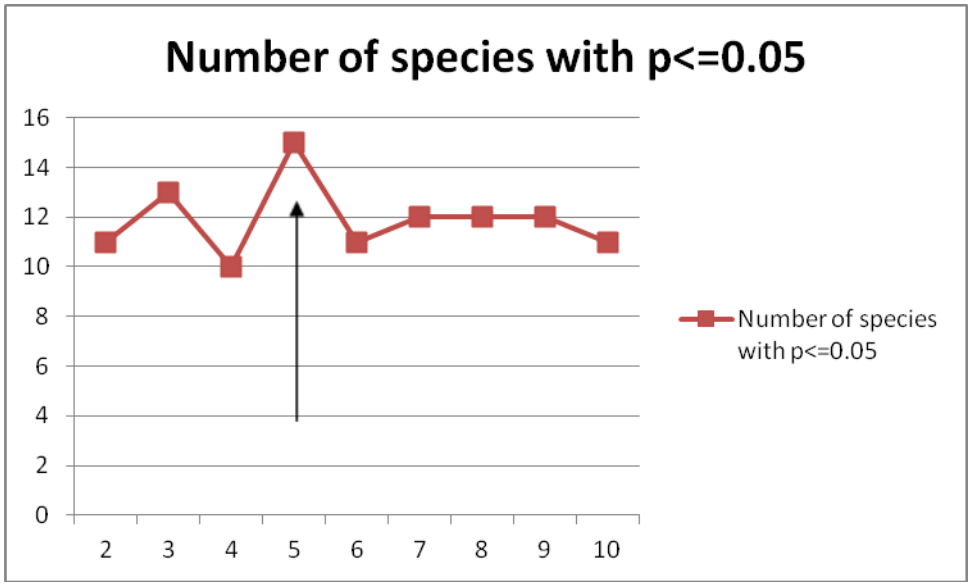


All Data Indicator Species Analysis

The criterion provided by ISA indicated that the dendrogram could be trimmed at either 5 or 9 groups. The lowest average p-value for all species occurred at both 5 and 9 groups (0.38), while the highest number of species with an IV p-value of <= 0.05 also coincided at 5 groups (15). The 5 group result was selected due to the appropriateness for a smaller number of groups identified for the smaller dataset, and for alignment with observations made from the dendrogram above.

Figure 3 Cypress Upland Dendrogram Diagram – All Data including Controls





All Data Community Group Identification – Treatments and Controls

Group one includes 24 control observations on undisturbed grassland. It represents the undisturbed reference plant community for plains rough fescue grassland on loamy and shallow-to-gravel range sites in the Cypress Upland, *Plains rough fescue – Western Porcupine Grass – Sedge* (MGA1). The community closely resembles the ecological site potential natural community under light disturbance described in the Mixedgrass Range Plant Community Guide. Healthy range scores for undisturbed grassland in 2011 also support this result. Several sites from both the cover crop treatment and the native seed mix treatment (are also present in this group. Two cover crop sites are observations after 12 years of recovery and one native seed mix sites is an observation from 11 year recovery. Two observations one year after recovery likely contained sod clumps with intact prairie selaginella, since cover values for this groundcover layer are very high for disturbed topsoils.

Group 1: Plains rough fescue - Western porcupine grass – Sedge Avg. Richness = 17.8; Shannon's Diversity Index = 1.70		
	Average Cover (%)	**Constancy**
Plains rough fescue	38.7	100
Western porcupine grass	5.5	89.7
Golden bean	1.8	86.2
Sun-loving sedge	1.2	69.0
Low sedge	1.2	62.1
Prairie selaginella	6.3	96.6
Moss and Lichen	2.5	86.2

#Control observations: 24
#Disturbed observations: 5

Control – Undisturbed Grassland	Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
01CCY01, 01CCY02, 01CCY12, 02CCY01, 02CCY02, 03CCY01, 03CCY02, 03CCY12, 04CCY01, 04CCY02, 05CCY01, 05CCY02, 07CCY12, 08CCY12, 09CCY12, 01MCY02, 02MCY02, 03MCY02, 06MCY11, 07MCY11, 08MCY11, 09MCY11, 15MCY11, 16MCY11	01CDY12, 03CDY01, 07CDY12	04CDY01		15MDY11

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 2 is a late seral plant community. Cover of long-lived and slower establishing grass species such as rough fescue is expanding. Decreaser grasses are dominant, but the disturbance forb pasture sagewort is still prominent. The groundcover layer of moss and lichen is present. Early records likely contained sod clumps with intact moss, lichen and prairie selaginella. Inclusion of an undisturbed control site in this group may reflect the "healthy with problems" range health score for this site. The majority of the observations in this group (8 of 11) are from 11-12 years after disturbance, indicating a trend towards recovery. Observations from the two different seeding strategies, cover crop and the native seeded mixes, are represented.

Group 2: Plains rough fescue - Pasture sage - Northern wheatgrass Avg. Richness = 17.8; Shannon's Diversity Index = 2.39		
	Average Cover (%)	**Constancy**
Plains rough fescue	9.3	100
Pasture sage	5.5	100
Low sedge	1.7	91.7
Northern wheatgrass	3.8	83.3
Western porcupine grass	3.2	83.3
June grass	1.8	83.3
Golden bean	3.3	83.3
Moss and Lichen	4.4	100
Prairie Selaginella	1.6	83.3

#Control observations: 1
#Disturbed observations: 11

Control	Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
02CCY12	01CDY01,		07MDY11	06MDY11
	01CDY02		08MDY11	09MDY11
	02CDY01		16MDY11	
	02CDY12			
	03CDY12			
	09CDY12			

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 3 is an early seral community dominated by the disturbance forb pasture sagewort. Early establishing western porcupine grass and northern wheatgrass are prominent. Slow to establish decreaser species rough fescue is present at low cover levels. The groundcover layer is absent and lower structural layers are also not well developed. Two native seed mixes (those with a lower proportion of rough fescue seed) and the cover crop treatment are represented in the group between one and three years into revegetation of the disturbed topsoils.

Group 3: Pasture sage - Northern wheatgrass - Western porcupine grass Avg. Richness = 16.9; Shannon's Diversity Index = 2.08		
	Average Cover (%)	**Constancy**
Pasture sage	10.1	100
Northern wheatgrass	2.7	100
Western porcupine grass	2.9	90
Low sedge	1.3	90
Plains rough fescue	0.7	90
Needle-and-thread	2.2	70
Prairie selaginella	0.1	70

#Control observations: 0
#Disturbed observations: 10

Control	Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
	01CDY03	04CDY02		03MDY03
	02CDY02	05CDY01		06MDY02
	02CDY03	05CDY02		06MDY03
		05CDY03		

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 4 is an early seral plant community dominated by the pioneer cultivar slender wheatgrass and early establishing seeded cultivar northern wheatgrass from the native seed mixes. The disturbance forb pasture sagewort and short sedges also present from the seedbank. Other seeded species such as rough fescue and western porcupine grass also establishing. This grouping is native seed mix driven, with slender wheatgrass and northern wheatgrass, not common on the undisturbed grassland, providing the dominant cover.

Group 4: Slender wheatgrass - Northern wheatgrass - Pasture sage Avg. Richness = 16.8; Shannon's Diversity Index = 2.15		
	Average Cover (%)	**Constancy**
Slender wheatgrass	7.4	100
Northern wheatgrass	6.5	100
Pasture sage	3.3	100
Plains rough fescue	1.2	100
Low sedge	1.1	100
Sun-loving sedge	0.8	100
Western porcupine grass	2.2	83.3
Golden bean	1.7	83.3

#Control observations: 0
#Disturbed observations: 6

Control	Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
			01MDY02	03MDY02
			01MDY03	
			02MDY02	
			02MDY03	
			17MDY11	

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 5 is a mid-seral plant community. The cover of grasses is greater than that of disturbance forbs such as the sageworts and decreaser grasses are present as a small component of the cover. The groundcover layer is present but this is likely due to pre-disturbance cover being preserved in sods replaced upright on the disturbance. Both cover crop and native seed mix strategies are represented in this cluster.

Group 5: Western porcupine grass - Plains rough fescue-Low sedge Avg. Richness = 18.3; Shannon's Diversity Index = 2.00		
	Average Cover (%)	**Constancy**
Western porcupine grass	14.0	100
Plains rough fescue	6.0	100
Low sedge	6.0	100
Pasture sage	0.7	100
Northern wheatgrass	1.3	66.7
Prairie selaginella	3.1	66.7
Moss and lichen	2.1	66.7

#Control observations: 2
#Disturbed observations: 4

Control	Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
	03CDY02	04CDY03	17MCY11	06MCY02
	03CDY03			
	08CDY12			

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Table 1 Summary of Plant Communities Identified in the Cluster Analysis – Treatments and Control Data and the Number of Years of Recovery

Seed Treatment	Cover Crop						Native Mix 1							Native Mix 2			Native Mix 3		Con-trol
Site #	01C	02C	03C	07C	08C	09C	01M	02M	07M	08M	15M	16M	17M	03M	06M	09M	04C	05C	
Pasture sage - Northern wheatgrass - Western porcupine grass (Grp 3)	3	2, 3												3	2, 3		2	1, 2	
Slender wheatgrass - Northern wheatgrass - Pasture sage (Grp 4)							2, 3	2, 3					11	2					
Western porcupine grass - Plains rough fescue-Low sedge (Grp 5)			2, 3		12								11		2		3		
Plains rough fescue - Pasture sage – Northern wheatgrass (Grp 2)	1, 2	1, **12**	**12**			**12**			**11**	**11**		**11**			**11**	**11**			1 obs
Plains rough fescue - Western porcupine grass - Prairie selaginella (Grp 1)	**12**		1	**12**							**11**						1		24 obs

Revegetation Treatment Data excluding the Undisturbed Controls

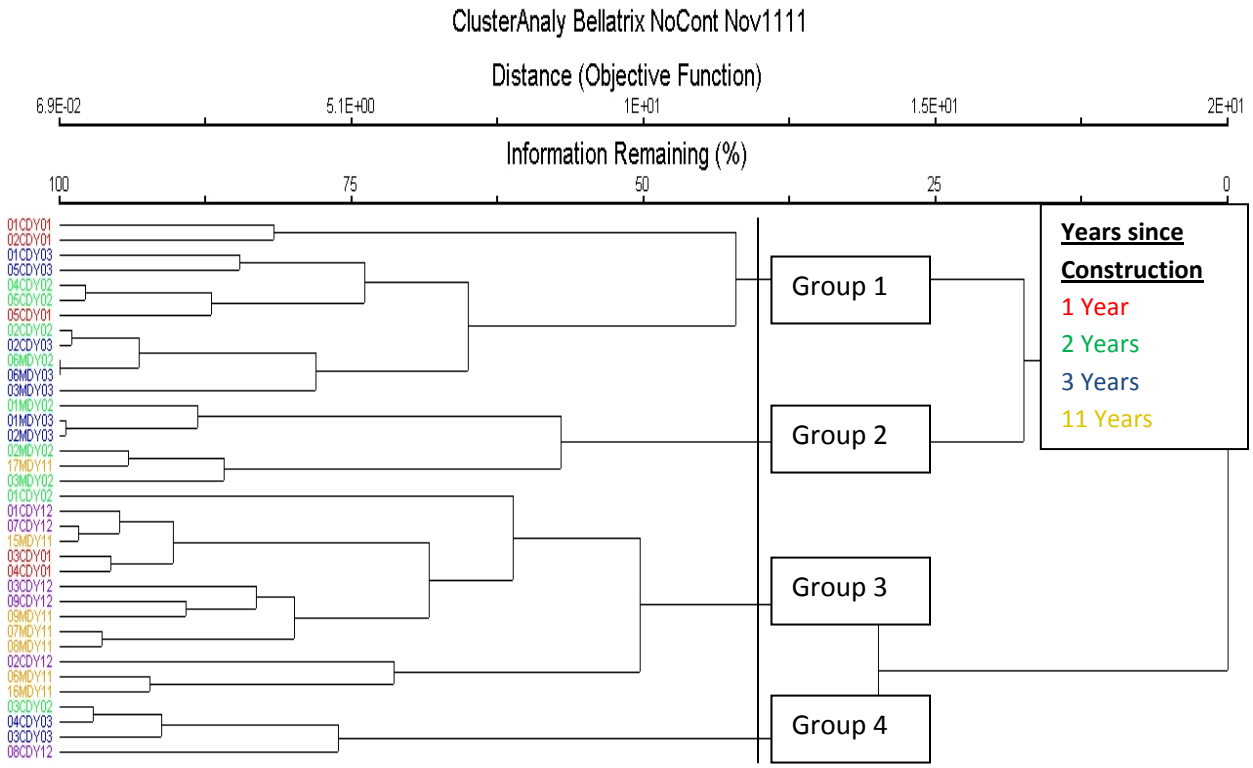
n=36

Treatment Data Cluster Analysis

Percent chaining is 4.61%, which is very good (ideal is <10%). This means there were a number of distinct groups to further investigate.

From observation of the cluster analysis, 12 groups are distinguished at the 75% information remaining level. However, given the size of the data set (n=36), and the fact that at this level, a majority of the community groups are composed of single sites or groups of less than three, a higher level of grouping is likely more meaningful for interpretation in the field. There appeared to be some distinction of groups that contained observations from the 11 and 12 years post-construction (Groups 3 and 4) and those that did not (Groups 1 and 2).

