Tree and Shrub Mitigation Plan

Badger Wind Project

Logan and McIntosh County, North Dakota

Final Report

Prepared for:

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS iv
INTRODUCTION and Regulatory background 1
CONSTRUCTION CORRIDOR DESCRIPTION 1
TREE AND SHRUB INVENTORY 4
METHODS 4
Pre-construction Desktop Review 4
Pre-construction Field Inventory 4
Post-construction Field Inventory 4
RESULTS 4
Pre-construction Field Inventory 4
Post-construction Field Inventory 5
TREE AND SHRUB REPLACEMENT PLAN 6
LANDOWNER CONSULTATION 6
PLANTING SCHEDULE 7
REPLACEMENT TREE AND SHRUB SUCCESS CHECK AND SUMMARY 7
REFERENCES 7

LIST OF TABLES

Table 1. Results of the pre-construction tree and shrub inventory at the Badger Wind Project in Logan and McIntosh counties, North Dakota, from September 13, 2024 – January 24, 2025. 5
Table 2. Results of the post-construction tree and shrub inventory at the Badger Wind Project in Logan and McIntosh counties, North Dakota, December 15, 2025. 6

LIST OF FIGURES

Figure 1. Location of the Construction Corridor at the Badger Wind Project in Logan and McIntosh counties, North Dakota. 2
Figure 2. Land cover within the Construction Corridor at the Badger Wind Project in Logan and McIntosh counties, North Dakota. 3

LIST OF APPENDICES

Appendix A. North Dakota Public Service Commission Tree and Shrub Mitigation Specifications.

Appendix B. Pre-construction Tree and Shrub Inventory Results at the Badger Wind Project in Logan and McIntosh Counties, North Dakota, from September 13, 2024 – January 24, 2025

Appendix C. Removed Tree and Shrub Inventory for the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix D. Post-construction Tree and Shrub Inventory Results at the Badger Wind Project in Logan and McIntosh Counties, North Dakota, December 15, 2025

Appendix E. US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) – North Dakota Field Office Technical Guide: Windbreak and Woodland Tree Care and Management

Appendix F Landowner Waivers for Tree and Shrub Replacement at the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix G. Tree and Shrub Replacement Quantity and Species by Landowner at the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix H. Tree and Shrub Planting Parcel Locations for the Badger Wind Project in Logan and McIntosh Counties, North Dakota

ACRONYMS AND ABBREVIATIONS

ADLS	Aircraft Detection Lighting System
Badger Wind	Badger Wind, LLC
Construction Corridor	consists of proposed Project infrastructure footprints and their associated survey buffers
EPC	Engineering, Procurement, and Construction
ft	foot
m	meter
MET	meteorological
MW	megawatt
NDPSC	North Dakota Public Service Commission
O&M	operations and maintenance
Project	Badger Wind Project
Plan	Tree and Shrub Mitigation Plan
SCD	Soil Conservation District
Specifications	*Tree and Shrub Mitigation Specifications*
WEST	Western EcoSystems Technology, Inc.
WTG	wind turbine generator

INTRODUCTION AND REGULATORY BACKGROUND

Badger Wind, LLC (Badger Wind), has developed the Badger Wind Project (Project) in Logan and McIntosh counties, North Dakota (Figure 1). The Project consists of 92 2.8-megawatt (MW) wind turbine generators (WTGs) with a nameplate generating capacity of up to 250 MW. Associated infrastructure includes underground collection and communication lines, WTG access roads, meteorological (MET) towers, an operations and maintenance (O&M) building, an Aircraft Detection Lighting System (ADLS) tower, generation tie line, and a substation.

On September 11, 2024, the North Dakota Public Service Commission (NDPSC) approved Findings of Fact, Conclusions of Law, and Order for the Project in Case No. PU-24-87, issuing First Amended Certificate of Site Compatibility Number 64 and incorporating the Certification Relating to Order Provisions Wind Energy Conversion Facility Siting, with accompanying *Tree and Shrub Mitigation Specifications* (Specifications; Appendix A). In accordance with the Specifications, the NDPSC requires, prior to the removal of any tree or shrub for construction, all deciduous trees one inch (2.5 centimeters) or greater in diameter at breast height and all shrubs and coniferous trees of any diameter to be inventoried to record the location, number, and species. The Specifications also require the development of a Tree and Shrub Mitigation Plan to replace trees and shrubs on a minimum two-to-one basis.

Badger Wind contracted Western EcoSystems Technology, Inc. (WEST), to develop this Tree and Shrub Mitigation Plan (Plan) for the Project within the Construction Corridor (defined below; Figure 2) to determine impacts to trees and shrubs from permanent infrastructure and temporary workspaces during construction. Construction of the Project required removal of trees and shrubs; however, trees and shrubs within the Construction Corridor were avoided where practical.

The Plan summarizes methods and results of the tree and shrub inventory efforts conducted from 2024–2025 and provides details regarding tree and shrub replacement (i.e., proposed amount, species, and location of trees and shrubs).

CONSTRUCTION CORRIDOR DESCRIPTION

The Construction Corridor consists of Project infrastructure footprints and their associated survey buffers (Figure 2) and includes:

- 250-foot (ft; 76-meter [m]) radius centered around turbines
- 300-ft (91-m) wide corridor for turbine access roads
- 100-ft (30-m) wide corridor for underground collection/communication lines
- 200-ft (61-m) wide corridor for ADLS tower, batch plant, crane walk paths, laydown yard, MET tower, O&M facility, marshaling yard, substation, transmission line, and turning radii locations

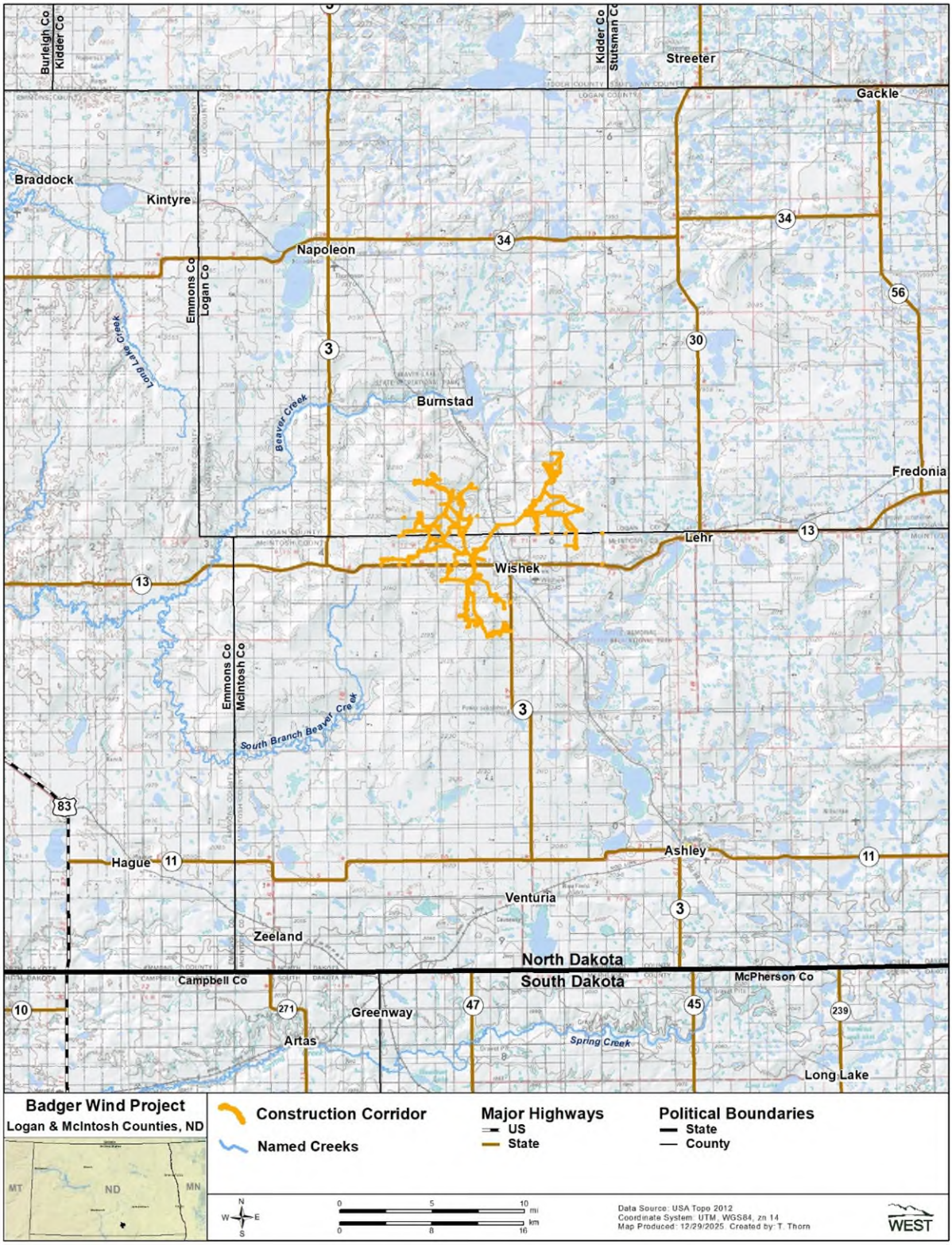

Figure 1. Location of the Construction Corridor at the Badger Wind Project in Logan and McIntosh counties, North Dakota.

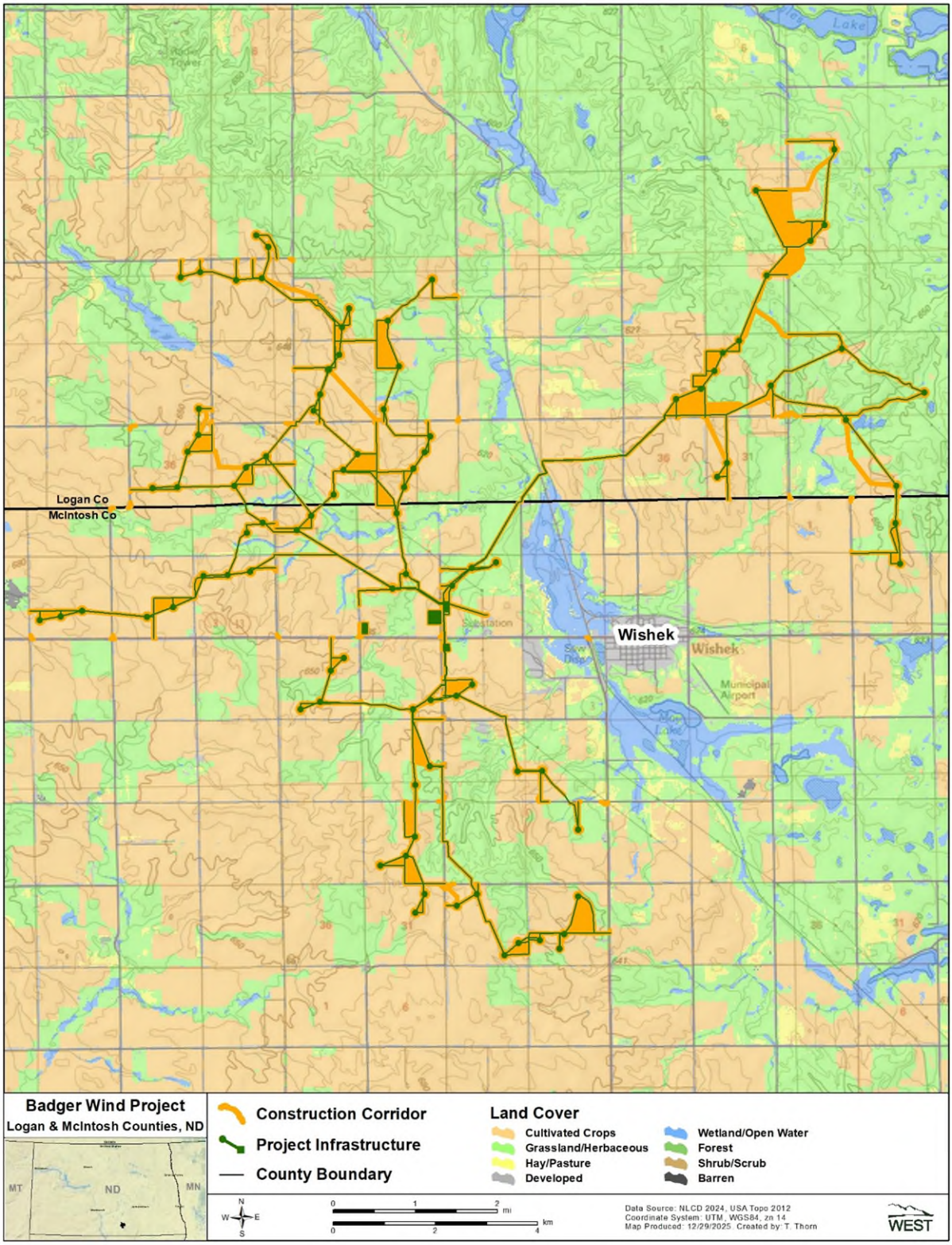

Figure 2. Land cover within the Construction Corridor at the Badger Wind Project in Logan and McIntosh counties, North Dakota.