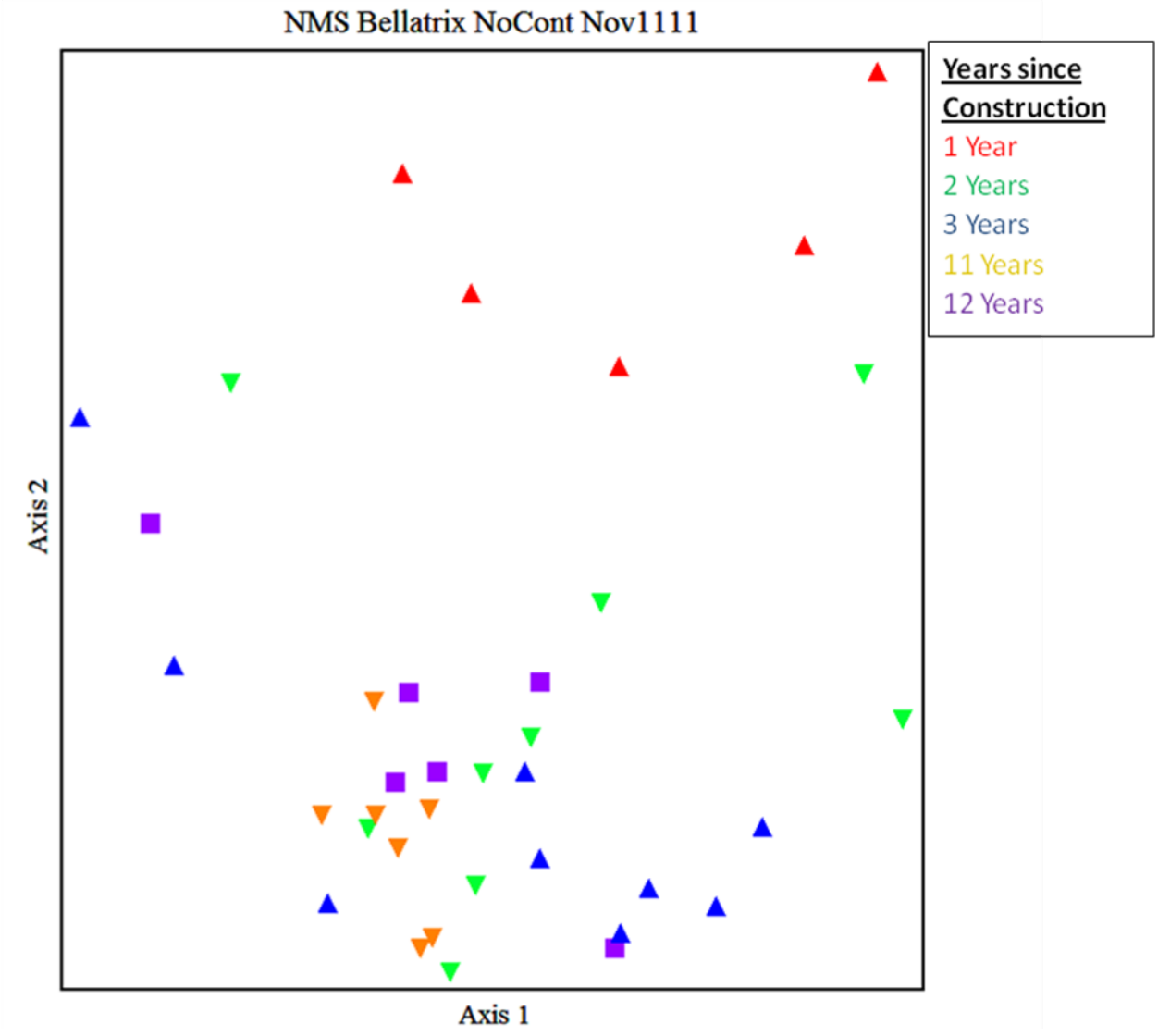
Figure 4 Cypress Upland Cluster Analysis Diagram – Treatment Data without Controls



Treatment Data NMS Ordination

NMS results were useful but not strong. Stress was 13.4 (<10 is ideal, but 10-20 produces useable results if interpreted with caution). A 3D solution was recommended, with 85.3% of the variation explained overall. Axes 2 (38.9%) and 1 (26.0%) were the strongest. The distinction between control and disturbed sites is visualized to an even greater degree than in the above cluster analysis.

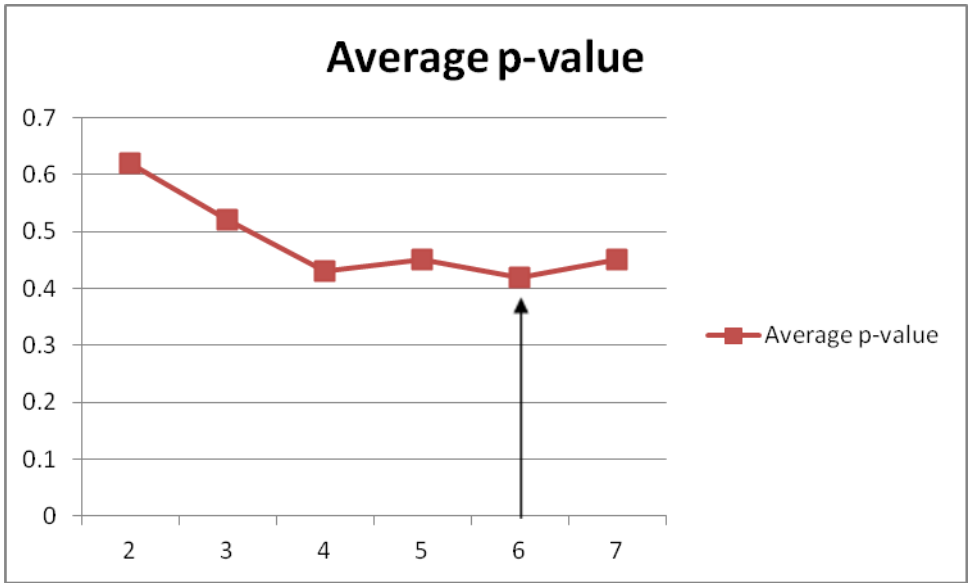
Figure 5 Cypress Upland NMS Diagram – Treatment Data without Controls

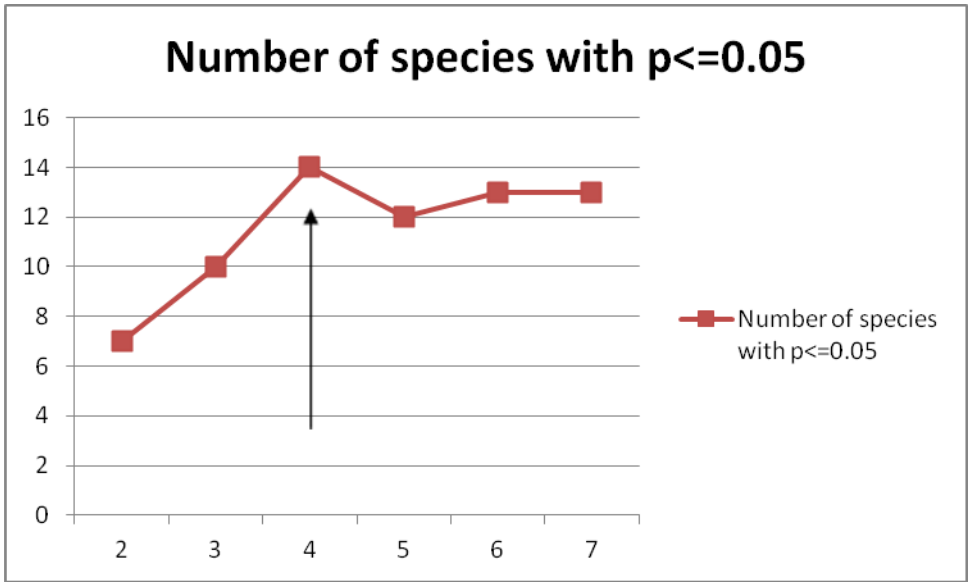


Treatment Data Indicator Species Analysis – No Controls

The criterion provided by ISA indicated that the dendrogram could be trimmed at either 4 or 6 groups. The lowest average p-value for all species occurred at 6 groups (0.42), while the highest number of species with an IV p-value of <= 0.05 occurred at 4 groups (14), without very much gain in average p-value (0.43). Due to a preference for a smaller number of groups based on the small dataset, four groups were chosen to be identified, consistent with the dendrogram observations shown above.

Figure 6 Cypress Upland Dendrogram Diagram – Treatment Data without Controls





Treatment Data Community Group Identification – No Undisturbed Controls

Group 1 is an early seral association including observations between one and three years post-construction. The community is dominated by the disturbance forb pasture sagewort, which is naturally present in the grassland. Cover values of seeded or seedbank grasses is low. These observations occurred between one and three years post disturbance, including the drought years of 2001 and 2002. It includes many observations from both the cover crop seeding treatment and the native seed mix treatments where rough fescue is not the dominant species in the mix.

Group 1: Pasture sage - Low sedge - Plains rough fescue Avg. Richness = 16.2; Shannon's Diversity Index = 2.08		
	Average Cover (%)	**Constancy**
Pasture sage	8.5	100
Northern wheatgrass	2.3	91.7
Low sedge	1.1	91.7
Plains rough fescue	0.6	91.7
Western porcupine grass	2.5	83.3

Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
01CDY01	04CDY02		03MDY03
01CDY03	05CDY01		06MDY02
02CDY01	05CDY02		06MDY03
02CDY02	05CDY03		
02CDY03			

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 2 is an early seral association dominated by the seeded colonizing species slender wheatgrass, early establishing northern wheatgrass and the disturbance forb pasture sagewort, which is naturally present in the grassland. It includes observations between two and three years' post-construction from seed mix sites only. Other seeded species include green needle grass, rough fescue and western porcupine grass. The latter two species are prominent naturally in the area.

Group 2: Slender wheatgrass – Northern wheatgrass – Pasture sage
Avg. Richness = 16.8; Shannon's Diversity Index = 2.15

	Average Cover (%)	Constancy
Slender wheatgrass	7.4	100
Northern wheatgrass	6.5	100
Pasture sage	3.3	100
Plains rough fescue	1.2	100
Low sedge	1.1	100
Sun-loving sedge	0.8	100
Green needle grass	3.3	83.3
Western porcupine grass	2.2	83.3

Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
		01MDY02	03MDY02
		01MDY03	
		02MDY02	
		02MDY03	
		17MDY11	

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 3 is a late seral association. The long-lived grass species plains rough fescue is dominant. Wild-harvested seed from this species was seeded in all three native seed mixes represented in this cluster. Pasture sage is also still prominent. Other seeded species present on most sites are northern wheatgrass and western porcupine grass. June grass has established at low cover from the seed bank. Moss, lichen and selaginella are present, likely from chunks of sod salvaged upright from the original construction clean-up. Eleven of the 13 observations in this cluster are 11 to 12 years after reseeding and represent both revegetation strategies.

Group 3: Plains rough fescue – Pasture sage – Northern wheatgrass Avg. Richness = 17.4; Shannon's Diversity Index = 2.28		
	Average Cover (%)	**Constancy**
Plains rough fescue	12.2	100
Pasture sage	6.0	92.9
Northern wheatgrass	3.9	85.7
Western porcupine grass	3.5	85.7
Golden bean	2.2	85.7
June grass	1.7	78.6
Moss and Lichen	4.4	85.7
Prairie selaginella	0.9	78.6

Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
01CDY12	04CDY01	07MDY11	06MDY11
02CDY12		08MDY11	09MDY11
03CDY01		15MDY11	
03CDY12		16MDY11	
07CDY12			
09CDY12			

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Group 4 is a mid-seral plant community with a small number of observations. These observations span two, three and twelve years post-construction. They may be clustering together because of the presence of common wild rose. Western porcupine grass, a colonizing species present in the seed bank and the Cypress mix is dominant. Moss, lichen and prairie selaginella are only present in trace cover values on 50% of the sites.

Group 4: Western porcupine grass – Plains rough fescue Avg. Richness = 17.0; Shannon's Diversity Index = 1.92		
	Average Cover (%)	**Constancy**
Western porcupine grass	13.4	100
Plains rough fescue	3.8	100
Common wild rose	2.4	100
Low sedge	1.9	100
Northern wheatgrass	1.7	75
Sun-loving sedge	1.0	75
Pasture sage	0.8	100

Cover Crop: Rye/Flax	Cypress Native Seed Mix	MF Native Seed Mix 1	MF Native Seed Mix 2
03CDY02	04CDY03		
03CDY03			
08CDY12			

CC = Cypress Control
CD = Cypress Disturbed topsoils
MC = Merry Flats control
MD = Merry Flats Disturbed topsoils

Appendix C Seral Stage Definitions

C.1 Definitions of Seral Stages for Disturbance Plant Communities

Seral Stage	Description
Bare ground	< 5% cover of live vegetation.
Pioneer	Site dominated by annual weeds, a cover crop or first year seeded colonizing grasses such as slender wheatgrass.
Early seral	Site dominated by disturbance forbs such as pasture sagewort and other species such as low sedge. Seeded species and colonizing grasses such as spear grasses also establishing.
Mid-seral	Cover of grasses greater than that of disturbance forbs such as the sageworts; decreaser grasses present as a small component of the cover.
Late mid-seral	Cover of grasses greater than that of disturbance forbs such as the sageworts; decreaser grasses occupy about 50% of the cover; infill species present.
Late Seral - native	Cover of long-lived grass species expanding; native species cover from the seed bank established; slower establishing infill species present; decreaser grasses dominant; no more than one structural layer missing.
Late Seral - cultivars	Cover of long-lived grass species expanding; seeded cultivars clearly still dominant; slower establishing species such as fescues present; decreaser grasses dominant; no more than one structural layer missing.
Reference	Community closely resembles the ecological site potential natural community under light disturbance described in the Range Plant Community Guides.
Trending to Modified *	A primarily native plant community where non-native species are increasing over time and occupying > 5% of the total live cover; the succession time scale is as little as 5 and as many as 20 years or more.
Modified	> 70% cover of non-native species.