The 2,087-acre (845-hectare) Construction Corridor is located within the Northwestern Glaciated Plains Level III Ecoregion, an ecoregion mainly composed of mixed-grass prairie (US Environmental Protection Agency 2012, 2013). Primary land uses include agriculture and livestock grazing. According to the National Land Cover Database (2024), the primary land cover within the Construction Corridor is predominantly cultivated crops (74%), followed by grassland/herbaceous (20%; Figure 2). The remaining land cover types comprise less than 6% of the Construction Corridor (Figure 2).

TREE AND SHRUB INVENTORY

METHODS

Pre-construction Desktop Review

WEST completed a pre-construction desktop review of existing tree and shrub cover within the Construction Corridor using current aerial photography, existing land cover data, and the tree data layer from the bat habitat assessment completed at the Project (Atwell, LLC 2020). Based on the desktop review, a digital data layer of polygons delineating trees and shrubs was used to guide field efforts.

Pre-construction Field Inventory

Following methodology outlined in the Specifications for the Project, WEST completed a field-based inventory prior to the start of construction to create an inventory of individual shrubs and deciduous and coniferous trees in the Construction Corridor. Each tree and shrub polygon identified during the desktop review within the Construction Corridor was assessed in the field to determine location, quantity, planting type (i.e., natural or planted), and species (both native and non-native species).

Post-construction Field Inventory

Following construction, WEST re-inventoried trees and shrubs identified during the pre-construction field inventory. The tree and shrub post-construction field inventory followed methodology outlined in the Specifications for the Project. Location, quantity, planting type (i.e., natural or planted), and species (both native and non-native species) were recorded for all trees and shrubs removed during construction. Pre- and post-construction tree and shrub inventories were compared and the total number of trees and shrubs impacted was calculated.

RESULTS

Pre-construction Field Inventory

The pre-construction field inventory was completed between September 13, 2024, and January 24, 2025, prior to the commencement of ground clearing construction within the Construction Corridor. Overall, 946 shrubs representing 13 species and 3,091 trees representing 10 species were identified during pre-construction inventory field efforts (Table 1). The most common shrub species was chokecherry (*Prunus virginiana*), followed by common lilac (*Syringa vulgaris*), Tatarian honeysuckle (*Lonicera tatarica*), Siberian peashrub (*Caragana arborescens*), and winterberry holly (*Ilex verticillata*; Table 1). The most common tree species recorded was

Siberian elm (*Ulmus pumila*), followed by Oregon ash (*Fraxinus latifolia*), ponderosa pine (*Pinus ponderosa*), and green ash (*F. pennsylvanica*; Table 1). All trees (100%) and most shrubs (99.8%) were planted. Maps depicting tree and shrub locations are included in Appendix B.

Table 1. Results of the pre-construction tree and shrub inventory at the Badger Wind Project in Logan and McIntosh counties, North Dakota, from September 13, 2024 – January 24, 2025.

Common name	Scientific Name	Count
Shrubs		
Black cherry*	*Prunus serotina*	2
American plum	*Prunus americana*	6
Chokecherry	*Prunus virginiana*	237
Common juniper	*Juniperus communis*	1
Common lilac	*Syringa vulgaris*	178
Eastern cottonwood	*Populus deltoides*	2
Eastern red cedar	*Juniperus virginiana*	2
Late lilac	*Syringa villosa*	117
Nannyberry	*Viburnum lentago*	2
Serviceberry	*Amelanchier alnifolia*	7
Siberian peashrub	*Caragana arborescens*	130
Tatarian honeysuckle	*Lonicera tatarica*	139
Winterberry holly	*Ilex verticillata*	123
Overall Shrubs	**13 species**	**946**
Trees		
American elm	*Ulmus americana*	9
American plum	*Prunus americana*	3
Boxelder	*Acer negundo*	32
Green ash	*Fraxinus pennsylvanica*	163
Oregon ash	*Fraxinus latifolia*	424
Ponderosa pine	*Pinus ponderosa*	182
Rocky Mountain juniper	*Juniperus scopulorum*	1
Siberian elm	*Ulmus pumila*	2,190
Silver maple	*Acer saccharinum*	54
White spruce	*Picea glauca*	33
Overall Trees	**10 species**	**3,091**
Total	**22 Species**	**4,037**

* Natural planting type.

Post-construction Field Inventory

The post-construction field inventory was executed on December 15, 2025, following ground clearing construction within the Construction Corridor. The survey team was able to utilize roads built during construction to facilitate site access as well as spatial data on disturbance areas where tree removal had occurred. Overall, 29 shrubs representing five species and 168 trees representing three species were recorded as being removed during post-construction inventory field efforts (Table 2; Appendix C). The most common shrub species removed were winterberry holly and Tatarian honeysuckle (Table 2). The most common tree species removed was Siberian elm, followed by Oregon ash, and green ash (Table 2). Maps depicting tree and shrub removal locations recorded during the post-construction inventory are included in Appendix D.

Table 2. Results of the post-construction tree and shrub inventory at the Badger Wind Project in Logan and McIntosh counties, North Dakota, December 15, 2025.

Common name	Scientific Name	Count
Shrubs		
Chokecherry	*Prunus virginiana*	1
Serviceberry	*Amelanchier alnifolia*	2
Siberian peashrub	*Caragana arborescens*	3
Tatarian honeysuckle	*Lonicera tatarica*	10
Winterberry holly	*Ilex verticillata*	13
Overall Shrubs	**5 species**	**29**
Trees		
Green ash	*Fraxinus pennsylvanica*	6
Oregon ash	*Fraxinus latifolia*	25
Siberian elm	*Ulmus pumila*	137
Overall Trees	**3 species**	**168**
Total	**8 Species**	**197**

TREE AND SHRUB REPLACEMENT PLAN

This tree and shrub replacement plan was developed in accordance with US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) – North Dakota Field Office Technical Guide: Windbreak and Woodland Tree Care and Management (Appendix E) and in consultation with the North Dakota NRCS, Logan and McIntosh County Soil Conservation Districts (SCDs), and affected landowners. Tree and shrub replacement on a minimum 2:1 basis, for a total of 394 trees and shrubs, is required per the Specifications. However, 494 trees and shrubs will be planted (2.5:1 replacement ratio) in order to provide additional benefit to landowners and account for potential tree and shrub mortality. This Plan includes the proposed number and species for replacement trees and shrubs, as well as approximate planting locations and approximate timing for plantings. Replacement trees and shrubs were selected based on characteristics that would provide the highest survival rates at the planting site for the region, landowner preference, and wildlife benefits. Replacement trees and shrubs will be the same or similar to species removed and based on input from the NRCS, Logan and McIntosh County SCDs, and landowners; any invasive or noxious tree and shrub species will be replaced with suitable species. Trees and shrubs removed during construction will be replaced with conservation grade bare-root saplings between one to two years old.

LANDOWNER CONSULTATION

Landowners who had trees and/or shrubs removed from their property were consulted between January 21st and February 13th, 2026 to determine how they wanted to proceed with tree and shrub replacement. Conversations with landowners and their tenant farmers (if applicable) occurred to discuss options for tree and shrub species based on NRCS and SCD recommendations, replacement location, and quantity of trees and shrubs. Landowners were also consulted on whether they approved the use of weed barrier fabric and tree protectors. All landowners were given the option to waive tree replacement, in which case replacement trees

and shrubs would be planted in an alternate location. One landowner (Green Acres LLLP) opted to waive tree and shrub replacement on his property and provide all of them to his tenant farmer (Phillip Wanner) who will have the trees planted on his property. Another landowner (Lyle Bettenhausen) has requested to plant approximately half of his replacement trees on the border of his property with an adjacent landowner (Jeremy Herr) who is also Mr. Bettenhausen's tenant farmer. Coordination is ongoing between Mr. Herr and Mr. Bettenhausen to determine specific planting locations, which are likely to occur on both sides of the respective property lines. Once specific planting locations are agreed upon, a waiver will be provided in the event that some of Mr. Bettenhausen's replacement trees are planted on Mr. Herr's property. Waivers will be included in Appendix F once obtained.

Tree and shrub replacement quantity and species by landowner and/or recipient is provided in Appendix G and the planting locations by parcel are shown in Appendix H. Specific planting locations are expected to be finalized in late March or early April. Coordination is still ongoing and will continue into the spring season since landowners/recipients requested time to assess the proposed planting areas once snow cover has lessened.

PLANTING SCHEDULE

Replacement trees and shrubs will be planted in the spring of 2026. Exact timing will depend on weather conditions, coordination with landowners, and Plan approval. Arrangements have been made with the USDA-NRCS Ashley Field Office in Ashley, North Dakota to acquire the replacement trees and shrubs from the Towner State Nursery associated with North Dakota State University. Prior to planting, all required materials, (i.e., stakes and tube tree protectors) will be acquired. Prairie View Landscaping will conduct the tree and shrub replacement planting with support from the Project's Engineering, Procurement, and Construction (EPC) contractor. Trees will be planted by hand and weed barrier material and tree protectors will be installed during the planting process. Trees will be watered thoroughly after planting.

REPLACEMENT TREE AND SHRUB SUCCESS CHECK AND SUMMARY

All tree and shrub replacements will be visually inspected by WEST two years following the completion of planting (i.e., spring/summer 2028) to determine survival rates, as required by the Specifications. A summary report will be filed with the NDPSC following inspection and will include a summary of the surviving replacement trees and shrubs.

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Atwell, LLC (Atwell). 2020. Bat Habitat Assessment Memorandum for the Badger Wind Project. Prepared for Badger Wind, LLC, Chicago, Illinois. Prepared by Atwell.

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Appendix A. North Dakota Public Service Commission Tree and Shrub Mitigation Specifications.

BW Exhibit 15

STATE OF NORTH DAKOTA
PUBLIC SERVICE COMMISSION

Badger Wind, LLC **Case No. PU-24-87**
Amend-Badger Wind Project-Logan & McIntosh
Siting Application

Tree and Shrub Mitigation Specifications

Inventory
Prior to cutting or clearing trees or shrubs for construction:

- All trees one-inch or greater in diameter at breast height must be inventoried to record the location, number, and species.
- All shrubs and all coniferous trees of any diameter must be inventoried to record the location, number, and species.

Clearing
The maximum width of tree and shrub removal is 50 feet, unless otherwise approved by the Commission.

Replacement

1. Landowners must be given the option to have trees and shrubs that are removed from their property replaced on their property. The landowner may waive this option in writing. If the landowner waives this option, the company shall plant replacement trees and shrubs in an alternate location in the same region, if practical.

2. Trees and shrubs must be replaced on a minimum two-to-one basis. The company shall develop a Tree and Shrub Mitigation Plan (Plan) in consultation with landowners who are seeking replacement trees and shrubs and in accordance with USDA-NRCS-North Dakota Field Office Technical Guide: Windbreak and Woodland Tree Care and Management. The guidelines outlined in the Technical Guide shall be followed until filing of the Plan summary outlined in number 5 below.

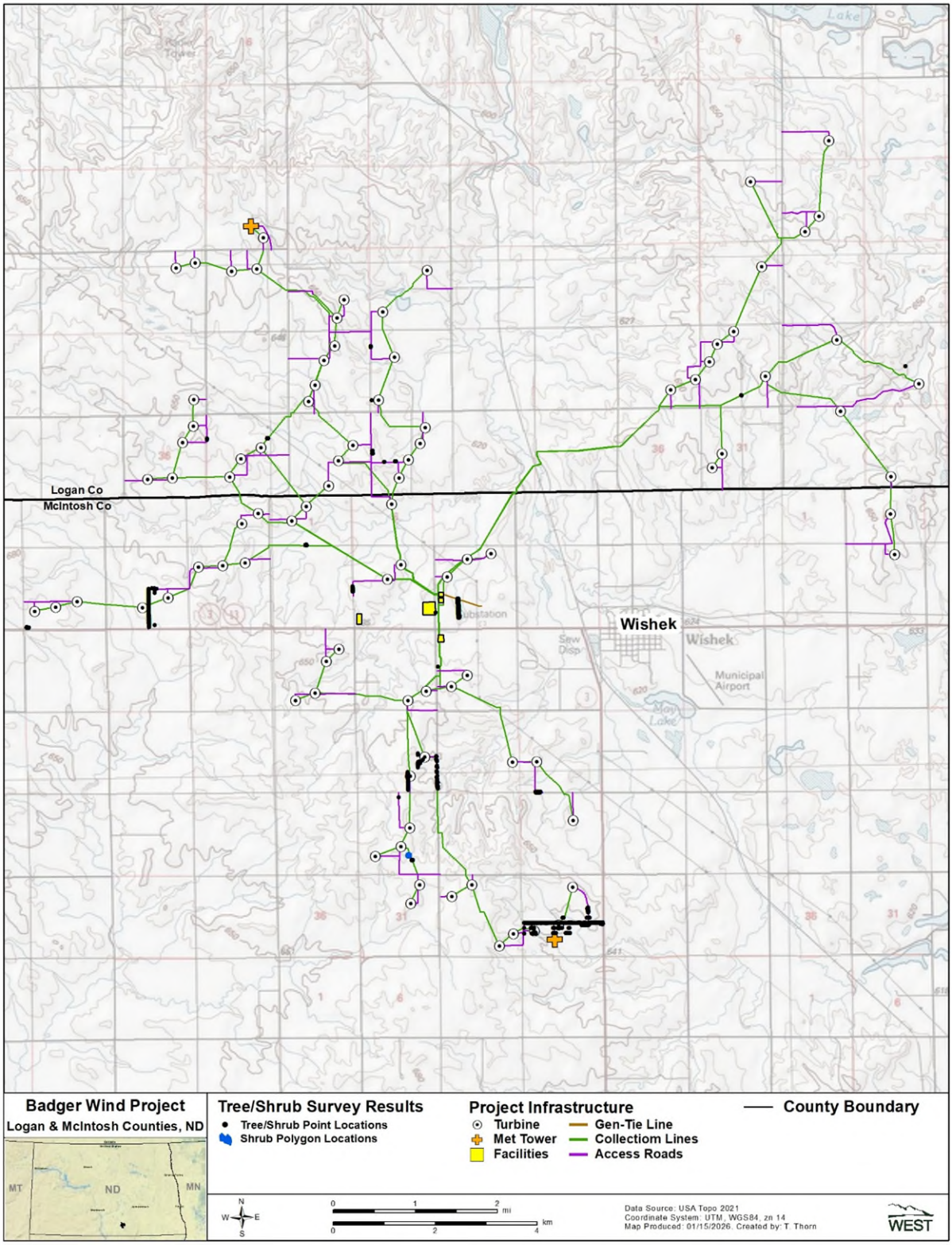
3. The purpose of the company's Tree and Shrub Mitigation Plan is to create sustainable plantings, appropriate for the local soil and growing conditions that will provide long-term benefit to landowners, farmers and ranchers, the community, wildlife and the environment.

4. The Plan, including the proposed number, variety, type, location, and approximate date for plantings, shall be filed with and approved by the Commission.

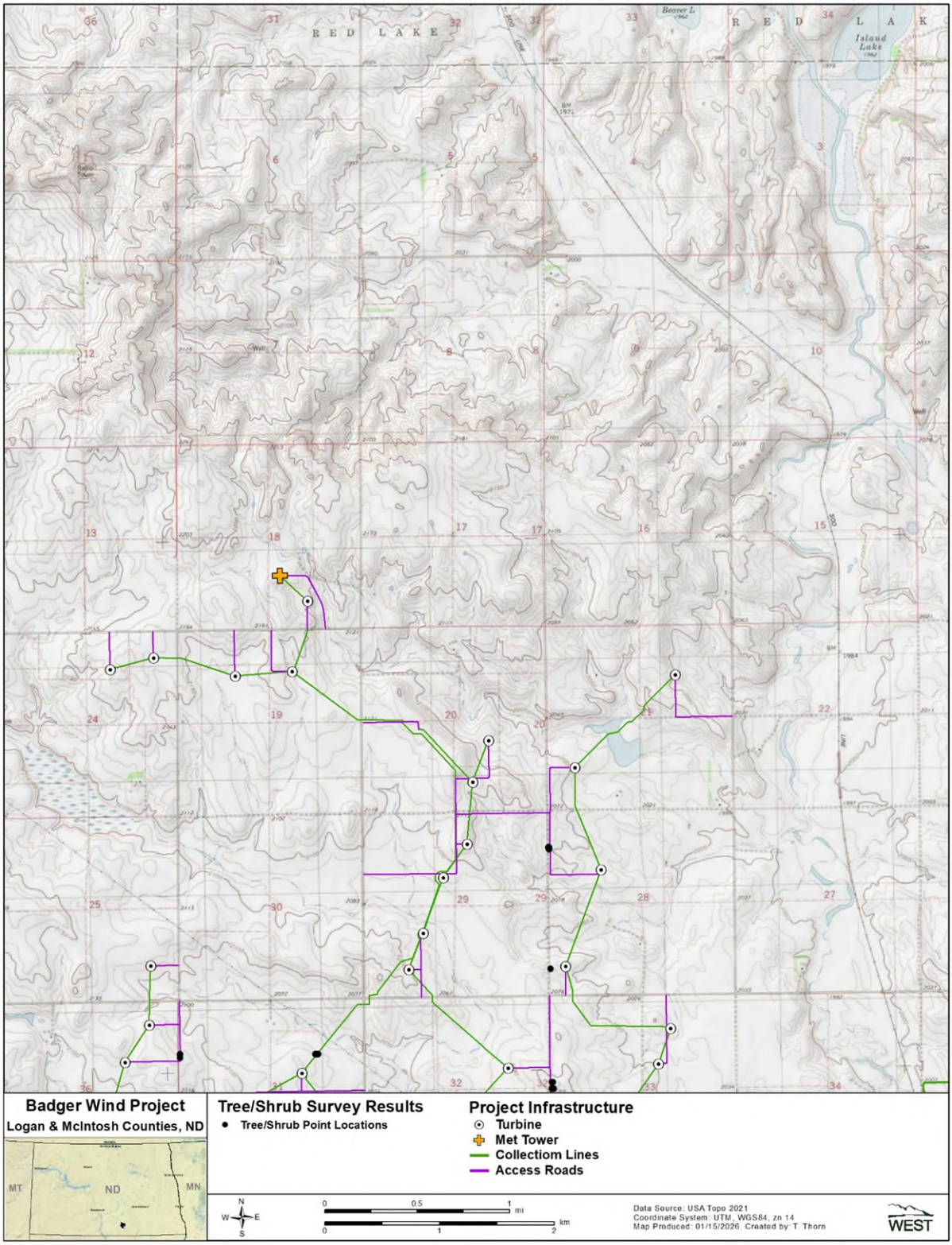
5. Two years after completion of the plan, the company must file a summary documenting how the plan achieved the purpose outlined in number 3 above. The summary must also report the number of surviving replacement trees and shrubs.

6. The Commission will consider, on a limited basis as conditions warrant, mitigation plans that provide long-term wildlife habitat and conservation benefits but do not involve the replanting of trees and shrubs.

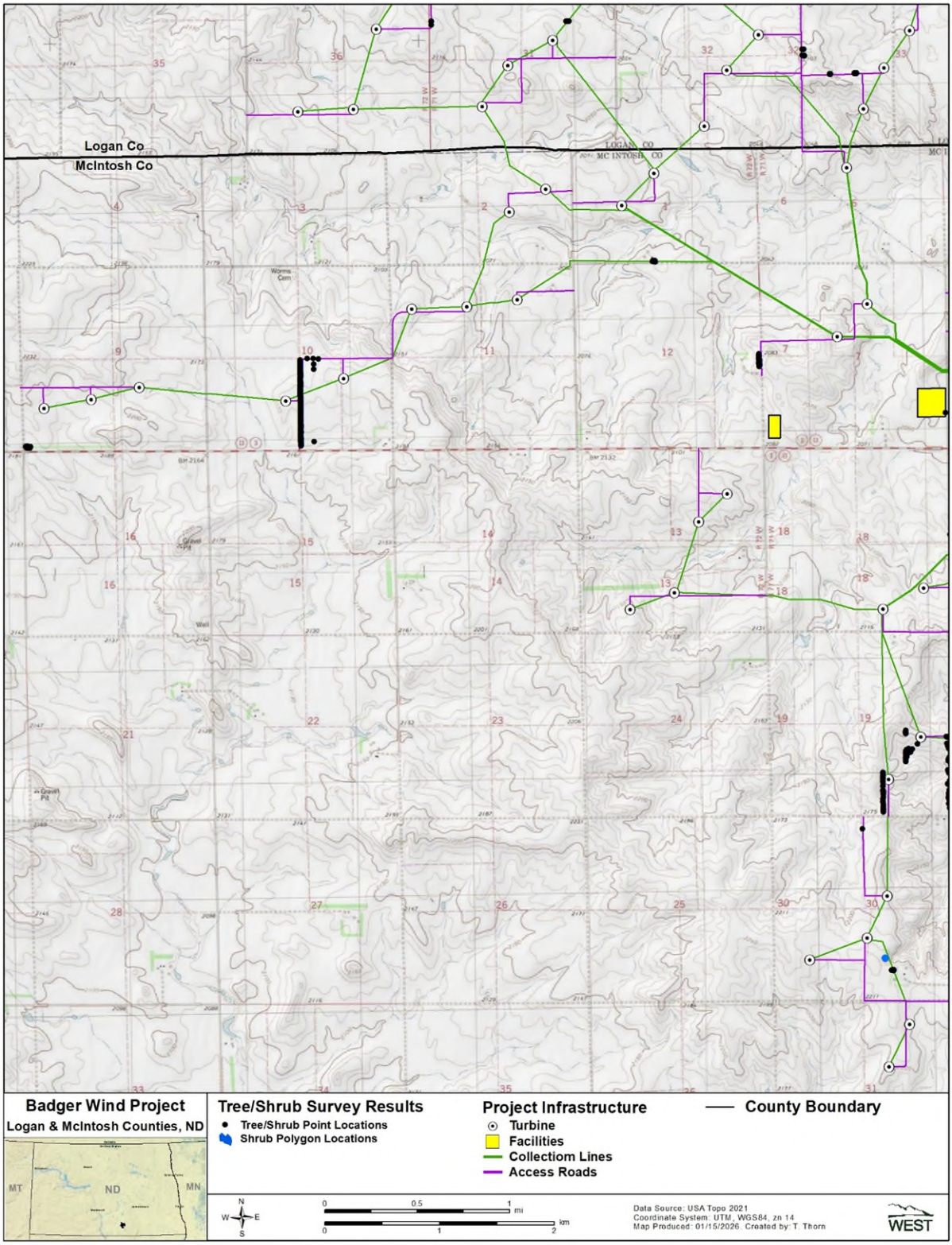
Appendix B. Pre-construction Tree and Shrub Inventory Results at the Badger Wind Project in Logan and McIntosh Counties, North Dakota, from September 13, 2024 – January 24, 2025