* Invasive non-native species that are known to replace native species and establish permanent dominance in grassland communities include crested wheatgrass, smooth brome and sheep fescue. There has been a debate about whether Kentucky bluegrass should be included in this category. Our feeling is that Kentucky bluegrass is a somewhat naturalized species that is relatively stable. Cover values are high in wet years but are reduced in dry years and in pastures with improved range health. It does not illustrate the same “fire front” effect on the landscape as the previously listed invasive species.

Appendix D Cypress Project Data

D.1 Locations of Cypress Project Monitoring Plots

Site Label	Legal Land Description	Easting	Northing	NAD83 Zone	Range Pin Number
01C	LSD5-Sec2-Twp7-Rge1-W4M	569056	5486815	12U	85
02C	LSD7-Sec2-Twp7-Rge1-W4M	569604	5486798	12U	92
03C	LSD14-Sec1-Twp7-Rge1-W4M	571018	5487316	12U	93
04C	LSD5-Sec3-Twp7-Rge30-W3M	572348	5486918	12U	97
05C	LSD12-Sec34-Twp6-Rge30-W3M	572387	5485731	12U	98
06C	LSD16-Sec1-Twp7-Rge1-W4M	572092	5487331	12U	96
07C	NW1-7-1-W4M	570051	5487134	12U	n/a
08C	LSD6-Sec2-Twp7-Rge1-W4M	569179	5486826	12U	n/a
09C	NW1-7-1-W4M	570974	5487134	12U	n/a
01M	Sec 32-6-30-W3M	572765	5485592	12U	n/a
02M	Sec 33-6-30-W3M	573056	5485585	12U	n/a
03M	NE 28-6-30-W3M	573596	5484381	12U	n/a
04M	NW 34-6-30-W3M	574770	5485517	12U	n/a
05M	NW 34-6-30-W3M	574607	5485529	12U	n/a
06M	Sec 35-6-30-W3M	575932	5485316	12U	n/a
07M	NE34-6-30-W3M	575438	5485484	12U	n/a
08M	SE34-6-30-W3M	575556	5485485	12U	n/a
09M	SW35-6-30-W3M	575794	5485370	12U	n/a
15M	LSD10-Sec34-Twp6-Rge30-W3M	571548	5485500	12U	n/a
16M	LSD10-Sec34-Twp6-Rge30-W3M	575303	5485493	12U	n/a
17M	LSD11-Sec34-Twp6-Rge30-W3M	574917	5485507	12U	n/a

D.2 Cypress Upland Monitoring Project Micro-Plot Data

D.2.1 Cypress Pipeline Cover Charts

Cover of Vegetation over Time on Disturbed Topsoils at Site 1

Revegetation Strategy: Rye/Flax
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: 5-2-7-1-W4M **UTM(NAD83):** 12U 569056 5486815

Year 1 off RoW		1 Years Recovery		Year 2 off RoW		2 Years Recovery		3 Years Recovery		Year 12 off RoW		12 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[2]		Site Cover[2]	
Total Veg	107.1	Total Veg	3.6	Total Veg	97.5	Total Veg	7.7	Total Veg	35.7	Total Veg	55.0	Total Veg	42.0
Litter	73.6	Litter	6.1	Litter	79.6	Litter	2.1	Litter	3.6	Litter	48.0	Litter	25.0
Exposed Soil	0.8	Exposed Soil	87.8	Exposed Soil	0.7	Exposed Soil	82.8	Exposed Soil	71.5	Exposed Soil	1.2	Exposed Soil	34.0
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	14.4	Moss/Lichen	0.2	Moss/Lichen	14.6	Moss/Lichen	0.1	Moss/Lichen	0.0	Moss/Lichen	6.8	Moss/Lichen	4.4
SELADEN	23.2	SELADEN	0.3	SELADEN	20.8	SELADEN	0.0	SELADEN	0.1	SELADEN	14.6	SELADEN	0.2
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
FESTHAL	38.2	SECACER	1.4	FESTHAL	38.4	THERRHO	3.6	ARTEFRI	12.0	FESTHAL	37.0	FESTHAL	15.6
ERIGCAE	10.7	LINUUSI	0.6	ERIGCAE	7.5	FESTHAL	1.6	THERRHO	6.8	ERIGCAE	4.2	HETEVIL	7.4
CARESTE	7.2	FESTHAL	0.4	CARESTE	5.2	HETEVIL	0.6	HETEVIL	5.3	KOELMAC	3.4	ARTEFRI	4.2
STIPCUR	4.7	ARENCON	0.3	STIPCUR	3.8	STIPCOM	0.6	CARESTE	3.6	THERRHO	3.2	AGRODAS	2.2
HETEVIL	2.3	THERRHO	0.3	THERRHO	2.1	ARTEFRI	0.4	STIPCOM	2.3	ARTEFRI	3.0	STIPCUR	2.2
THERRHO	2.2	CARESTE	0.2	HETEVIL	1.6	CARESTE	0.3	AGRODAS	1.8	HETEVIL	2.0	THERRHO	2.0
FESTIDA	2.1	ARTEFRI	0.1	FESTIDA	1.5	STIPCUR	0.3	ERIGCAE	1.5	COMAUMB	1.2	KOELMAC	1.8
KOELMAC	0.7			KOELMAC	0.8	CHENSAL	0.3	FESTHAL	1.1	PHLOHOO	0.8	CARESTE	1.6
ARTEFRI	0.5			AGRODAS	0.6	COMAUMB	0.1	COMAUMB	0.5	AGRODAS	0.7	COMAUMB	1.6
AGRODAS	0.4			ARTEFRI	0.4	KOELMAC	0.1	LESQARE	0.3	CARESTE	0.6	CALAMON	0.6
PHLOHOO	0.3			PHLOHOO	0.3	POTEFRU	0.1	HIERODO	0.3	STIPCUR	0.6	ASTRDAS	0.4
ASTRDAS	0.1			COMAUMB	0.1			STIPCUR	0.3				
COMAUMB	0.1			ASTRDAS	0.1			CHENSAL	0.1				
SENECAN	0.1			SENECAN	0.1								
				VICIAME	0.1								

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 2

Revegetation Strategy: Rye/Flax
Ecological Range Site: NA(MF5)
Legal Land Description: 7-2-7-1-W4M **UTM(NAD83):** 12U 569604 5486798

Year 1 off RoW		1 Years Recovery		Year 2 off RoW		2 Years Recovery		3 Years Recovery		Year 12 off RoW		12 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[2]		Site Cover[2]	
Total Veg	65.9	Total Veg	5.9	Total Veg	59.6	Total Veg	12.6	Total Veg	34.5	Total Veg	52.0	Total Veg	59.0
Litter	80.4	Litter	3.8	Litter	65.4	Litter	3.2	Litter	7.3	Litter	65.0	Litter	33.0
Exposed Soil	0.5	Exposed Soil	87.8	Exposed Soil	0.4	Exposed Soil	81.9	Exposed Soil	64.3	Exposed Soil	2.0	Exposed Soil	13.4
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	1.9	Moss/Lichen	0.1	Moss/Lichen	1.5	Moss/Lichen	0.0	Moss/Lichen	0.0	Moss/Lichen	1.4	Moss/Lichen	4.0
SELADEN	7.0	SELADEN	0.3	SELADEN	9.4	SELADEN	0.1	SELADEN	0.0	SELADEN	7.8	SELADEN	0.8
Species	%Cover	Species	%Cover	Species	%Cover	Species	%Cover	Species	%Cover	Species	%Cover	Species	%Cover
FESTHAL	36.1	ARTEFRI	1.6	FESTHAL	26.8	ARTEFRI	6.2	ARTEFRI	14.4	FESTHAL	19.4	STIPCOM	8.0
ACHIMIL	5.7	SECACER	1.5	ACHIMIL	4.0	GRINSQU	1.5	ACHIMIL	5.3	THERRHO	14.0	AGRODAS	7.6
CAREOBT	4.6	LINUUSI	0.8	CAREOBT	3.3	KOELMAC	1.1	CARESTE	3.1	FESTIDA	4.4	ASTRDAS	6.0
ARTECAN	2.6	CAREPEN	0.6	ARTECAN	2.1	STIPCOM	1.0	HETEVIL	3.0	ARTELUD	3.0	ACHIMIL	5.2
STIPCUR	2.1	VICIAME	0.3	STIPCUR	1.8	CARESTE	0.7	STIPCUR	2.3	AGRODAS	2.4	GUTISAR	5.0
ANTEAPR	0.9	ERIGCAE	0.3	ANTEPAR	1.5	FESTHAL	0.6	KOELMAC	2.2	ASTRDAS	2.0	ARTEFRI	3.6
PHLOHOO	0.9	ACHIMIL	0.1	ANTEAPR	1.2	ACHIMIL	0.3	STIPCOM	1.0	STIPCUR	1.8	CARESTE	3.2
ARTEFRI	0.8	STIPCUR	0.1	AGRODAS	0.8	CALAMON	0.3	AGRODAS	0.7	ANTEAPR	1.2	KOELMAC	3.2
CAREPEN	0.7	AGRODAS	0.1	ARENCON	0.8	AGROSMI	0.3	THERRHO	0.5	CARESTE	1.0	THERRHO	3.0
KOELMAC	0.5	CARESTE	0.1	PHLOHOO	0.8	THERRHO	0.3	VICIAME	0.5	GEUMTRI	1.0	HETEVIL	2.8
AGRODAS	0.4	FESTHAL	0.1	KOELMAC	0.7	VICIAME	0.1	FESTHAL	0.4	POASAND	1.0	ERIGCAE	1.0
ANEMPAT	0.4	KOELMAC	0.1	SOLIMIS	0.6	AGRODAS	0.1	CALAMON	0.3	ANEMPAT	0.6	FESTHAL	1.0
HETEVIL	0.4	PHLOHOO	0.1	ARTEFRI	0.6	ANDROCC	0.1	GAILARI	0.3	ARTEFRI	0.6	VICIAME	0.8
SOLIMIS	0.4	SOLIMIS	0.1	CARESTE	0.6	HETEVIL	0.1	GUTISAR	0.3	KOELMAC	0.6	ANDRSEP	0.6
THERRHO	0.2	THERRHO	0.1	CAREPEN	0.5	OXYTSER	0.1	SOLIMIS	0.3	PHLOHOO	0.6	STIPCUR	0.6
ASTRDAS	0.1			HETEVIL	0.5	SOLIMIS	0.1	ANTEAPR	0.1	CALAMON	0.2	PHLOHOO	0.4
ERIGCAE	0.1			THERRHO	0.5	SPHACOC	0.1	ASTRDAS	0.1	VICIAME	0.2	CALAMON	0.2
FESTIDA	0.1			ANEMPAT	0.3			HIERODO	0.1				
POACUSI	0.1			ASTRDAS	0.3			LESQARE	0.1				
				POASAND	0.3			OROBFAS	0.1				
				GEUMTRI	0.3			OXYTSER	0.1				
				OXYTSER	0.3			PHLOHOO	0.1				
				STIPCOM	0.3								
				CALAMON	0.1								
				POTECON	0.1								
				CERAARV	0.1								
				ERIGCAE	0.1								
				FESTIDA	0.1								
				POACUSI	0.1								

[1] Mean percent canopy cover - pre-2011 data
[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 3

Revegetation Strategy: Rye/Flax
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: 14-1-7-1-W4M **UTM(NAD83):** 12U 571018 5487316

Year 1 off RoW		1 Years Recovery		Year 2 off RoW		2 Years Recovery		3 Years Recovery		Year 12 off RoW		12 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[2]		Site Cover[2]	
Total Veg	92.2	Total Veg	12.4	Total Veg	87.7	Total Veg	16.8	Total Veg	33.9	Total Veg	85.4	Total Veg	73.4
Litter	90.7	Litter	5.0	Litter	86.8	Litter	1.9	Litter	3.2	Litter	38.0	Litter	22.0
Exposed Soil	0.5	Exposed Soil	85.0	Exposed Soil	0.6	Exposed Soil	0.0	Exposed Soil	73.7	Exposed Soil	0.0	Exposed Soil	3.6
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	0.6	Moss/Lichen	0.0	Moss/Lichen	0.6	Moss/Lichen	0.0	Moss/Lichen	0.1	Moss/Lichen	0.4	Moss/Lichen	1.0
SELADEN	3.1	SELADEN	0.0	SELADEN	2.5	SELADEN	0.0	SELADEN	0.4	SELADEN	13.4	SELADEN	0.0
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
FESTHAL	68.2	FESTHAL	8.8	FESTHAL	57.1	STIPCUR	10.0	STIPCUR	15.6	FESTHAL	30.0	FESTHAL	19.0
STIPCUR	10.4	CAREPEN	1.1	STIPCUR	16.6	ANTEAPR	1.5	LUPIARG	8.5	STIPCUR	14.6	ROSAARK	11.4
CAREPEN	5.1	SECACER	1.0	CAREPEN	5.6	ARTEFRI	1.5	FESTHAL	2.9	ROSAARK	6.4	STIPCOM	9.6
ROSAARK	2.6	LINUUSI	0.9	ROSAARK	1.9	FESTHAL	1.4	ROSAWOO	2.3	STIPCOM	4.0	ARTEFRI	9.0
THERRHO	0.8	SELADEN	0.4	LUPIARG	1.5	CAREPEN	0.9	ARTELUD	1.6	FESTIDA	3.0	STIPCUR	8.0
ARENCON	0.5	AGOSGLA	0.1	THERRHO	0.6	ROSAWOO	0.8	CAREPEN	0.7	GENTAFF	3.0	ACHIMIL	4.2
ANEMPAT	0.4	CAMPROT	0.1	ANEMPAT	0.5	AGOSGLA	0.5	ACHIMIL	0.6	CAREPEN	2.8	THERRHO	2.4
GENTAMA	0.3	ROSAARK	0.1	ARENCON	0.4	AGRODAS	0.1	CARESTE	0.5	ANEMPAT	2.6	AGRODAS	2.0
ARTEFRI	0.1	ANTEAPR	0.1	ARTEFRI	0.3	BESSWYO	0.1	AGOSGLA	0.3	CARESTE	2.6	CARESTE	2.0
HELIHOO	0.1	THERRHO	0.1	GENTAMA	0.2	CARESTE	0.1	ARTEFRI	0.3	ARENCON	1.6	KOELMAC	2.0
				ASTRDAS	0.1	CERAARV	0.1	CIRSUND	0.3	HELIHOO	1.6	SYMPOCC	2.0
				CAMPROT	0.1	PHLOHOO	0.1	THERRHO	0.3	ANEMMUL	1.0	HETEVIL	1.6
				HELIHOO	0.1					LIATPUN	1.0	ASTECIL	1.0
										ANTEPAR	0.2	VICIAME	1.0
										CAMPROT	0.2	ANDRSEP	0.6
										CAREOBT	0.2	ASTEFAL	0.6
										LINULEW	0.2	CAREOBT	0.6
												CAREPEN	0.6