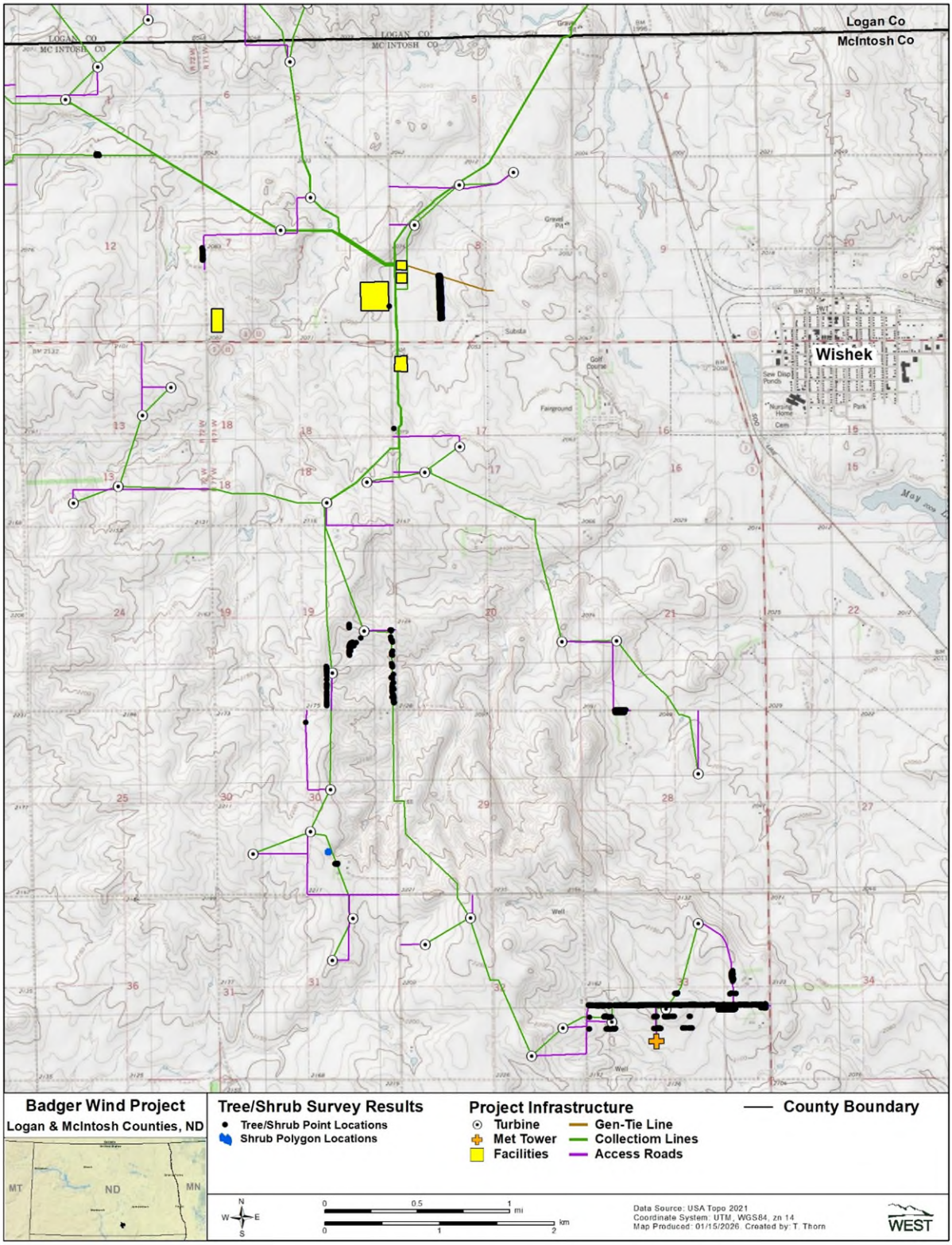
Appendix B1. Pre-construction tree and shrub inventory results at the Badger Wind Project, Logan and McIntosh counties, North Dakota, conducted from September 13, 2024 – January 24, 2025.



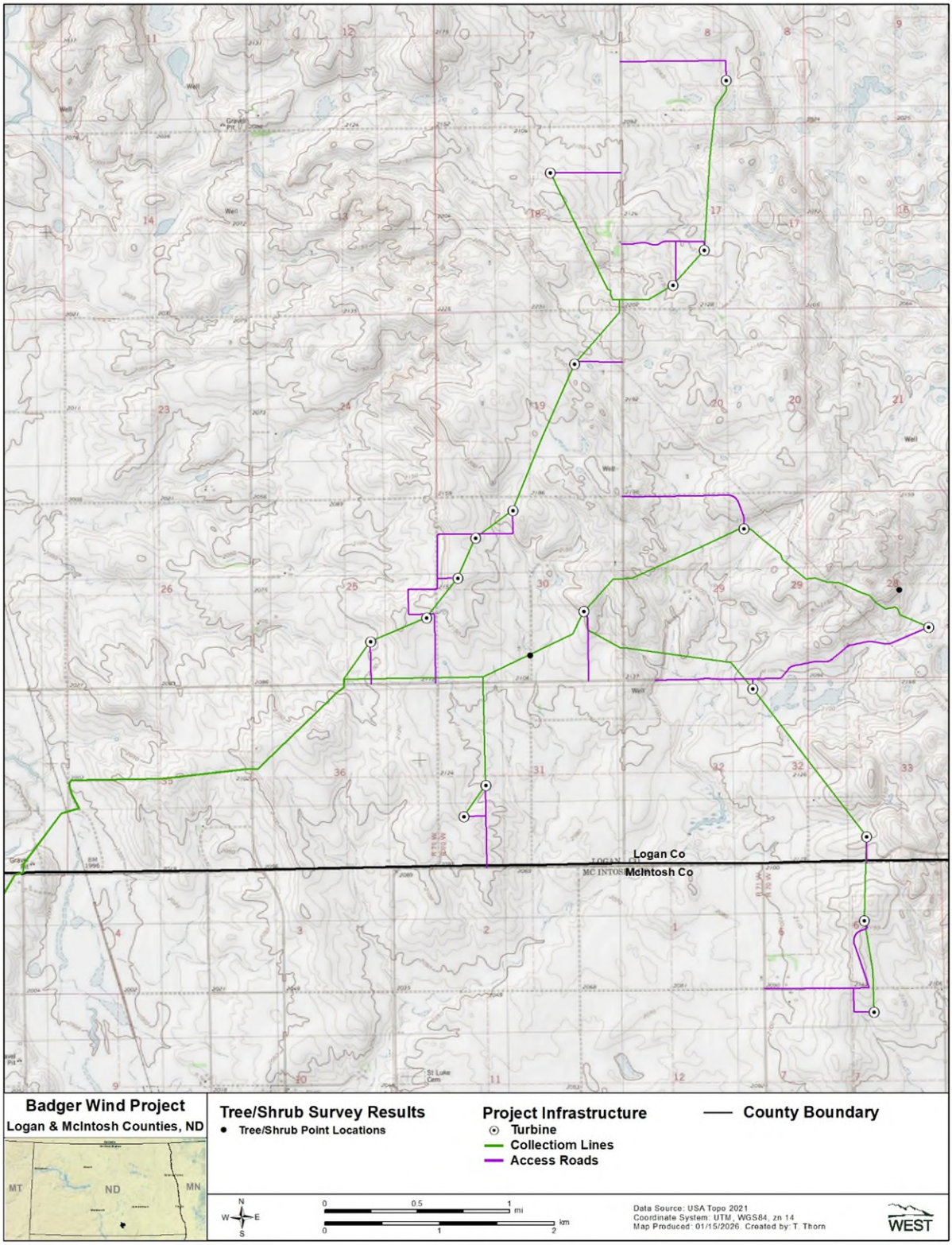
Appendix B2. Pre-construction tree and shrub inventory results in the northern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, conducted from September 13, 2024 – January 24, 2025.



Appendix B3. Pre-construction tree and shrub inventory results in the western region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, conducted from September 13, 2024 – January 24, 2025.



Appendix B4. Pre-construction tree and shrub inventory results in the southern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, conducted from September 13, 2024 – January 24, 2025.



Appendix B5. Pre-construction tree and shrub inventory results in the eastern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, conducted from September 13, 2024 – January 24, 2025.

Appendix C. Removed Tree and Shrub Inventory for the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix C. Removed tree and shrub inventory for the Badger Wind Project in Logan and McIntosh counties, North Dakota

Common Name	Scientific Name	Latitude	Longitude	Total Removed
Siberian Elm	*Ulmus pumila*	46.2062119869	-99.5860167914	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930501661	-99.6501608815	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930486230	-99.6501857406	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930424953	-99.6501772973	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930560193	-99.6502556924	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930491965	-99.6502250159	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2930543248	-99.6502825494	1
Siberian Elm	*Ulmus pumila*	46.2931249919	-99.6656642951	1
Siberian Elm	*Ulmus pumila*	46.2931459693	-99.6656719649	1
Siberian Elm	*Ulmus pumila*	46.2928727001	-99.6656639501	1
Winterberry holly	*Ilex verticillata*	46.3091201660	-99.6237323444	1
Winterberry holly	*Ilex verticillata*	46.3091087055	-99.6237168017	1
Winterberry holly	*Ilex verticillata*	46.3090950868	-99.6237587198	1
Winterberry holly	*Ilex verticillata*	46.3091064635	-99.6237429220	1
Winterberry holly	*Ilex verticillata*	46.3090876672	-99.6237203294	1
Winterberry holly	*Ilex verticillata*	46.3090960288	-99.6237367174	1
Winterberry holly	*Ilex verticillata*	46.3090819912	-99.6237647376	1
Winterberry holly	*Ilex verticillata*	46.3090738064	-99.6237796946	1
Winterberry holly	*Ilex verticillata*	46.3090942485	-99.6237477361	1
Winterberry holly	*Ilex verticillata*	46.3090850150	-99.6237412781	1
Winterberry holly	*Ilex verticillata*	46.3090767006	-99.6237502487	1
Winterberry holly	*Ilex verticillata*	46.3090731828	-99.6237658318	1
Winterberry holly	*Ilex verticillata*	46.3090638116	-99.6237730147	1
Siberian elm	*Ulmus pumila*	46.2184037607	-99.6143377101	1
Siberian elm	*Ulmus pumila*	46.2184005926	-99.6143560367	1
Siberian elm	*Ulmus pumila*	46.2184072370	-99.6143565137	1
Siberian elm	*Ulmus pumila*	46.2184058634	-99.6143700216	1
Siberian elm	*Ulmus pumila*	46.2184067361	-99.6143810754	1
Siberian elm	*Ulmus pumila*	46.2184023709	-99.6143772504	1
Siberian elm	*Ulmus pumila*	46.2184102746	-99.6143987632	1
Siberian elm	*Ulmus pumila*	46.2184141251	-99.6144035773	1
Siberian elm	*Ulmus pumila*	46.2184089606	-99.6144118166	1
Siberian elm	*Ulmus pumila*	46.2184087356	-99.6144199814	1
Siberian elm	*Ulmus pumila*	46.2184060300	-99.6144268643	1
Siberian elm	*Ulmus pumila*	46.2184072339	-99.6144361143	1
Siberian elm	*Ulmus pumila*	46.2184098494	-99.6144402232	1
Siberian elm	*Ulmus pumila*	46.2184088574	-99.6144460748	1
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Siberian elm	*Ulmus pumila*	46.2184030894	-99.6144529253	1
Siberian elm	*Ulmus pumila*	46.2184048186	-99.6144567126	1
Siberian elm	*Ulmus pumila*	46.2184166872	-99.6144673307	1
Siberian elm	*Ulmus pumila*	46.2184183156	-99.6144708890	1
Siberian pea shrub	*Caragana arborescens*	46.2184467946	-99.6144776596	1
Siberian elm	*Ulmus pumila*	46.2184399233	-99.6144686656	1
Siberian elm	*Ulmus pumila*	46.2184491018	-99.6144592091	1
Siberian pea shrub	*Caragana arborescens*	46.2184484393	-99.6144248260	1
Siberian pea shrub	*Caragana arborescens*	46.2184579099	-99.6144130366	1
Siberian elm	*Ulmus pumila*	46.2079872032	-99.5698830188	1
Siberian elm	*Ulmus pumila*	46.2079834421	-99.5699015520	1
Serviceberry	*Amelanchier alnifolia*	46.2079799520	-99.5699700296	1
Siberian elm	*Ulmus pumila*	46.2079575140	-99.5700048447	1
Siberian elm	*Ulmus pumila*	46.2070687461	-99.5699007884	1