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 4

Revegetation Strategy: Cypress Seed Mix
Ecological Range Site: NA
Legal Land Description: 5-3-7-30-W3M **UTM(NAD83):** 12U 572348 5486918

Year 1 off RoW		1 Years Recovery		Year 2 off RoW		2 Years Recovery		3 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]	
Total Veg	82.9	Total Veg	10.3	Total Veg	78.9	Total Veg	32.1	Total Veg	46.8
Litter	70.6	Litter	8.4	Litter	70.6	Litter	11.1	Litter	20.7
Exposed Soil	1.2	Exposed Soil	84.3	Exposed Soil	1.0	Exposed Soil	33.8	Exposed Soil	47.9
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	1.6	Moss/Lichen	0.0	Moss/Lichen	1.9	Moss/Lichen	0.3	Moss/Lichen	0.1
SELADEN	3.7	SELADEN	0.1	SELADEN	8.2	SELADEN	0.1	SELADEN	0.1
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
FESTHAL	58.4	FESTHAL	4.3	FESTHAL	51.3	ARTEFRI	8.2	STIPCUR	18.1
STIPCUR	8.3	AGRODAS	2.2	STIPCUR	7.3	STIPCUR	7.8	CARESTE	6.6
THERRHO	2.6	STIPCUR	0.8	ARTEFRI	2.0	AGRODAS	4.1	AGRODAS	6.5
ASTRDAS	2.6	ASTEFAL	0.7	THERRHO	1.9	STIPCOM	3.5	ROSAWOO	3.0
ARTEFRI	2.4	CAREPEN	0.6	ASTRDAS	1.8	CAREFIL	1.8	FESTHAL	2.0
PHLOHOO	1.1	KOELMAC	0.4	PHLOHOO	1.1	CARESTE	1.6	AGROTRA	1.8
HETEVIL	0.9	FESTIDA	0.3	ASTEFAL	0.9	ASTEFAL	1.5	ASTEFAL	1.8
GUTISAR	0.4	LINULEW	0.3	CARESTE	0.8	THERRHO	0.6	CERAARV	1.5
ASTEFAL	0.1	ARTEFRI	0.3	HETEVIL	0.7	STIPVIR	0.5	STIPVIR	1.5
CAREPEN	0.1	OXYTSER	0.3	ROSAARK	0.4	KOELMAC	0.4	KOELMAC	0.7
OXYTMON	0.1	AGROSUB	0.1	CAREFIL	0.3	COMAUMB	0.4	ARTEFRI	0.6
ROSAARK	0.1	ROSAARK	0.1	GUTISAR	0.3	ASTRDAS	0.3	AGROSUB	0.5
GENTAMA	0.1	CHENSP	0.1	CAREPEN	0.2	ACHIMIL	0.3	THERRHO	0.5
SENECAN	0.1	COMAUMB	0.1	OXYTMON	0.1	ERIGCAE	0.3	AGROSMI	0.3
		PHLOHOO	0.1	GENTAMA	0.1	FESTHAL	0.3	COMAUMB	0.3
		THERRHO	0.1	SENECAN	0.1	HETEVIL	0.3	ERIGCAE	0.3
						ROSAWOO	0.3	HELIHOO	0.3
						CAREPEN	0.1	HIERODO	0.3
						OXYTSER	0.1	SENECAN	0.3
								CALAMON	0.1
								FESTIDA	0.1
								PHLOHOO	0.1

[1] Mean percent canopy cover - pre-2011 data
[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 5

Revegetation Strategy: Cypress Seed Mix
Ecological Range Site: NA
Legal Land Description: 12-34-6-30-W3M **UTM(NAD83):** 12U 572387 5485731

Year 1 off RoW		1 Years Recovery		Year 2 off RoW		2 Years Recovery		3 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[1]	
Total Veg	109.6	Total Veg	7.5	Total Veg	106.6	Total Veg	17.9	Total Veg	54.8
Litter	89.3	Litter	2.8	Litter	87.1	Litter	3.4	Litter	14.6
Exposed Soil	0.0	Exposed Soil	88.9	Exposed Soil	0.0	Exposed Soil	73.7	Exposed Soil	64.5
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	0.6	Moss/Lichen	0.0	Moss/Lichen	1.0	Moss/Lichen	0.1	Moss/Lichen	0.2
SELADEN	2.9	SELADEN	0.3	SELADEN	12.4	SELADEN	0.3	SELADEN	0.0
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
FESTHAL	75.5	ARTEFRI	1.6	FESTHAL	65.2	ARTEFRI	4.1	ARTEFRI	9.9
CAREOBT	15.9	STIPCUR	1.1	CAREOBT	11.9	STIPCUR	3.8	HETEVIL	7.9
STIPCUR	4.6	FESTHAL	1.0	STIPCUR	7.1	AGRODAS	2.1	AGRODAS	6.5
THERRHO	3.0	CAREPEN	0.8	THERRHO	2.1	STIPVIR	1.8	STIPCOM	6.3
CERAARV	2.5	AGRODAS	0.8	CERAARV	2.0	ERIGCAE	1.6	STIPCUR	5.3
ERIGCAE	2.1	AGROSUB	0.4	ERIGCAE	1.5	AGROSUB	0.9	ERIGCAE	3.4
ASTRDAS	0.8	ASTRDAS	0.3	ASTRDAS	1.1	CARESTE	0.9	SOLIMIS	3.0
AGRODAS	0.4	CERAARV	0.3	HETEVIL	0.5	FESTHAL	0.7	STIPVIR	3.0
HETEVIL	0.4	ERIGCAE	0.3	AGRODAS	0.4	HETEVIL	0.5	CARESTE	2.6
KOELMAC	0.4	KOELMAC	0.3	CARESTE	0.3	KOELMAC	0.5	KOELMAC	2.6
ARTELUD	0.3	SOLIMIS	0.3	KOELMAC	0.3	CAREPEN	0.4	CAREPEN	1.8
ACHIMIL	0.1	THERRHO	0.3	PHLOHOO	0.3	POTEPEN	0.3	FESTHAL	1.4
CAREPEN	0.1	AGROTRA	0.1	ARTEFRI	0.3	SOLIMIS	0.3	AGROTRA	0.3
SOLIMIS	0.1	ASTEFAL	0.1	ARTELUD	0.2	CAREOBT	0.1	ANTEAPR	0.3
		GAILARI	0.1	SOLIMIS	0.1	CALAMON	0.1	BROMINE	0.3
				ACHIMIL	0.1			THERRHO	0.3
				ANTEAPR	0.1			OROBFAS	0.1
				CAREPEN	0.1			OXYTSER	0.1
								PHLOHOO	0.1
								ROSAWOO	0.1

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 6

Revegetation Strategy: Cypress Seed Mix
Ecological Range Site: NA
Legal Land Description: 16-1-7-1-W4M **UTM(NAD83):** 12U 572092 5487331

YEAR 1 OFF ROW		1 YEARS RECOVERY		YEAR 2 OFF ROW		2 YEARS RECOVERY		3 YEARS RECOVERY	
SITE COVER[1]		SITE COVER[1]		SITE COVER[1]		SITE COVER[1]		SITE COVER[1]	
Total Veg	111.9	Total Veg	3.6	Total Veg	111.1	Total Veg	8.6	Total Veg	23.2
Litter	92.4	Litter	13.6	Litter	94.1	Litter	2.3	Litter	4.0
Exposed Soil	0.0	Exposed Soil	81.9	Exposed Soil	0.0	Exposed Soil	88.9	Exposed Soil	79.4
GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)	
Moss/Lichen	1.3	Moss/Lichen	0.1	Moss/Lichen	1.0	Moss/Lichen	0.0	Moss/Lichen	0.0
SELADEN	0.4	SELADEN	0.0	SELADEN	0.3	SELADEN	0.0	SELADEN	
SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER
FESTHAL	75.7	FESTHAL	2.4	FESTHAL	76.3	STIPCOM	2.8	ROSAWOO	6.3
CAREPEN	19.7	AGRODAS	0.5	CAREPEN	18.1	HETEVIL	1.8	ASTEFAL	6.0
THERRHO	4.7	AGROSUB	0.3	POTEFRU	3.9	CALALON	1.5	AGRODAS	2.1
ROSAARK	2.6	AGROTRA	0.1	THERRHO	3.9	ROSAWOO	1.2	STIPCUR	1.8
ELEACOM	2.5	COMAUMB	0.1	ELEACOM	2.0	AGRODAS	0.8	STIPVIR	1.6
GEUMTRI	2.1	CAREPEN	0.1	ROSAARK	1.9	AGROSUB	0.3	ARTELUD	1.5
ACHIMIL	0.9	PHLOHOO	0.1	GEUMTRI	1.5	GEUMTRI	0.3	VICIAME	1.5
STIPCUR	0.7	STIPVIR	0.1	ACHIMIL	0.7	CARESTE	0.1	CARESTE	0.6
CERAARV	0.4	SYMPOCC	0.1	STIPCUR	0.5	COMAUMB	0.1	AGROTRA	0.5
COMAUMB	0.4			CERAARV	0.4	THERRHO	0.1	FESTHAL	0.4
ASTEFAL	0.1			COMAUMB	0.3			CAREPEN	0.3
GALIBOR	0.1			ROSAWOO	0.3			SILEMEN	0.3
HETEVIL	0.1			HETEVIL	0.2			SYMPOCC	0.3
POTEFRU	0.1			ASTEFAL	0.1			THERRHO	0.3
				GALIBOR	0.1			ELEACOM	0.1
								POLYARE	0.1

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 7

Revegetation Strategy: Rye/Flax
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: NW 1-7-1-W4M **UTM(NAD83):** 12U 570053 5846784

YEAR 12 OFF ROW		12 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	81.6	Total Veg	68.6
Litter	32.0	Litter	37.0
Exposed Soil	0.0	Exposed Soil	1.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
Moss/Lichen	0.2	Moss/Lichen	2.2
SELADEN	6.0	SELADEN	0.0
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	48.0	FESTHAL	28.0
STIPCUR	13.0	ARTEFRI	8.6
GENTAFF	3.6	STIPCUR	7.0
CARESTE	3.0	CARESTE	5.4
ANEMPAT	2.8	STIPCOM	4.8
ANDRSEP	1.4	ANDRSEP	3.2
ANTEPAR	1.2	ACHIMIL	2.6
KOELMAC	1.0	CAREFIL	1.4
STIPCOM	1.0	GAILARI	1.4
CERAARV	0.6	VICIAME	1.4
AGRODAS	0.4	FESTIDA	1.0
		KOELMAC	1.0
		OXYTMON	1.0
		THERRHO	1.0
		AGRODAS	0.4
		ASTRPEC	0.4

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 8

Revegetation Strategy: Rye/Flax
Ecological Range Site: NA(MF5)
Legal Land Description: 6-2-7-1-W4M **UTM(NAD83):** 12U 569179 5486826

YEAR 12 OFF ROW		12 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	53.0	Total Veg	38.0
Litter	54.0	Litter	33.0
Exposed Soil	0.8	Exposed Soil	39.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
Moss/Lichen	3.4	Moss/Lichen	0.0
SELADEN	4.0	SELADEN	0.0
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	22.0	STIPCUR	10.0
GEUMTRI	12.2	FESTHAL	9.0
STIPCUR	8.6	ASTEFAL	5.6
CAREPEN	4.0	ARTELUD	4.0
GENTAMA	2.4	ROSAWOO	3.6
THERRHO	1.8	CAREPEN	2.4
GEUMALE	1.4	STIPVIR	2.4
ROSAWOO	1.4	SPHACOC	1.2
ANTEAPR	1.0	ARTEFRI	1.0
ASTEFAL	0.8	GUTISAR	1.0
PHLOHOO	0.8	LIATPUN	1.0
ANEMPAT	0.6	CARESTE	0.6
ACHIMIL	0.4	GALIBOR	0.6
GALIBOR	0.2	AGRODAS	0.4
		ANDRSEP	0.4
		GAILARI	0.4
		GENTAMA	0.4
		LOMASP	0.2

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 9

Revegetation Strategy: Rye/Flax
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: NW 1-7-1-W4M **UTM(NAD83):** 12U 570974 5487134