Appendix C. Removed tree and shrub inventory for the Badger Wind Project in Logan and McIntosh counties, North Dakota

Common Name	Scientific Name	Latitude	Longitude	Total Removed
Siberian elm	*Ulmus pumila*	46.2070526799	-99.5698963938	1
Serviceberry	*Amelanchier alnifolia*	46.2070536050	-99.5698968592	1
Siberian elm	*Ulmus pumila*	46.2070746042	-99.5698364484	1
Siberian elm	*Ulmus pumila*	46.2070724538	-99.5698476593	1
Siberian elm	*Ulmus pumila*	46.2070728112	-99.5698575336	1
Siberian elm	*Ulmus pumila*	46.2070608221	-99.5698404144	1
Siberian elm	*Ulmus pumila*	46.2070543317	-99.5698393634	1
Siberian elm	*Ulmus pumila*	46.2070453758	-99.5698307099	1
Siberian elm	*Ulmus pumila*	46.2070574345	-99.5698243148	1
Siberian elm	*Ulmus pumila*	46.2070522584	-99.5698061365	1
Siberian elm	*Ulmus pumila*	46.2070500141	-99.5698064195	1
Siberian elm	*Ulmus pumila*	46.2070505376	-99.5698109631	1
Siberian elm	*Ulmus pumila*	46.2070538518	-99.5697972719	1
Siberian elm	*Ulmus pumila*	46.2070627524	-99.5697976447	1
Siberian elm	*Ulmus pumila*	46.2070507825	-99.5697700638	1
Siberian elm	*Ulmus pumila*	46.2070442791	-99.5697706144	1
Siberian elm	*Ulmus pumila*	46.2070441765	-99.5697648445	1
Siberian elm	*Ulmus pumila*	46.2070538269	-99.5697554895	1
Siberian elm	*Ulmus pumila*	46.2070473415	-99.5697563249	1
Siberian elm	*Ulmus pumila*	46.2070529914	-99.5697417219	1
Siberian elm	*Ulmus pumila*	46.2070974330	-99.5696902574	1
Siberian elm	*Ulmus pumila*	46.2070466670	-99.5696759041	1
Siberian elm	*Ulmus pumila*	46.2070567171	-99.5696467646	1
Siberian elm	*Ulmus pumila*	46.2070382133	-99.5696341253	1
Siberian elm	*Ulmus pumila*	46.2070414337	-99.5695745293	1
Siberian elm	*Ulmus pumila*	46.2070339026	-99.5714829390	1
Siberian elm	*Ulmus pumila*	46.2070361736	-99.5715020686	1
Siberian elm	*Ulmus pumila*	46.2070281359	-99.5715242453	1
Siberian elm	*Ulmus pumila*	46.2070555390	-99.5757332926	1
Siberian elm	*Ulmus pumila*	46.2070493328	-99.5757469326	1
Siberian elm	*Ulmus pumila*	46.2071122160	-99.5769773146	1
Siberian elm	*Ulmus pumila*	46.2071185658	-99.5769747158	1
Siberian elm	*Ulmus pumila*	46.2071032973	-99.5770048911	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2070975517	-99.5770477866	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2071005333	-99.5770531244	1
Siberian elm	*Ulmus pumila*	46.2071282796	-99.5770147852	1
Siberian elm	*Ulmus pumila*	46.2071022069	-99.5770812327	1
Siberian elm	*Ulmus pumila*	46.2071084797	-99.5770867950	1
Siberian elm	*Ulmus pumila*	46.2071154071	-99.5770850011	1
Siberian elm	*Ulmus pumila*	46.2071104864	-99.5770741216	1
Siberian elm	*Ulmus pumila*	46.2071153847	-99.5770974931	1
Siberian elm	*Ulmus pumila*	46.2071081209	-99.5770761572	1
Siberian elm	*Ulmus pumila*	46.2070733185	-99.5771738400	1
Siberian elm	*Ulmus pumila*	46.2070771326	-99.5771697589	1
Siberian elm	*Ulmus pumila*	46.2070838952	-99.5771554389	1
Siberian elm	*Ulmus pumila*	46.2071013527	-99.5771406499	1
Chokecherry	*Prunus virginiana*	46.2070970245	-99.5771418537	1
Siberian elm	*Ulmus pumila*	46.2071047185	-99.5771735831	1
Siberian elm	*Ulmus pumila*	46.2071098436	-99.5771717128	1
Siberian elm	*Ulmus pumila*	46.2070798400	-99.5771641121	1
Siberian elm	*Ulmus pumila*	46.2070679105	-99.5771733854	1
Siberian elm	*Ulmus pumila*	46.2070890888	-99.5772603235	1

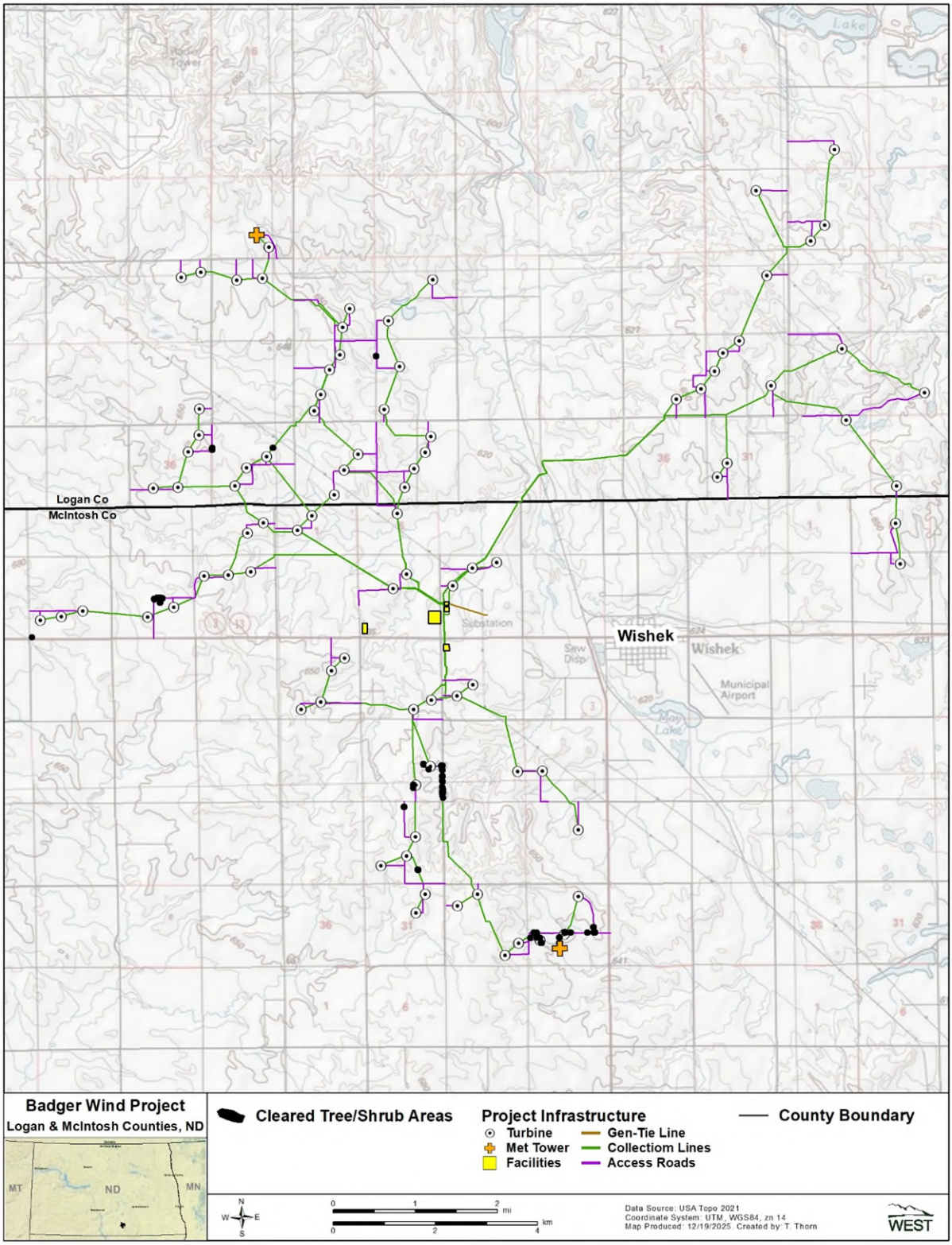
Appendix C. Removed tree and shrub inventory for the Badger Wind Project in Logan and McIntosh counties, North Dakota

Common Name	Scientific Name	Latitude	Longitude	Total Removed
Siberian elm	*Ulmus pumila*	46.2070944906	-99.5772792088	1
Siberian elm	*Ulmus pumila*	46.2071021522	-99.5772768094	1
Siberian elm	*Ulmus pumila*	46.2071174804	-99.5772657385	1
Siberian elm	*Ulmus pumila*	46.2071177141	-99.5772976323	1
Siberian elm	*Ulmus pumila*	46.2070974740	-99.5773014286	1
Siberian elm	*Ulmus pumila*	46.2070950090	-99.5772911698	1
Siberian elm	*Ulmus pumila*	46.2071160567	-99.5773198378	1
Green ash	*Fraxinus pennsylvanica*	46.2600647164	-99.7119264821	1
Oregon ash	*Fraxinus latifolia*	46.2665109298	-99.6808160882	1
Oregon ash	*Fraxinus latifolia*	46.2664975023	-99.6808133690	1
Oregon ash	*Fraxinus latifolia*	46.2665631132	-99.6808183996	1
Oregon ash	*Fraxinus latifolia*	46.2665281727	-99.6808170360	1
Oregon ash	*Fraxinus latifolia*	46.2666052753	-99.6808200399	1
Oregon ash	*Fraxinus latifolia*	46.2665902289	-99.6808210245	1
Oregon ash	*Fraxinus latifolia*	46.2665749701	-99.6808154801	1
Oregon ash	*Fraxinus latifolia*	46.2666427886	-99.6808238766	1
Oregon ash	*Fraxinus latifolia*	46.2666300592	-99.6808186008	1
Oregon ash	*Fraxinus latifolia*	46.2666174099	-99.6808205214	1
Oregon ash	*Fraxinus latifolia*	46.2666636750	-99.6808252250	1
Oregon ash	*Fraxinus latifolia*	46.2666950843	-99.6808286844	1
Siberian elm	*Ulmus pumila*	46.2667833189	-99.6800000973	1
Siberian elm	*Ulmus pumila*	46.2667726469	-99.6793307913	1
Siberian elm	*Ulmus pumila*	46.2667335880	-99.6787717454	1
Siberian elm	*Ulmus pumila*	46.2659379087	-99.6792983181	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2295415041	-99.6177305760	1
Tatarian honeysuckle	*Lonicera tatarica*	46.2062138665	-99.5835469836	1
Oregon ash	*Fraxinus latifolia*	46.2052863886	-99.5832600383	1
Oregon ash	*Fraxinus latifolia*	46.2052883010	-99.5832310066	1
Oregon ash	*Fraxinus latifolia*	46.2052873199	-99.5831968185	1
Oregon ash	*Fraxinus latifolia*	46.2052836146	-99.5831583895	1
Oregon ash	*Fraxinus latifolia*	46.2052876414	-99.5831391925	1
Oregon ash	*Fraxinus latifolia*	46.2052848530	-99.5786413395	1
Oregon ash	*Fraxinus latifolia*	46.2052818577	-99.5786174093	1
Oregon ash	*Fraxinus latifolia*	46.2052870943	-99.5785924460	1
Oregon ash	*Fraxinus latifolia*	46.2052835543	-99.5785593754	1
Oregon ash	*Fraxinus latifolia*	46.2052851458	-99.5785279299	1
Oregon ash	*Fraxinus latifolia*	46.2052850520	-99.5784966703	1
Siberian elm	*Ulmus pumila*	46.2062823832	-99.5841748332	1
Siberian elm	*Ulmus pumila*	46.2062338334	-99.5842656331	1
Siberian elm	*Ulmus pumila*	46.2062279833	-99.5842712170	1
Siberian elm	*Ulmus pumila*	46.2062288331	-99.5842802164	1
Siberian elm	*Ulmus pumila*	46.2062482169	-99.5842919663	1
Siberian elm	*Ulmus pumila*	46.2062448336	-99.5842900664	1
Siberian elm	*Ulmus pumila*	46.2062521833	-99.5843049829	1
Siberian elm	*Ulmus pumila*	46.2062394498	-99.5843081836	1
Siberian elm	*Ulmus pumila*	46.2062364165	-99.5843129662	1
Siberian elm	*Ulmus pumila*	46.2062357333	-99.5843072664	1
Siberian elm	*Ulmus pumila*	46.2062283669	-99.5843340668	1
Siberian elm	*Ulmus pumila*	46.2062244166	-99.5843465668	1
Siberian elm	*Ulmus pumila*	46.2062443164	-99.5843197171	1
Siberian elm	*Ulmus pumila*	46.2062414336	-99.5843204663	1
Siberian elm	*Ulmus pumila*	46.2070829664	-99.5851252166	1

Appendix C. Removed tree and shrub inventory for the Badger Wind Project in Logan and McIntosh counties, North Dakota

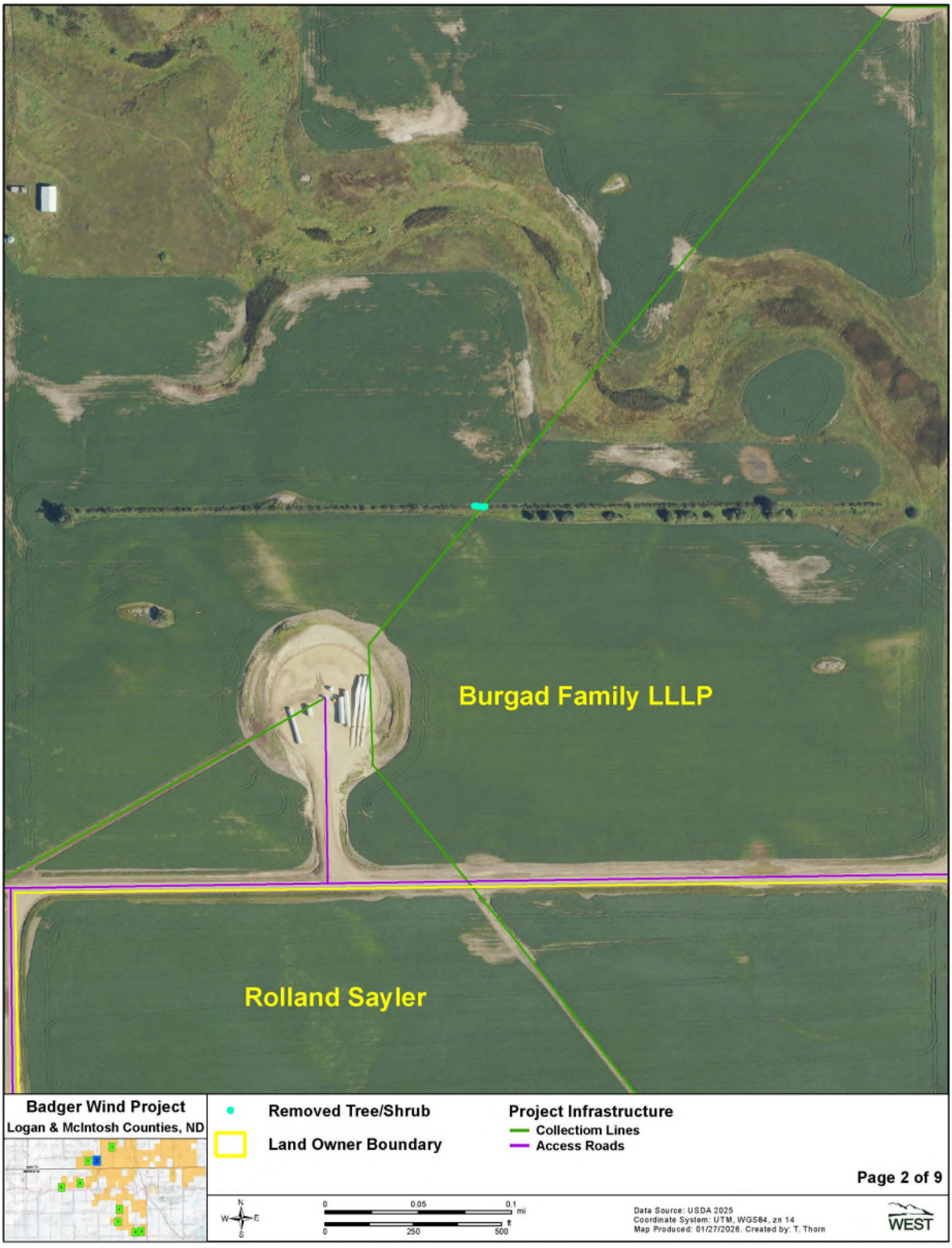
Common Name	Scientific Name	Latitude	Longitude	Total Removed
Siberian elm	*Ulmus pumila*	46.2367111278	-99.6079713767	1
Siberian elm	*Ulmus pumila*	46.2366307577	-99.6080188050	1
Siberian elm	*Ulmus pumila*	46.2367210873	-99.6081352869	1
Siberian elm	*Ulmus pumila*	46.2361549167	-99.6080804115	1
Siberian elm	*Ulmus pumila*	46.2359258362	-99.6079401243	1
Siberian elm	*Ulmus pumila*	46.2359275263	-99.6080108118	1
Siberian elm	*Ulmus pumila*	46.2349114778	-99.6079814019	1
Siberian elm	*Ulmus pumila*	46.2347901650	-99.6079759545	1
Siberian elm	*Ulmus pumila*	46.2339404189	-99.6079151475	1
Siberian elm	*Ulmus pumila*	46.2340641197	-99.6079997724	1
Siberian elm	*Ulmus pumila*	46.2338653713	-99.6079233204	1
Siberian elm	*Ulmus pumila*	46.2328977506	-99.6078992410	1
Siberian elm	*Ulmus pumila*	46.2330213494	-99.6080323633	1
Siberian elm	*Ulmus pumila*	46.2329663937	-99.6080408901	1
Siberian elm	*Ulmus pumila*	46.2324980634	-99.6078959757	1
Siberian elm	*Ulmus pumila*	46.2322927989	-99.6079482873	1
Siberian elm	*Ulmus pumila*	46.2322189414	-99.6078671882	1
Siberian elm	*Ulmus pumila*	46.2321943185	-99.6079608718	1
Siberian elm	*Ulmus pumila*	46.2320550841	-99.6078885259	1
Siberian elm	*Ulmus pumila*	46.2320067273	-99.6079591928	1
Siberian elm	*Ulmus pumila*	46.2319239232	-99.6079762815	1
Siberian elm	*Ulmus pumila*	46.2317268497	-99.6079141665	1
Siberian elm	*Ulmus pumila*	46.2314365981	-99.6079639090	1
Siberian elm	*Ulmus pumila*	46.2311004203	-99.6078248237	1
Siberian elm	*Ulmus pumila*	46.2361236887	-99.6114212631	1
Oregon ash	*Fraxinus latifolia*	46.2328677499	-99.6153592617	1
Siberian elm	*Ulmus pumila*	46.2328886373	-99.6153575998	1
Siberian elm	*Ulmus pumila*	46.2070786501	-99.5843567663	1
Siberian elm	*Ulmus pumila*	46.2331718546	-99.6153542572	1
Siberian elm	*Ulmus pumila*	46.2333540413	-99.6153431055	1
Green ash	*Fraxinus pennsylvanica*	46.2333803383	-99.6153526240	1
Oregon ash	*Fraxinus latifolia*	46.2334246282	-99.6153386202	1
Green ash	*Fraxinus pennsylvanica*	46.2371164292	-99.6127457391	1
Green ash	*Fraxinus pennsylvanica*	46.2370623680	-99.6127608200	1
Green ash	*Fraxinus pennsylvanica*	46.2369952381	-99.6127467039	1
Green ash	*Fraxinus pennsylvanica*	46.2369360513	-99.6127446594	1
Siberian elm	*Ulmus pumila*	46.2062109831	-99.5786747667	1
Siberian elm	*Ulmus pumila*	46.2062118000	-99.5785978503	1
Siberian elm	*Ulmus pumila*	46.2062166169	-99.5786028332	1
Siberian elm	*Ulmus pumila*	46.2061856361	-99.5786470339	1
Siberian elm	*Ulmus pumila*	46.2062170670	-99.5785831835	1

Appendix D. Post-construction Tree and Shrub Inventory Results at the Badger Wind Project in Logan and McIntosh Counties, North Dakota, December 15, 2025