YEAR 12 OFF ROW		12 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	94.8	Total Veg	82.8
Litter	27.0	Litter	20.0
Exposed Soil	0.0	Exposed Soil	0.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
Moss/Lichen	0.0	Moss/Lichen	0.2
SELADEN	3.0	SELADEN	1.0
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	49.0	FESTHAL	11.6
STIPCUR	11.0	STIPCOM	8.0
THERRHO	7.6	STIPCUR	8.0
KOELMAC	7.0	THERRHO	7.0
STIPCOM	4.0	FESTIDA	6.4
ARTELUD	3.2	ARTEFRI	6.2
FESTIDA	3.0	ARTELUD	6.0
GEUMTRI	2.8	GALIBOR	6.0
GALIBOR	2.6	KOELMAC	4.8
CARESTE	1.8	ASTRSP	3.0
ACHIMIL	1.4	HETEVIL	3.0
CAREPEN	1.4	CARESTE	2.2
GENTAFF	1.0	CAREPEN	1.8
ANTEPAR	0.2	ACHIMIL	1.6
		AGRODAS	1.6
		ANEMPAT	1.6
		SOLIMIS	1.6
		PHLOHOO	1.4
		ANDRSEP	0.4

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

D.2.2 Merry Flats Pipeline Cover Charts

Cover of Vegetation over Time on Disturbed Topsoils at Site 1

Revegetation Strategy: MF Seed Mix 1
Ecological Range Site: NA
Legal Land Description: 32-6-30-W3M **UTM(NAD83):** 12U 572765 5485592

YEAR 2 OFF ROW		2 YEARS RECOVERY		3 YEARS RECOVERY	
SITE COVER[1]		SITE COVER[1]		SITE COVER[1]	
Total Veg	72.5	Total Veg	27.1	Total Veg	42.5
Litter	92.8	Litter	14.4	Litter	24.0
Exposed Soil	0.1	Exposed Soil	57.6	Exposed Soil	24.0
GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	1.6	SELADEN	0.1	SELADEN	0.0
Moss/Lichen	0.2	Moss/Lichen	0.0	Moss/Lichen	0.0
SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER
FESTHAL	44.5	AGROTRA	7.6	AGROTRA	15.5
CAREOBT	12.7	AGRODAS	6.1	AGRODAS	8.3
AGRODAS	3.7	ACHIMIL	3.8	STIPCOM	4.5
CAREPEN	3.3	GALIBOR	2.1	STIPVIR	3.0
STIPCUR	1.8	VICIAME	2.0	FESTHAL	2.6
VICIAME	0.9	SOLATRI	1.5	GALIBOR	2.4
ARTEFRI	0.9	CAREPEN	1.2	ARTEFRI	1.8
ACHIMIL	0.6	FESTHAL	0.8	MUHLCUS	1.8
GEUMTRI	0.6	THERRHO	0.5	CARESTE	1.5
ANEMPAT	0.5	ERYSINC	0.3	ACHIMIL	0.4
KOELMAC	0.5	AGROSMI	0.3	CAREOBT	0.3
ASTEFAL	0.4	ASTRDAS	0.3	FESTIDA	0.3
ASTRDAS	0.3	CARESTE	0.3	THERRHO	0.3
THERRHO	0.3	STIPCUR	0.3	ASTRDAS	0.1
ANTEAPR	0.1	ARTEFRI	0.1	CAREPEN	0.1
ARTELUD	0.1	ANDRSEP	0.1	CHENALB	0.1
OXYTSPL	0.1	ERIGCAE	0.1		
		FESTIDA	0.1		
		HETEVIL	0.1		
		HIERODO	0.1		

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 2

Revegetation Strategy: MF Seed Mix 1
Ecological Range Site: NA
Legal Land Description: 33-6-30-W3M **UTM(NAD83):** 12U 573056 5485585

YEAR 2 OFF ROW		2 YEARS RECOVERY		3 YEARS RECOVERY	
SITE COVER[1]		SITE COVER[1]		SITE COVER[1]	
Total Veg	50.3	Total Veg	26.5	Total Veg	18.9
Litter	71.5	Litter	7.5	Litter	11.0
Exposed Soil	0.2	Exposed Soil	74.0	Exposed Soil	57.5
GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	8.8	SELADEN	0.1	SELADEN	0.3
Moss/Lichen	2.3	Moss/Lichen	0.1	Moss/Lichen	0.1
SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER
FESTHAL	20.7	AGRODAS	6.8	AGRODAS	5.4
STIPCUR	4.1	AGROTRA	4.1	AGROTRA	5.3
CAREOBT	2.7	THERRHO	4.1	STIPCOM	3.3
THERRHO	1.8	ARTEFRI	3.9	FESTIDA	1.8
HELIHOO	0.9	STIPCUR	3.3	FESTHAL	0.8
HETEVIL	0.9	CARESTE	1.9	CARESTE	0.6
ACHIMIL	0.8	STIPVIR	1.8	STIPCUR	0.3
CERAARV	0.8	FESTHAL	0.7	ARTEFRI	0.3
ERIGCAE	0.7	CAREPEN	0.1	CAREPEN	0.3
ANEMPAT	0.6	LESQARE	0.1	STIPVIR	0.3
ARTEFRI	0.6			COMAUMB	0.2
ASTEFAL	0.6			OXYTSER	0.1
OXYTSER	0.6			ARENCON	0.1
ROSAWOO	0.6			ASTRDAS	0.1
CAREPEN	0.5			HETEVIL	0.1
CARESTE	0.5			KOELMAC	0.1
COMAUMB	0.4			SOLIMIS	0.1
SENECAN	0.4				
POTECON	0.3				
SOLIMIS	0.3				
ANTEAPR	0.3				
KOELMAC	0.2				
GAILARI	0.2				
PHLOHOO	0.1				
CAMPROT	0.1				
ERYSINC	0.1				
SILEMEN	0.1				

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 3

Revegetation Strategy: MF Seed Mix 2
Ecological Range Site: NA
Legal Land Description: NE 28-6-30-W3M **UTM(NAD83):** 12U 573596 5484381

YEAR 2 OFF ROW		2 YEARS RECOVERY		3 YEARS RECOVERY	
SITE COVER[1]		SITE COVER[1]		SITE COVER[1]	
Total Veg	57.8	Total Veg	40.3	Total Veg	30.9
Litter	91.5	Litter	17.3	Litter	26.5
Exposed Soil	0.0	Exposed Soil	50.4	Exposed Soil	32.3
GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	1.6	SELADEN	0.0	SELADEN	0.2
Moss/Lichen	0.4	Moss/Lichen	0.0	Moss/Lichen	0.0
SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER
FESTHAL	31.3	ARTEFRI	7.7	ARTEFRI	8.4
STIPCUR	9.4	AGROTRA	6.8	STIPCOM	6.0
CAREOBT	7.3	STIPVIR	4.8	AGROTRA	5.0
THERRHO	4.2	AGRODAS	4.3	ACHIMIL	4.0
ANEMPAT	0.8	ACHIMIL	3.8	STIPVIR	3.8
ASTEFAL	0.5	GEUMTRI	3.8	FESTHAL	1.1
ARENCON	0.5	STIPCUR	3.3	AGRODAS	0.6
ACHIMIL	0.4	CAREPEN	2.4	CARESTE	0.6
CAMPROT	0.4	THERRHO	1.8	STIPCUR	0.4
POTEFRU	0.3	CARESTE	0.7	ARABHOL	0.3
AGRODAS	0.2	KOELMAC	0.3	CAREFIL	0.3
ANTEAPR	0.2	CAMPROT	0.3	THERRHO	0.3
CERAARV	0.2	FESTHAL	0.3	ARENCON	0.1
ANDRSEP	0.1	LINULEW	0.3	LYGOJUN	0.1
AGROSUB	0.1			MONONUT	0.1
CARESTE	0.1				
ERYSINC	0.1				
HIERODO	0.1				
LYGOJUN	0.1				
SILEDRU	0.1				
SOLIMIS	0.1				

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 4

Revegetation Strategy: MF Seed Mix 3
Ecological Range Site: Overflow
Legal Land Description: NW 34-6-30-W3M **UTM(NAD83):** 12U 574770 5485517

Year 2 off RoW		2 Years Recovery		3 Years Recovery		Year 11 Control		11 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[2]		Site Cover[2]	
Total Veg	75.2	Total Veg	38.3	Total Veg	60.9	Total Veg	58.0	Total Veg	81.0
Litter	55.9	Litter	1.9	Litter	0.0	Litter	62.0	Litter	59.0
Exposed Soil	0.6	Exposed Soil	69.2	Exposed Soil	0.0	Exposed Soil	1.6	Exposed Soil	0.8
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
SELADEN	0.3	SELADEN	0.0	SELADEN	0.0	SELADEN	0.0	SELADEN	0.0
Moss/Lichen	0.2	Moss/Lichen	0.0	Moss/Lichen	0.0	Moss/Lichen	0.2	Moss/Lichen	0.4
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
ANTEPAR	14.6	AGROSUB	5.3	AGROTRA	10.5	FESTHAL	15.0	GLYCLEP	14.0
FESTHAL	13.1	THERRHO	4.8	AGROSUB	8.0	ANTEAPR	8.4	ANTEAPR	12.2
POTEFRU	8.3	SYMPOCC	4.3	ARTEFRI	7.5	POTEFRU	8.0	AGRODAS	4.4
CAREPEN	5.0	ASTEFAL	3.3	ROSAWOO	5.8	AGRODAS	7.4	GALIBOR	4.0
AGRODAS	4.4	GLYCLEP	2.5	ARTELUD	4.3	CAREPEN	3.4	THERRHO	3.8
POAPRA	3.9	ROSAWOO	2.3	ASTEFAL	4.1	GEUMTRI	3.4	STIPVIR	3.6
STIPVIR	3.8	CIRSUND	2.0	SYMPOCC	3.6	ASTEFAL	3.2	ACHIMIL	3.2
GEUMTRI	3.6	ARTELUD	1.8	ACHIMIL	3.1	SOLIMIS	3.0	KOELMAC	3.0
THERRHO	3.4	STIPVIR	1.8	STIPVIR	2.2	ACHIMIL	2.8	STIPCUR	3.0
GLYCLEP	2.3	AGROTRA	1.5	STIPCUR	2.0	KOELMAC	2.6	SOLIMIS	2.4
CAREOBT	2.1	ANTEAPR	1.5	BROMANO	1.8	THERRHO	2.4	SOLIMOL	2.2
AGROSUB	2.0	FESTHAL	1.5	MUHLRIC	1.8	CARESTE	2.2	SYMPOCC	2.0
FRAGVIR	1.5	MUHLRIC	1.5	GLYCLEP	1.0	HELIHOO	2.2	COMAUMB	1.8
ACHIMIL	0.9	STIPCUR	1.5	SOLIMIS	1.0	GALIBOR	1.6	ASTEFAL	1.4
ASTEFAL	0.8	CARESP	0.6	FESTHAL	0.7	SOLIMOL	1.6	DANTINT	1.4
SYMPOCC	0.8	CAREPEN	0.3	CARESP	0.5	JUNCBAL	1.4	AGROSUB	1.2
HEDYALP	0.8	EQUILAE	0.3	CIRSUND	0.5	HEDYALP	1.0	HELIHOO	1.2
HELIHOO	0.6	POLYARE	0.3	HELIHOO	0.4	CERAARV	0.8	ARTEFRI	1.0
AGOSGLA	0.6	CARESTE	0.3	AGROSMI	0.3	CAMPROT	0.6	POAPRA	1.0
GALIBOR	0.6	CERAARV	0.3	GALIBOR	0.3	CARESP	0.6	POTEGRA	1.0
KOELMAC	0.5	HELIHOO	0.3	AGRODAS	0.3	COMAUMB	0.6	CERAARV	0.8
CERAARV	0.4	SILEMEN	0.3	DANTINT	0.3	DANTINT	0.6	GEUMTRI	0.8
MUHLRIC	0.3	VICIAME	0.3	POTEANS	0.3	MUHLRIC	0.6	JUNCBAL	0.8
POTEGRA	0.3	ACHIMIL	0.1	POTEGRA	0.3	CIRSUND	0.4	AGROTRA	0.6
CAMPROT	0.3	ANDRSEP	0.1	STELLOG	0.3	AGROSUB	0.2	CAREPEN	0.6
COMAUMB	0.1	GALIBOR	0.1	THERRHO	0.3	AGROTRA	0.2	CARESTE	0.6
ANDRSEP	0.1	MONONUT	0.1	JUNCBAL	0.1	CAREOBT	0.2	GERAVIS	0.6
HIERODO	0.1			CAREPEN	0.1	ORTHLUT	0.2	VIOLCAN	0.4
JUNCBAL	0.1			COMAUMB	0.1	PHLOHOO	0.2	ARABSP	0.2
TARAOFF	0.1			EQUILAE	0.1			BROMJAP	0.2
				FRAGVIR	0.1			LINULEW	0.2
				LINULEW	0.1			SISYSEP	0.2

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 5

Revegetation Strategy: MF Seed Mix 3
Ecological Range Site: Lentic-Herbaceous
Legal Land Description: NW 34-6-30-W3M **UTM(NAD83):** 12U 574607 5485529