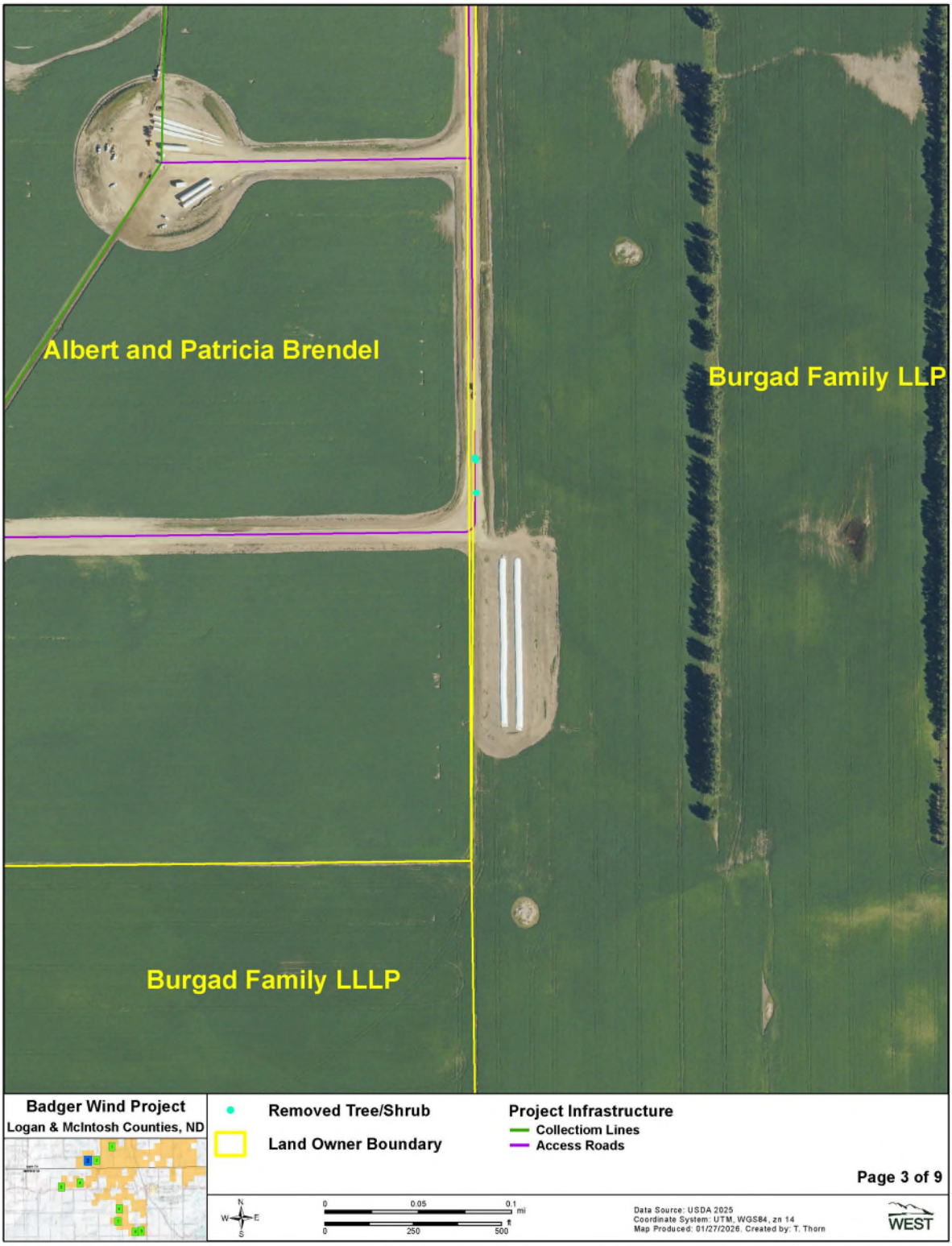


Appendix D1. Post-construction tree and shrub inventory results at the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.

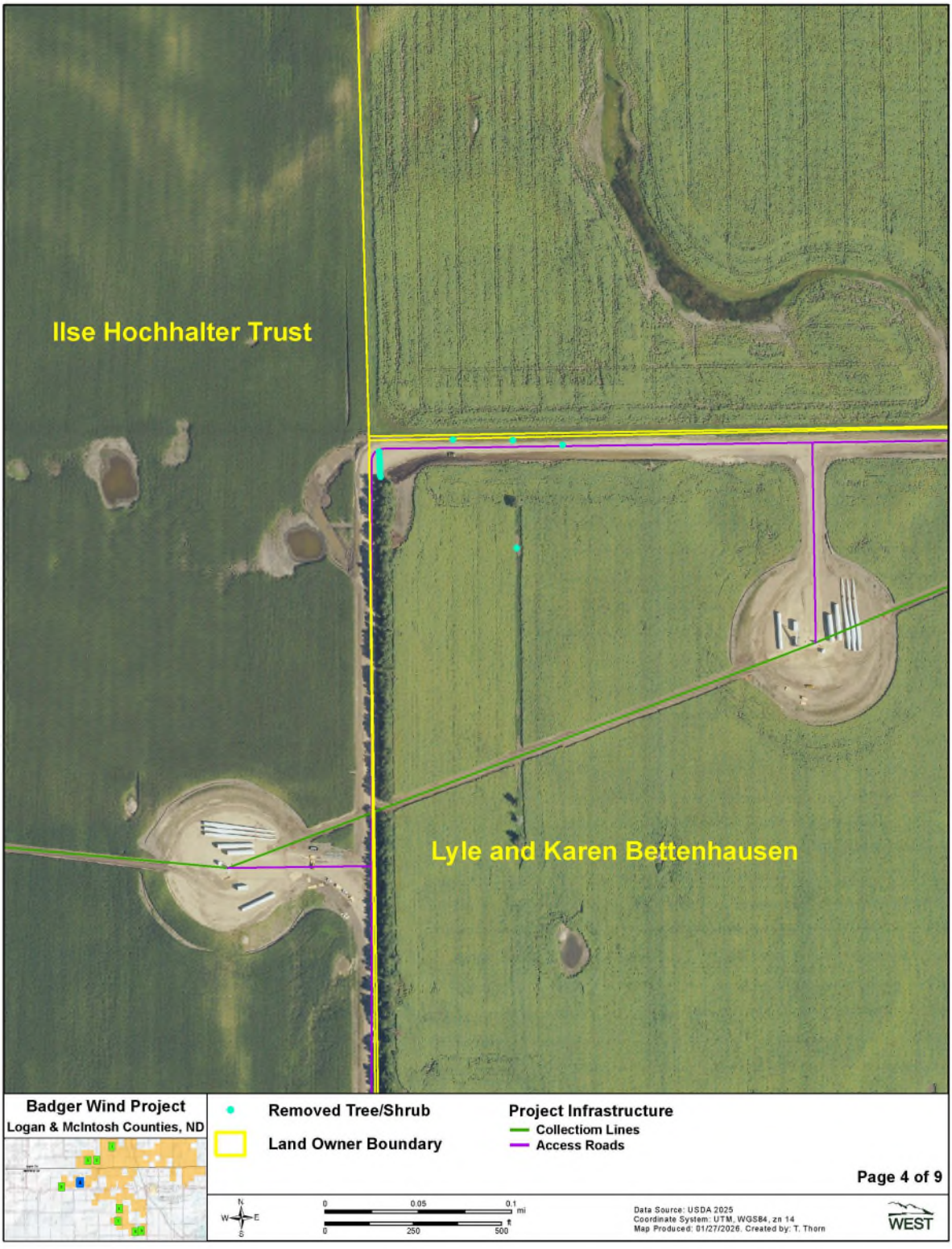
Appendix D2. Post-construction tree and shrub inventory results in the northern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



Appendix D3. Post-construction tree and shrub inventory results in the northwestern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



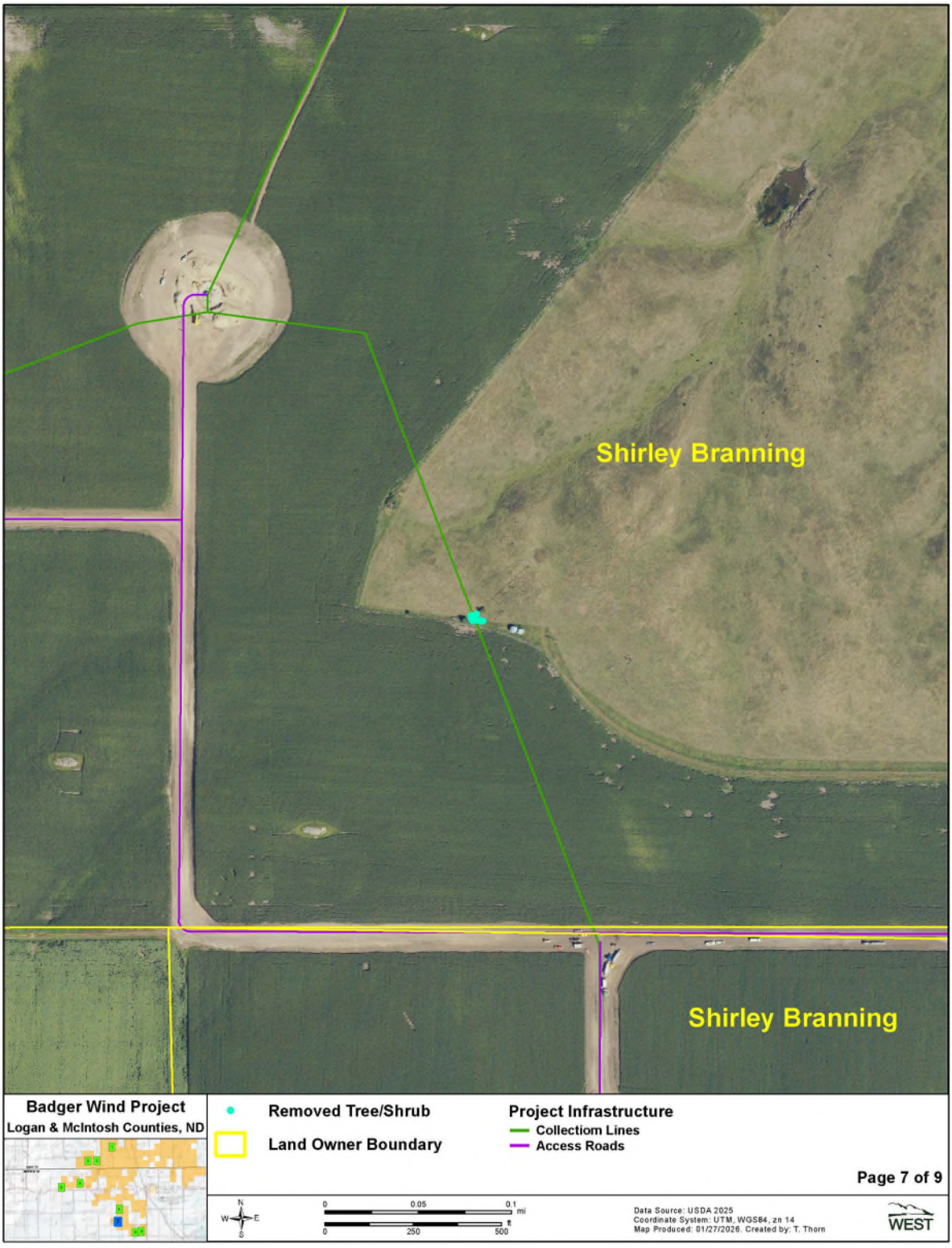
Appendix D4. Post-construction tree and shrub inventory results in the northwestern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