Year 2 off RoW		2 Years Recovery		3 Years Recovery		Year 11 off RoW		11 Years Recovery	
Site Cover[1]		Site Cover[1]		Site Cover[1]		Site Cover[2]		Site Cover[2]	
Total Veg	114.2	Total Veg	44.8	Total Veg	70.4	Total Veg	95.0	Total Veg	97.0
Litter	1.2	Litter	7.1	Litter	51.3	Litter	26.0	Litter	56.0
Exposed Soil	0.4	Exposed Soil	50.4	Exposed Soil	8.1	Exposed Soil	0.2	Exposed Soil	1.0
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
SELADEN	0.0	SELADEN	0.0	SELADEN	0.0	SELADEN	0.0	SELADEN	0.0
Moss/Lichen	24.7	Moss/Lichen	3.0	Moss/Lichen	3.3	Moss/Lichen	40.0	Moss/Lichen	46.0
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
JUNCBAL	26.0	POTEANS	11.3	DESCCES	42.8	CARELAN	19.0	JUNCBAL	17.0
CARESP	23.8	ASTEHES	7.9	ASTEHES	4.8	JUNCBAL	19.0	CALAINE	14.0
DESCCES	7.8	DESCCES	6.9	POAPAL	3.0	DESCCES	11.0	CARELAN	13.0
ASTEHES	7.4	CARESP	6.8	CARELAN	2.8	ELEOPAL	10.0	ELEOPAL	12.0
FRAGVIR	4.2	AGROTRA	3.3	CARESP	2.3	CAREPRG	9.0	CAREPRG	11.0
ANTEPAR	4.1	GLYCLEP	1.0	POAPRA	1.8	MENTARV	4.6	POTEGRA	11.0
POAPRA	3.4	MUHLRIC	1.0	SCIRSP	1.8	ASTEHES	4.2	ASTEHES	7.2
POTEGRA	3.0	POAPRA	1.0	AGROTRA	1.7	CALAINE	3.4	DESCCES	7.0
AGROTRA	2.8	JUNCBAL	0.7	MUHLRIC	1.6	EQUILAE	3.2	EQUILAE	2.6
MUHLRIC	2.3	POTEGRA	0.5	POTEANS	1.5	POTEFRU	2.6	POAPAL	1.6
POTEANS	2.1	EQUIARV	0.3	JUNCBAL	0.4	POTEANS	2.2	POTEANS	1.6
SOLIMOL	0.8	ASTEFAL	0.3	POTEGRA	0.4	GLYCSTR	1.6	MENTARV	0.8
EQUILAE	0.6	FRAGVIR	0.3	AGROSUB	0.3	POTEGRA	1.6	POTEFRU	0.8
POTEFRU	0.3	MENTARV	0.3	EQUIVAR	0.3	TARAOFF	0.6	TARAOFF	0.8
POTEPLA	0.3	STIPVIR	0.3	GLYCLEP	0.3	FRAGVIR	0.4	GLYCLEP	0.6
ROSAWOO	0.3	EQUILAE	0.1	MENTARV	0.3	GLYCLEP	0.4	VICIAME	0.6
EQUIARV	0.3	CHENSP	0.1	SOLIMOL	0.3			FRAGVIR	0.4
POAPAL	0.3	FESTHAL	0.1	ACHIMIL	0.3			EQUIARV	0.2
DODESP	0.1	FESTIDA	0.1	STELLOG	0.3				
ERIGCAN	0.1	POTEFRU	0.1	FRAGVIR	0.2				
STELLOG	0.1	STELLOG	0.1	PHLEALP	0.1				
				ASTEEAT	0.1				
				ASTEFAL	0.1				
				CAREPEN	0.1				
				DANTCAL	0.1				
				JUNCCON	0.1				
				ORTHLUT	0.1				
				POTEPLA	0.1				

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 6

Revegetation Strategy: MF Seed Mix 2
Ecological Range Site: Loamy to Shallow-to-Gravel
Legal Land Description: 35-6-30-W3M **UTM(NAD83):** 12U 575932 5485316

YEAR 2 OFF ROW		2 YEARS RECOVERY		3 YEARS RECOVERY		YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[1]		SITE COVER[1]		SITE COVER[1]		SITE COVER[2]		SITE COVER[2]	
Total Veg	71.3	Total Veg	45.5	Total Veg	29.1	Total Veg	74.0	Total Veg	72.2
Litter	72.6	Litter	14.8	Litter	17.3	Litter	34.0	Litter	31.0
Exposed Soil	0.0	Exposed Soil	57.4	Exposed Soil	40.3	Exposed Soil	0.0	Exposed Soil	1.0
GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	11.9	SELADEN	0.0	SELADEN	0.2	SELADEN	3.8	SELADEN	1.6
Moss/Lichen	0.7	Moss/Lichen	0.0	Moss/Lichen	0.6	Moss/Lichen	1.0	Moss/Lichen	22.4
SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER
CAREOBT	23.0	ARTEFRI	21.2	ARTEFRI	15.1	FESTHAL	33.0	FESTHAL	14.0
STIPCUR	13.6	AGRODAS	8.8	STIPCUR	3.8	GEUMTRI	11.0	ARTEFRI	8.8
GEUMTRI	9.3	STIPCUR	4.8	AGROTRA	3.3	STIPCOM	9.4	AGRODAS	8.0
FESTHAL	8.4	ACHIMIL	3.8	STIPVIR	2.0	FESTIDA	5.0	ACHIMIL	7.2
ANEMPAT	1.2	STIPVIR	2.3	AGRODAS	1.8	CERAARV	2.2	STIPCOM	7.0
ACHIMIL	0.7	CAREPEN	1.9	STIPCOM	1.5	ACHIMIL	2.0	FESTIDA	6.0
ANTEAPR	0.4	CERAARV	1.5	CARESTE	0.4	ANTEPAR	2.0	CARESTE	3.4
HELIHOO	0.4	AGROTRA	0.9	CERAARV	0.3	KOELMAC	2.0	KOELMAC	2.6
POTEPEN	0.4	FESTHAL	0.3	ASTEFAL	0.1	CARESTE	1.8	GEUMTRI	2.2
HETEVIL	0.3	CARESTE	0.2	LYGOJUN	0.1	GENTAMA	1.6	ANTEPAR	2.0
OXYTSER	0.3			ACHIMIL	0.1	ARTELUD	1.4	CERAARV	1.8
ERIGCAE	0.3			POTEPEN	0.1	HETEVIL	1.0	GRINSQU	1.6
CERAARV	0.2					ARTEFRI	0.8	HETEVIL	1.6
VICIAME	0.2					AGRODAS	0.6	VICIAME	1.6
ARTEFRI	0.1					CAMPROT	0.4	STIPVIR	1.4
CARESTE	0.1					PHLOHOO	0.4	BOUTGRA	1.2
KOELMAC	0.1							ANDRSEP	0.4
PHLOHOO	0.1								
POTEGRA	0.1								
SENECAN	0.1								

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 7

Revegetation Strategy: (Nat Rec, Annual Cover Crop, Seed Mix X)
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: NE 34-6-30-W3M **UTM(NAD83):** 12U 575438 5485484

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	90.2	Total Veg	67.2
Litter	54.0	Litter	44.0
Exposed Soil	0.0	Exposed Soil	2.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	5.0	SELADEN	0.6
Moss/Lichen	0.0	Moss/Lichen	1.2
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	52.0	FESTHAL	13.6
GEUMTRI	9.6	ARTEFRI	10.4
STIPCUR	6.0	AGRODAS	6.2
ASTRDAS	4.0	ACHIMIL	4.8
GENTAMA	2.6	ASTEFAL	4.8
ANTEAPR	2.2	STIPCOM	4.2
ARTEFRI	2.0	THERRHO	3.6
ACHIMIL	1.6	CARESTE	2.8
ASTEFAL	1.4	COMAUMB	2.6
GALIBOR	1.4	FESTIDA	2.6
CARESTE	1.2	STIPCUR	2.6
FESTIDA	1.0	ROSAWOO	2.4
THERRHO	1.0	GALIBOR	2.0
AGRODAS	0.6	GENTAMA	1.6
CAREPEN	0.6	AGROTRA	0.8
POAPRA	0.6	ANDRSEP	0.8
ROSAWOO	0.6	STIPVIR	0.6
ANDRSEP	0.4	ASTRPEC	0.4
CAMPROT	0.2	CAMPROT	0.2
		PHLOHOO	0.2

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 8

Revegetation Strategy: (Nat Rec, Annual Cover Crop, Seed Mix X)
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: SE 34-6-30-W3M **UTM(NAD83):** 12U 575555 5485485

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	88.0	Total Veg	72.4
Litter	36.0	Litter	46.0
Exposed Soil	0.0	Exposed Soil	0.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	4.6	SELADEN	5.2
Moss/Lichen	0.4	Moss/Lichen	6.6
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	59.0	FESTHAL	12.6
FESTIDA	12.0	ARTEFRI	11.6
STIPCUR	6.0	AGRODAS	7.4
STIPCOM	2.4	ACHIMIL	6.0
THERRHO	2.2	AGROTRA	5.4
ASTEFAL	2.0	STIPCUR	4.6
GENTAMA	2.0	FESTIDA	3.8
ACHIMIL	1.6	CAREPEN	2.6
HELIHOO	1.6	KOELMAC	2.0
KOELMAC	1.4	STIPVIR	2.0
CAREPEN	1.2	CARESTE	1.8
CARESTE	0.6	ANDRSEP	1.6
ANTEAPR	0.2	THERRHO	1.6
CAMPROT	0.2	GAILARI	1.4
		STIPCOM	1.4
		ASTRPEC	1.0
		GEUMTRI	1.0
		ROSAWOO	1.0
		CAMPROT	0.2

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 9

Revegetation Strategy: (Nat Rec, Annual Cover Crop, Seed Mix X)
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: SW 35-6-30-W3M **UTM(NAD83):** 12U 575794 5485370

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	66.4	Total Veg	66.8
Litter	46.0	Litter	38.0
Exposed Soil	0.0	Exposed Soil	0.4
GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	2.0	SELADEN	2.0
Moss/Lichen	2.8	Moss/Lichen	2.4
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	50.0	FESTHAL	14.6
GENTAMA	3.0	STIPCUR	9.0
FESTIDA	2.6	CAREPEN	5.0
GALIBOR	2.0	HETEVIL	5.0
ARTEFRI	1.6	ARTEFRI	4.4
CARESTE	1.4	FESTIDA	4.4
CAREPEN	1.2	THERRHO	3.8
VICIAME	0.6	KOELMAC	3.6
CAMPROT	0.4	CARESTE	3.2
COMAUMB	0.4	AGROTRA	3.0
		AGRODAS	2.4
		ACHIMIL	1.6
		ASTEFAL	1.6
		GAILARI	1.0
		GALIBOR	1.0
		VICIAME	1.0
		ANDRSEP	0.4

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 15

Revegetation Strategy: MF Seed Mix 1
Ecological Range Site: Shallow-to-Gravel to Loamy
Legal Land Description: 10-34-6-30-W3M **UTM(NAD83):** 12U 571548 5485500

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	51.0	Total Veg	48.0
Litter	68.0	Litter	51.0
Exposed Soil	0.0	Exposed Soil	9.4
GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	7.0	SELADEN	1.0
Moss/Lichen	4.8	Moss/Lichen	4.2
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	27.0	FESTHAL	21.4
CAREPEN	6.0	ARTEFRI	8.0
ROSAWOO	5.8	AGRODAS	6.2
STIPCUR	4.0	STIPVIR	6.2
CAREOBT	3.4	STIPCUR	3.0
ARTEFRI	1.4	AGROTRA	2.2
POTEHIP	1.0	THERRHO	2.2
GENTAMA	0.8	CERAARV	1.3
HELIHOO	0.8	ARABHOL	0.8
THERRHO	0.8	POASAND	0.8
AGRODAS	0.6	ACHIMIL	0.6
ACHIMIL	0.2	ROSAWOO	0.6
CAMPROT	0.2	ANDRSEP	0.4
		CAREOBT	0.4
		CAREPEN	0.4
		GENTAMA	0.4

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 16

Revegetation Strategy: MF Seed Mix 1
Ecological Range Site: Shallow-to-Gravel
Legal Land Description: 10-34-6-30-W3M **UTM(NAD83):** 12U 575303 5485493

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	47.0	Total Veg	39.0
Litter	72.0	Litter	42.0
Exposed Soil	0.6	Exposed Soil	11.0
GROUNDCOVER (%)		GROUNDCOVER (%)	
SELADEN	12.6	SELADEN	0.2
Moss/Lichen	1.6	Moss/Lichen	12.6
SPECIES	% COVER	SPECIES	% COVER
FESTHAL	27.0	ARTEFRI	8.8
THERRHO	7.6	AGRODAS	7.8
ANTEAPR	2.0	HETEVIL	6.6
KOELMAC	2.0	FESTHAL	4.2
HELIHOO	1.6	STIPCUR	3.2
CERAARV	1.0	KOELMAC	2.4
GENTAMA	1.0	STIPVIR	2.4
GEUMTRI	1.0	AGROTRA	2.2
CAMPROT	0.8	ACHIMIL	1.2
CAREOBT	0.8	ASTRSTR	1.0
LYGOJUN	0.8	HELIHOO	0.8
POTECON	0.4	GAILARI	0.6
STIPCUR	0.4	SOLIMIS	0.6
ANDRSEP	0.2	ANDRSEP	0.4
ARABHOL	0.2	ARABHOL	0.4
ARTEFRI	0.2		
CARESTE	0.2		

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

Cover of Vegetation over Time on Disturbed Topsoils at Site 17

Revegetation Strategy: MF Seed Mix 1
Ecological Range Site: Shallow-to-Gravel to Loamy
Legal Land Description: 11-34-6-30-W3M **UTM(NAD83):** 12U 574917 5485507

YEAR 11 OFF ROW		11 YEARS RECOVERY	
SITE COVER[2]		SITE COVER[2]	
Total Veg	60.0	Total Veg	42.0
Litter	57.0	Litter	62.0
Exposed Soil	1.0	Exposed Soil	9.4
GROUNDCOVER (%)		GROUNDCOVER (%)	
Moss/Lichen	11.6	Moss/Lichen	4.0
SPECIES	% COVER	SPECIES	% COVER
STIPCUR	17.0	STIPVIR	10.0
FESTHAL	12.6	AGRODAS	8.0
THERRHO	7.0	ARTEFRI	6.2
SELADEN	6.0	STIPCUR	6.2
GEUMTRI	5.4	AGROTRA	5.4
ANEMPAT	4.0	THERRHO	3.6
ARTELUD	2.0	FESTHAL	2.0
CAREFIL	2.0	CARESTE	1.6
CAREOBT	2.0	CAREPEN	1.0
CERAARV	1.8	PHLOHOO	1.0
ACHIMIL	1.2	ASTEFAL	0.8
PHLOHOO	1.2	GUTISAR	0.6
ASTEFAL	1.0	MUHLCUS	0.6
ERIGCAE	1.0	ACHIMIL	0.4
AGRODAS	0.8	OXYTSER	0.4
ARTEFRI	0.8	ANDRSEP	0.2
GAILARI	0.6	CERAARV	0.2
HELIHOO	0.6	COMAUMB	0.2
ANDRSEP	0.4		

[1] Mean percent canopy cover - pre-2011 data

[2] Mean percent foliar cover - all 2011 data

D.3 Cypress Upland Monitoring Site Range Health – 2011

Revegetation Strategy	Site	1A	2	3	4.1	4.2	5.1	5.2	Site Score	Range Health	ERS	Plant Community Name (Code)
Assisted Natural Recovery	01CD11	40	7	0	7	1	5	5	65	Healthy with problems	SWG	MGA1
Assisted Natural Recovery	02CD11	27	3	0	7	3	5	5	50	Healthy with problems	NA	MGA3
Assisted Natural Recovery	03CD11	15	3	25	10	5	5	5	68	Healthy with problems	SWG	MGA31
Assisted Natural Recovery	07CD11	15	7	13	10	5	5	5	60	Healthy with problems	SWG	MGA31
Assisted Natural Recovery	08CD11	27	7	0	7	1	5	5	56	Healthy with problems	NA	No Call
Assisted Natural Recovery	09CD11	15	7	13	10	5	5	5	60	Healthy with problems	SWG	MGA31
MF Native Seed Mix 1	07MD11	15	3	25	10	5	5	5	68	Healthy with problems	SWG	MGA31
MF Native Seed Mix 1	08MD11	15	7	25	10	5	5	5	72	Healthy with problems	SWG	MGA31
MF Native Seed Mix 1	15MD11	27	10	13	7	3	5	5	70	Healthy with problems	SWG-LO	MGA1
MF Native Seed Mix 1	16MD11	27	10	0	7	3	5	5	57	Healthy with problems	SWG	MGA1
MF Native Seed Mix 1	17MD11	15	3	13	7	3	5	5	51	Healthy with problems	SWG-LO	No Call
MF Native Seed Mix 2	06MD11	27	7	13	10	5	5	5	72	Healthy with problems	LO-SWG	MGA1
MF Native Seed Mix 2	09MD11	15	7	13	10	5	5	5	60	Healthy with problems	SWG	MGA31
Undisturbed Control	01CC11	40	7	0	10	5	5	5	72	Healthy with problems	SWG	MGA1
Undisturbed Control	02CC11	40	7	0	7	3	5	5	67	Healthy with problems	NA	MGA1

Revegetation Strategy	Site	1A	2	3	4.1	4.2	5.1	5.2	Site Score	Range Health	ERS	Plant Community Name (Code)
Undisturbed Control	03CC11	27	10	25	10	5	5	5	87	Healthy	SWG	MGA31
Undisturbed Control	06MC11	27	10	25	10	5	5	5	87	Healthy	LO-SWG	MGA1
Undisturbed Control	07CC11	27	10	25	10	5	5	5	87	Healthy	SWG	MGA31
Undisturbed Control	07MC11	27	10	25	10	5	5	5	87	Healthy	SWG	MGA31
Undisturbed Control	08CC11	40	10	13	7	3	5	5	83	Healthy	NA	MGA1
Undisturbed Control	08MC11	27	7	25	10	5	5	5	84	Healthy	SWG	MGA31
Undisturbed Control	09CC11	27	7	25	10	5	5	5	84	Healthy	SWG	MGA31
Undisturbed Control	09MC11	27	7	25	10	5	5	5	84	Healthy	SWG	MGA31
Undisturbed Control	15MC11	40	10	25	10	5	5	5	100	Healthy	SWG-LO	MGA1
Undisturbed Control	16MC11	40	10	25	10	5	5	5	100	Healthy	SWG	MGA1
Undisturbed Control	17MC11	27	7	25	10	5	5	5	84	Healthy	SWG-LO	MGA1

Appendix E Majorville Project Data

E.1 Locations of Majorville Monitoring Plots

Site Label	Legal Land Description	Easting	Northing	NAD83 Zone
13	NW 1-19-19-W4M	0392913	5604875	12U
14	SW 15-19-19-W4M	0389739	5607044	12U
17	SW 3-19-19-W4M	0389723	5604168	12U
18	SW 5-19-19-W4M	0386054	5603743	12U
19	NE 36-18-20-W4M	0385252	5602833	12U
20	NW 13-18-20-W4M	0384250	5598102	12U
21	SW 1-18-20-W4M	0385268	5594049	12U
22	SW 2-18-20-W4M	0382563	5594235	12U

E.2 Majorville Upland Monitoring Site Range Health – 2011

Site	1A	1B	2	3	4.1	4.2	5.1	5.2	Site Total	Site Total (/60)	ERS	Plant Community Name (Code)
09HC08	16	0	6	15	6	3	3	3	87	52	Lo	DMGA3
09HD08	8	0	2	8	6	1	3	3	52	31	Lo	DMGA3
10HC08	8	0	4	15	6	3	3	3	70	42	Lo	DMGA1
10HD08	8	0	2	15	6	3	3	3	67	40	Lo	DMGA1
11HC08	8	0	4	8	6	3	3	3	58	35	BlO	DMGA16
11HD08	8	0	2	15	6	1	3	3	63	38	BlO	DMGA16
12HC08	16	0	6	15	6	3	3	3	87	52	BlO	DMGA15
12HD08	8	0	2	15	6	1	3	3	63	38	BlO	DMGA15
13HC08	16	0	4	15	6	3	3	3	83	50	Lo	MGA21
13HC11	27	0	10	25	10	5	5	5	87		Lo	MGA21
13HD08	8	0	2	15	6	3	3	3	67	40	Lo	MGA22
13HD11	27	10	13	10	5	5	5	5	80		Lo	MGA21
14HC08	8	0	4	15	6	3	3	3	70	42	Lo	MGA22
14HC11	27	0	10	25	10	5	5	5	87		Li	MGA22
14HD08	8	0	2	15	6	1	3	3	63	38	Lo	MGA22
14HD11	27	0	7	25	10	3	5	5	82		Lo	MGA21
15HC08	16	0	4	0	6	3	3	3	58	35	Len	No Call
15HD08	8	0	2	0	0	0	3	3	27	16	Len	MGA19
17HC08	16	0	6	15	6	3	3	3	87	52	Lo	MGA21
17HC11	27	0	10	13	10	5	5	5	75		Lo	MGA21
17HD08	0	0	0	0	0	0	3	3	10	6	Lo	MGA21

Site	1A	1B	2	3	4.1	4.2	5.1	5.2	Site Total	Site Total (/60)	ERS	Plant Community Name (Code)
17HD11	15	0	3	13	7	0	5	5	48		Lo	MGA21
18HC08	8	0	6	15	6	3	3	3	73	44	TB	MGA21
18HC11	27	0	10	25	10	5	3	3	83		Lo	MGA21
18HD08	8	0	2	8	6	1	3	3	52	31	TB	MGA22
18HD11	27	0	7	13	7	3	5	5	67		Lo	MGA21
19HC08	16	0	6	15	6	3	3	3	87	52	Lo	No Call
19HC11	27	0	7	25	10	5	5	5	84		Sb	MGC5
19HD08	8	0	2	15	6	2	2	2	62	37	Lo	No Call
19HD11	27	0	7	25	7	3	3	3	75		Sb	No Call
20HC08	16	0	6	15	6	3	3	3	87	52	Lo	MGA21
20HC11	27	0	10	25	10	5	5	5	87		Lo	MGA21
20HD08	8	0	2	8	6	0	3	3	50	30	Lo	MGA22
20HD11	27	0	7	0	10	5	5	5	59		Lo	MGA22
21HC08	8	0	2	15	6	3	3	3	67	40	Lo	MGA23
21HC11	27	0	10	25	10	5	5	5	87		Lo	MGA21
21HD08	8	0	2	8	0	1	1	2	37	22	Lo	MGA22
21HD11	27	0	7	13	10	5	3	3	68		Lo	MGA21
22HC08	8	0	6	8	6	3	3	3	62	37	Li	MGA22
22HC11	27	0	10	25	10	5	5	5	87		Li	MGA21
22HD08	8	0	4	0	6	0	3	3	40	24	Li	MGA22
22HD11	40	0	7	0	10	5	5	5	72		Li	MGA22

E.3 Majorville Upland Micro-plot Data

Cover of Vegetation over Time on Disturbed Topsoils at Site 13

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: NW-1-19-19-W4M **UTM (NAD83):** 12U 0392913 5604875

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	43.50	Total Veg	25.50	Total Veg	77.00	Total Veg	64.80
Litter	94.90	Litter	94.30	Litter	30.00	Litter	37.00
Exposed Soil	2.90	Exposed Soil	5.70	Exposed Soil	0.00	Exposed Soil	0.00
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	0.90	Moss/Lichen	1.20	Moss/Lichen	1.20	Moss/Lichen	2.60
SELADEN	2.20	SELADEN	0.00	SELADEN	5.20	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
CARESP	16.10	AGROSMI	13.60	AGRODAS	12.00	STIPVIR	16.00
AGRODAS	8.60	STIPVIR	4.40	STIPVIR	12.00	AGROSMI	11.60
STIPCUR	3.60	POAPRA	1.80	CAREPEN	11.00	AGRODAS	8.80
AGROSMI	3.30	AGRODAS	1.60	STIPCUR	9.20	CAREPEN	5.80
ARTEGNA	2.00	CARESP	1.60	AGROSMI	8.40	TARAOFF	4.80
ARTEFRI	1.90	ARTEGNA	1.10	BOUTGRA	5.60	ACHIMIL	4.20
STIPVIR	1.80	HORDJUB	0.50	AGROSCA	3.60	AGROSCA	3.20
BOUTGRA	1.50	FORBUNK	0.40	KOELMAC	3.00	KOELMAC	3.00
KOELMAC	0.70	TRAGDUB	0.40	ACHIMIL	2.80	RATICOL	2.60
TARAOFF	0.70	ACHIMIL	0.30	ARTEFRI	2.60	ASTEFAL	1.00
ANEMPAT	0.50	ARTEFRI	0.30	SPHACOC	2.00	CARESTE	1.00
TRAGDUB	0.40	AGROSCA	0.10	VICIAME	1.60	ARTELUD	0.60
ACHIMIL	0.30	VICIAME	0.10	TRAGDUB	1.00	ASTRPEC	0.60
ARNIFUL	0.30			TARAOFF	0.40		
SPHACOC	0.30			ASTESP	0.20		
AGROSCA	0.20						
VICIAME	0.20						
SOLIMIS	0.10						

Cover of Vegetation over Time on Disturbed Topsoils at Site 14

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: 3-15-19-19-W4M **UTM (NAD83):** 12U 0389739 5607044

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	43.40	Total Veg	21.90	Total Veg	71.80	Total Veg	50.20
Litter	99.20	Litter	55.50	Litter	33.00	Litter	43.00
Exposed Soil	0.80	Exposed Soil	41.50	Exposed Soil	0.00	Exposed Soil	8.00
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	1.30	Moss/Lichen	0.90	Moss/Lichen	3.40	Moss/Lichen	0.40
SELADEN	3.30	SELADEN	0.00	SELADEN	3.00	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
BOUTGRA	11.60	AGRODAS	10.10	BOUTGRA	15.00	AGROSMI	19.00
CARESP	5.40	AGROSMI	9.20	STIPCOM	12.00	AGRODAS	9.00
STIPCOM	5.40	CARESP	1.00	STIPCUR	11.00	STIPCOM	6.20
STIPCUR	5.40	KOELMAC	0.50	AGRODAS	8.00	STIPVIR	5.00
AGRODAS	5.10	STIPVIR	0.50	KOELMAC	6.60	BOUTGRA	4.60
STIPVIR	2.30	STIPCOM	0.40	AGROSMI	4.00	CARESTE	3.60
AGROSMI	1.70	TRAGDUB	0.20	CARESTE	4.00	ARTEFRI	1.60
ANEMPAT	0.90	CALAMON	0.10	SPHACOC	2.00	KOELMAC	1.00
SPHACOC	0.60	SPHACOC	0.10	LIATPUN	1.60	SPHACOC	1.00
ASTEFAL	0.50	STIPCUR	0.10	VICIAME	1.60		
KOELMAC	0.50			ARTEFRI	1.00		
ARTEFRI	0.30			ASTEFAL	1.00		
ACHIMIL	0.10			CALAMON	0.80		
FORBUNK	0.10						
PHLOHOO	0.10						
TRAGDUB	0.10						

Cover of Vegetation over Time on Disturbed Topsoils at Site 17

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: 6-3-19-19-W4M **UTM (NAD83):** 12U 0389723 5604168

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	43.10	Total Veg	29.50	Total Veg	63.00	Total Veg	45.00
Litter	100.00	Litter	18.70	Litter	56.00	Litter	32.00
Exposed Soil	0.00	Exposed Soil	81.50	Exposed Soil	0.40	Exposed Soil	23.00
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	1.40	Moss/Lichen	0.00	Moss/Lichen	1.20	Moss/Lichen	0.40
SELADEN	1.60	SELADEN	0.00	SELADEN	6.80	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
AGRODAS	8.40	AGROSMI	28.00	AGRODAS	26.00	AGROSMI	39.00
STIPCUR	6.90	GRINSQU	1.60	AGROSMI	12.00	AGRODAS	5.20
CARESP	6.60	AGRODAS	0.30	STIPCOM	6.40	KOELMAC	0.80
BOUTGRA	5.70	STIPVIR	0.10	KOELMAC	4.20	CARESTE	0.20
STIPVIR	3.00			BOUTGRA	2.60	TRAGDUB	0.20
AGROSMI	2.60			CARESTE	2.20		
POAPRA	2.50			ACHIMIL	2.00		
MUHLRIC	1.60			STIPCUR	2.00		
ACHIMIL	1.50			POASAN	1.80		
SPHACOC	1.00			ARTEFRI	1.60		
KOELMAC	0.70			SPHACOC	1.20		
ARTEFRI	0.50			VICIAME	0.80		
ARNIFUL	0.30			ANTEAPR	0.60		
CALAMON	0.30			STIPVIR	0.60		
VICIAME	0.30			CALALON	0.40		
PHLOHOO	0.10			TRAGDUB	0.40		
				PHLOHOO	0.20		

Cover of Vegetation over Time on Disturbed Topsoils at Site 18

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: 4-5-19-19-W4M **UTM (NAD83):** 12U 0386054 5603743

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	43.60	Total Veg	15.80	Total Veg	58.40	Total Veg	47.00
Litter	97.00	Litter	34.50	Litter	58.00	Litter	60.00
Exposed Soil	0.00	Exposed Soil	65.00	Exposed Soil	0.20	Exposed Soil	10.60
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	2.60	Moss/Lichen	0.00	Moss/Lichen	1.20	Moss/Lichen	0.40
SELADEN	1.50	SELADEN	0.00	SELADEN	0.20	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
STIPCUR	14.70	AGROSMI	4.70	STIPCUR	28.00	AGRODAS	16.00
CARESP	5.60	AGRODAS	4.20	CAREPEN	9.80	ASTEFAL	9.40
ASTEFAL	5.30	STIPVIR	2.80	AGRODAS	7.00	STIPCUR	5.00
MUHLCUS	4.30	HORDJUB	1.50	ARTEFRI	6.80	AGROSMI	4.40
AGRODAS	3.70	STIPCOM	1.10	HELIHOO	4.60	STIPVIR	4.00
POAPRA	3.20	STIPCUR	0.60	STIPVIR	1.60	ACHIMIL	3.00
STIPCOM	1.70	TRAGDUB	0.30	ANEMPAT	1.00	ARTEFRI	2.40
ANEMPAT	1.50	ARTEFRI	0.20	THERRHO	1.00	CAREPEN	2.00
ARTEFRI	0.80	ASTEFAL	0.20	AGROSMI	0.60	KOELMAC	1.80
CALAMON	0.60	CARESP	0.20	PHLOHOO	0.60	POAPRA	1.00
SOLIMIS	0.50	CALAMON	0.10	BOUTGRA	0.40	CAREFIL	0.60
ANTESP	0.40	POAPRA	0.10	ANDRSEP	0.20	CAREOBT	0.50
LYGOJUN	0.40	THERRHO	0.10	ASTEFAL	0.20	ANEMPAT	0.40
BOUTGRA	0.30					CALAMON	0.40
STIPVIR	0.30					VICIAME	0.40
AGROSMI	0.20					ANDRSEP	0.20
KOELMAC	0.10					ANTEAPR	0.20
POAJUN	0.10					ASTRDAS	0.20
						LINUSP	0.20
						PHLOHOO	0.20
						SOLIMIS	0.20

Cover of Vegetation over Time on Disturbed Topsoils at Site 19

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Sub-irrigated

Legal Land Description: 9-36-18-20-W4M **UTM (NAD83):** 12U 0385252 5602833

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	54.90	Total Veg	47.30	Total Veg	74.00	Total Veg	74.00
Litter	100.00	Litter	85.00	Litter	81.00	Litter	69.00
Exposed Soil	0.00	Exposed Soil	14.50	Exposed Soil	0.00	Exposed Soil	1.40
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	0.20	Moss/Lichen	0.80	Moss/Lichen	0.00	Moss/Lichen	2.60
SELADEN	0.00	SELADEN	0.00	SELADEN	0.00	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
SYMPOCC	22.00	STIPVIR	10.80	SYMPOCC	22.00	DESCCES	12.00
CARESP	12.70	SYMPOCC	10.40	CAREOBT	21.60	HORDJUB	9.40
STIPVIR	11.00	AGROSMI	9.70	ARTEGNA	11.00	SYMPOCC	8.60
ARTEGNA	9.20	ARTEGNA	7.40	CAREPEN	9.60	STIPVIR	6.00
STIPCUR	6.70	DESCCES	3.80	STIPVIR	6.40	AGROSMI	5.80
AGRODAS	2.40	HORDJUB	2.70	AGROSUB	2.40	GRINSQU	5.60
AGROSMI	1.60	LACTPUL	2.40	SOLIMIS	2.40	POAPRA	5.00
SOLIMIS	1.30	ACHIMIL	1.30	ACHIMIL	1.60	ARTEGNA	4.20
ACHIMIL	0.50	ARTEFRI	1.30	AGROTRA	1.60	CAREPRG	4.00
LACTPUL	0.50	CARESP	1.10	LACTPUL	1.60	ASTEFAL	3.00
JUNCBAL	0.40	SONCULI	1.00	AGROSMI	1.00	ACHIMIL	2.40
VICIAME	0.40	AGROSCA	0.50	ASTEFAL	1.00	MUHLRIC	2.00
ARTEFRI	0.20	MENTARV	0.40	MUHLRIC	1.00	AGROSCA	1.60
ASTEFAL	0.20	OXYTSER	0.40	HORDJUB	0.60	POAPAL	1.00
		AGRODAS	0.30	STIPCUR	0.20	HELIHOO	0.80
		ASTEFAL	0.20			CARESP	0.40
		ANDRSEP	0.10			ANDRSEP	0.20
		KOELMAC	0.10			TARAOFF	0.20
		MUHLRIC	0.10			VICIAME	0.20
		VICIAME	0.10				

Cover of Vegetation over Time on Disturbed Topsoils at Site 20

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: 11-13-18-20-W4M **UTM (NAD83):** 12U 0384250 5598102

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	41.80	Total Veg	19.60	Total Veg	54.00	Total Veg	32.00
Litter	99.50	Litter	33.00	Litter	56.00	Litter	50.80
Exposed Soil	0.00	Exposed Soil	67.00	Exposed Soil	0.40	Exposed Soil	4.60
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	3.50	Moss/Lichen	0.00	Moss/Lichen	1.20	Moss/Lichen	4.60
SELADEN	3.80	SELADEN	0.00	SELADEN	2.40	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
AGRODAS	18.60	AGRODAS	6.70	AGRODAS	23.00	AGRODAS	9.00
STIPCOM	10.80	AGROSMI	4.70	STIPCOM	17.00	STIPCOM	8.00
STIPCUR	5.00	STIPVIR	3.20	BOUTGRA	6.60	AGROSMI	7.60
BOUTGRA	3.80	STIPCOM	2.20	STIPVIR	4.00	CARESTE	6.40
AGROSMI	2.30	CARESP	0.60	CARESTE	2.80	HORDJUB	4.00
CARESP	2.20	LEPIRAM	0.50	SPHACOC	1.20	STIPVIR	4.00
KOELMAC	0.50	STIPCUR	0.40	ARTEFRI	1.00	SPHACOC	3.60
SPHACOC	0.50	KOELMAC	0.30	AGROSMI	0.80	ARTEFRI	3.00
ARTEFRI	0.20	LYGOJUN	0.30	CAREPEN	0.40	BOUTGRA	2.20
STIPVIR	0.10	ARTEFRI	0.20	KOELMAC	0.40	TARAOFF	1.60
		HORDJUB	0.20	HORDJUB	0.20	KOELMAC	1.20
		POASAN	0.20	TARAOFF	0.20	CAREPEN	0.40
		SYMPOCC	0.20				
		TRAGDUB	0.20				
		BOUTGRA	0.10				
		VICIAME	0.10				

Cover of Vegetation over Time on Disturbed Topsoils at Site 21

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Loamy

Legal Land Description: SW-1-18-20-W4M **UTM (NAD83):** 12U 0385268 5594049

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	46.60	Total Veg	31.60	Total Veg	59.00	Total Veg	53.40
Litter	93.20	Litter	47.30	Litter	53.00	Litter	41.40
Exposed Soil	4.80	Exposed Soil	50.20	Exposed Soil	0.60	Exposed Soil	5.00
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	4.00	Moss/Lichen	1.40	Moss/Lichen	0.80	Moss/Lichen	9.00
SELADEN	2.80	SELADEN	0.00	SELADEN	2.00	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
BOUTGRA	15.90	ARTEFRI	9.40	AGRODAS	34.00	AGROSMI	16.00
AGRODAS	10.80	AGRODAS	6.50	BOUTGRA	12.00	AGRODAS	6.40
STIPCOM	8.60	AGROSMI	5.90	STIPCOM	6.00	ARTEFRI	5.20
AGROSMI	2.80	STIPCOM	2.20	CARESTE	3.00	CARESTE	5.00
CARESP	2.20	ASTEFAL	2.00	KOELMAC	1.20	MUHLRIC	5.00
ASTEFAL	1.00	CARESP	2.00	SPHACOC	0.60	HORDJUB	3.00
SPHACOC	0.70	HETEVIL	2.00	LYGOJUN	0.40	STIPCOM	2.60
KOELMAC	0.50	KOELMAC	1.60	ARTEFRI	0.20	AGROTRA	2.00
THERRHO	0.50	POASAN	0.90	ASTRDAS	0.20	BOUTGRA	2.00
GAURCOC	0.30	LYGOJUN	0.20	MUHLRIC	0.20	STIPVIR	1.60
LYGOJUN	0.30	AGROPEC	0.10	TRAGDUB	0.20	ASTEFAL	1.00
CALAMON	0.20	SYMPOCC	0.10			LYGOJUN	1.00
TRAGDUB	0.20					SYMPOCC	1.00
CIRSUND	0.10					AGROPEC	0.60
POASAN	0.10					TARAOFF	0.60
						CALAMON	0.40

Cover of Vegetation over Time on Disturbed Topsoils at Site 22

Revegetation Strategy: Minimal Disturbance and Natural Recovery

Ecological Range Site: Limy

Legal Land Description: 2-18-20-W4M **UTM (NAD83):** 12U 0382563 5594235

2008 Off RoW		On RoW After 4 Years Recovery - 2008		2011 Off RoW		On RoW After 7 Years Recovery - 2011	
Site Cover (%)		Site Cover (%)		Site Cover (%)		Site Cover (%)	
Total Veg	46.00	Total Veg	23.20	Total Veg	50.00	Total Veg	31.00
Litter	97.80	Litter	23.50	Litter	56.00	Litter	56.80
Exposed Soil	0.20	Exposed Soil	76.30	Exposed Soil	0.60	Exposed Soil	7.80
Groundcover (%)		Groundcover (%)		Groundcover (%)		Groundcover (%)	
Moss/Lichen	2.50	Moss/Lichen	0.00	Moss/Lichen	2.00	Moss/Lichen	0.20
SELADEN	3.40	SELADEN	0.00	SELADEN	1.80	SELADEN	0.00
Species	% Cover	Species	% Cover	Species	% Cover	Species	% Cover
STIPCOM	20.30	ARTEFRI	7.60	AGRODAS	25.00	STIPCOM	19.00
AGRODAS	9.50	AGROSMI	7.00	BOUTGRA	17.00	AGROSMI	10.00
BOUTGRA	5.60	AGRODAS	3.80	STIPCOM	7.40	AGRODAS	9.00
SPHACOC	2.10	STIPCOM	1.60	KOELMAC	2.00	KOELMAC	3.00
AGROSMI	2.00	SPHACOC	1.00	CARESTE	1.60	ARTEFRI	2.60
CARESP	1.50	HORDJUB	0.90	SPHACOC	0.60	CALAMON	1.20
KOELMAC	1.10	KOELMAC	0.90	POTEPEN	0.40	HORDJUB	1.00
ARTEFRI	0.60	CARESP	0.60	AGROSMI	0.20	SYMPOCC	1.00
PHLOHOO	0.30	POASAN	0.30	TARAOFF	0.20	TRAGDUB	1.00
TRAGDUB	0.30	TRAGDUB	0.20			CARESTE	0.80
CERAARV	0.20	TARAOFF	0.10			STIPVIR	0.60
CALAMON	0.10						

Appendix F Data Index for the Accompanying CD

F.1 Cypress Uplands Data

Appendix F.1.1 Cypress Project Scanned MF5 Data Sheets
Appendix F.1.2 Merry Flats Project Scanned MF5 Data Sheets
Appendix F.1.3 Cypress Project Scanned Range Health Data Sheets
Appendix F.1.4 Merry Flats Project Scanned Range Health Data Sheets
Appendix F.1.5 Cypress Project Site Photos
Appendix F.1.6 Merry Flats Project Site Photos

F.2 Majorville Project

Appendix F2.1 Husky Majorville Project Scanned MF5 Data Sheets
Appendix F.2.2 Cypress Project Scanned Range Health Data Sheets
Appendix F.2.3 Husky Majorville Project Site Photos