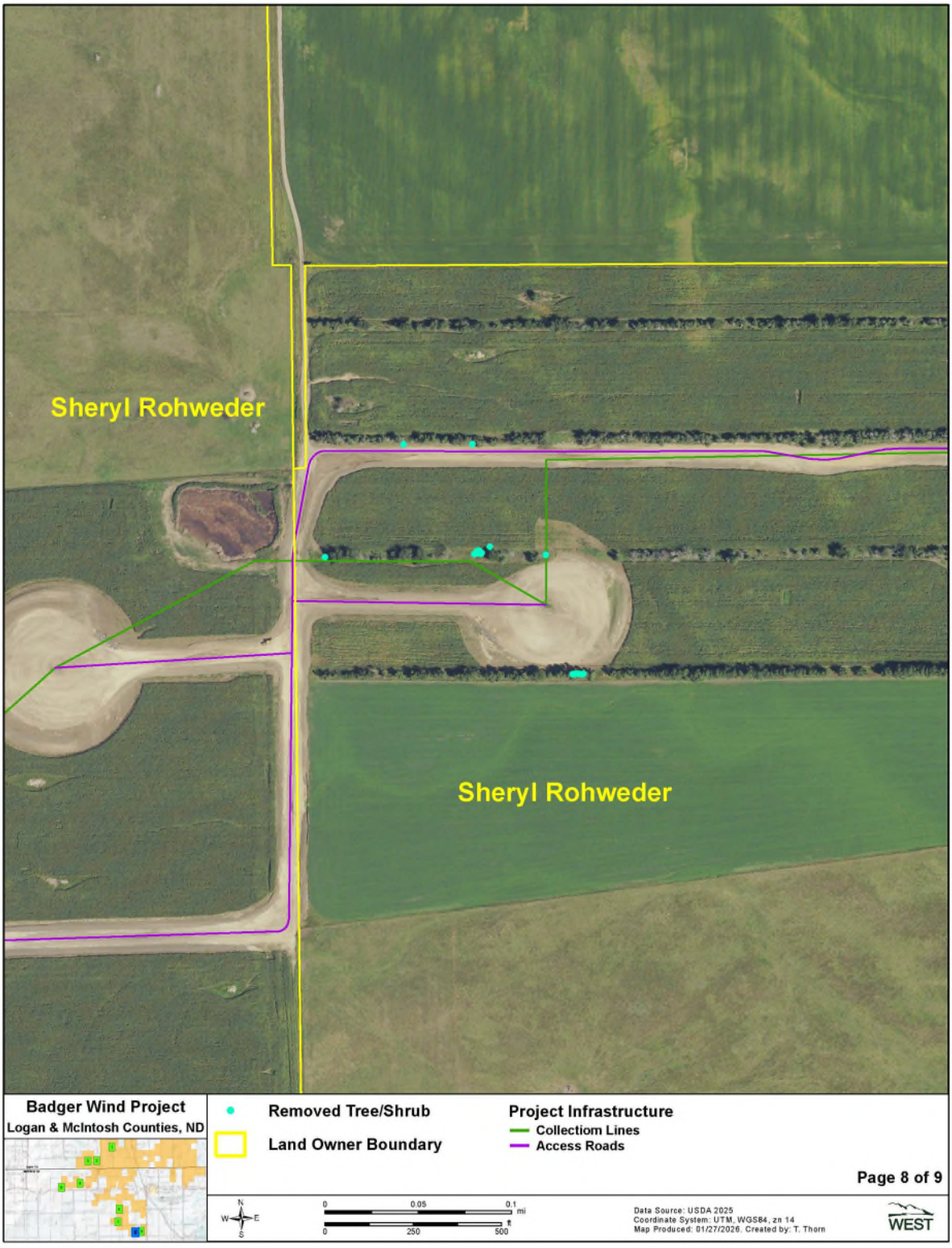
Appendix D5. Post-construction tree and shrub inventory results in the western region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.

Appendix D6. Post-construction tree and shrub inventory results in the western region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.

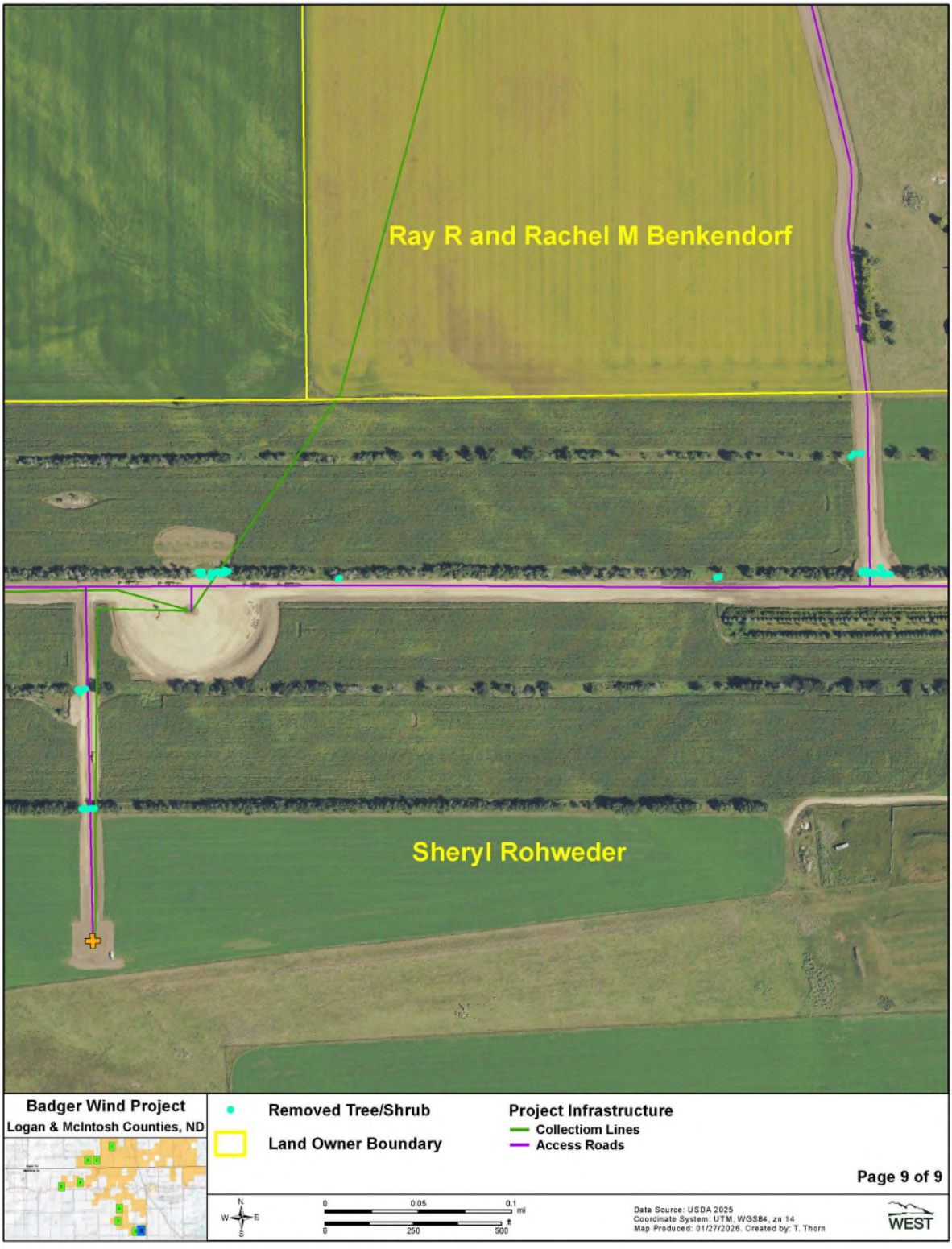
Appendix D7. Post-construction tree and shrub inventory results in the southern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



Appendix D8. Post-construction tree and shrub inventory results in the southern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



Appendix D9. Post-construction tree and shrub inventory results in the southern region of the Badger Wind Project, Logan and McIntosh counties, North Dakota, December 15, 2025.



Appendix D10. Post-construction tree and shrub inventory results in the southern region of the Badger Wind Project, Logan and McIntosh Counties, North Dakota, December 15, 2025.

Appendix E. US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) – North Dakota Field Office Technical Guide: Windbreak and Woodland Tree Care and Management

TREE CARE AND MANAGEMENT

This technical note provides guidance for establishing trees and shrubs as part of the following Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Practices:

Alley Cropping (practice code 311)
Recreation Area Improvement (practice code 562)
Riparian Forest Buffer (practice code 391)
Stream Bank and Shoreline Protection (practice code 580)
Tree/Shrub Establishment (practice code 612)
Upland Wildlife Habitat Management (practice code 645)
Wetland Wildlife Habitat Management (practice code 644)
Windbreak/Shelterbelt Establishment (practice code 380)
Windbreak/Shelterbelt Renovation (practice code 650)

The success of any tree planting is dependent upon site preparation, stock quality, planting and handling techniques, and maintenance employed by the planner, vendor, planter, and landowner. This document illustrates a wide variety of methods that have proven successful for conservation tree and shrub plantings in North Dakota.

TABLE OF CONTENTS

Subject Matter	Page
Windbreak Suitability Groups	2
Plant Stock Requirements	2
Storage of Stock	3
Care and Handling Requirements	3
Planting Site Preparation	4
Planting	8
Maintenance After Planting	11
Replanting	16
Preventing and Repairing Damage	16
Required Survival Percentage	19
Additional Information	20
Acknowledgements	20
Other Resources	20

WINDBREAK SUITABILITY GROUPS

Refer to "Expected 20-Year Tree Heights" in Section II - North Dakota FOTG to determine expected 20-year heights of trees and shrubs for the soils of each windbreak suitability group.

PLANT STOCK REQUIREMENTS

Planting stock must be grown from locally adapted seed or cuttings of known origin and meet height and caliper standards listed below. Planting stock should not come from sources greater than 200 miles away in latitude, 400 miles away in longitude, or 2,000 feet difference in elevation, unless long-term replicated field trials or extensive historical data indicate that the stock is hardy for a given location. "Planting stock sources" refers to the location where the plant naturally occurred or was propagated, not the location of the nursery from where it was purchased.

Bare Root Deciduous Seedlings shall not be less than ¼ inch caliper at 1 inch above the root collar. Bare root deciduous seedlings shall have a shoot (top growth) of at least 12 inches. Bare root seedlings should not be topped, unless untopped stock is not available. Rooted planting stock must not exceed a 2:1 shoot-to-root ratio (see Figure 1).

Bare Root Coniferous Stock shall be either 3-0 or 2-1 aged stock at a minimum (3-0 equals 3 years in a seedling bed; 2-1 equals 2 years in a seedling bed and 1 year in a transplant bed). Coniferous seedlings or transplants shall have at least a 6-inch shoot. Coniferous seedlings or transplants shall have a minimum stem diameter of 3/16 inch at 1 inch above the root collar. Rooted planting stock should have a well-developed fibrous root system and should not exceed a 2:1 shoot-to-root ratio (see Figure 1).

Vegetative Deciduous Cuttings shall be no less than ½ inch diameter at the base, have the apical bud and all lateral side branches removed, and produced in lengths long enough to reach a soil depth that remains saturated throughout the growing season, or the site must be irrigated (see Figure 7). Depth to the saturated zone must be determined before cuttings are ordered or harvested. In no case will vegetative deciduous cuttings be less than 10 inches in length. Tops of dormant-season-collected cuttings may be dipped in latex paint, paraffin or sealing wax to prevent desiccation and mark the top.

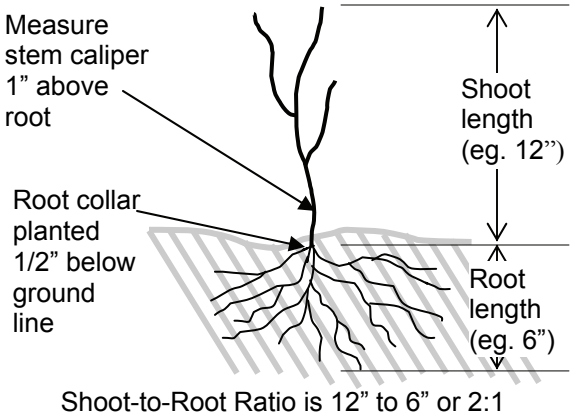
Vegetative material should be collected while dormant. Dormancy means no bud swell, no green showing on buds, and no separation of bud scales. Actively growing materials can be used, but survival will usually be lower.

Vegetative material works best if planted within 2 -3 weeks of harvest. Willow and cottonwood species can be stored up to 6 months. Proper storage consists of 34-38 degrees F with nearly 100 percent relative humidity. Storage in plastic bags will achieve the desired humidity. Care must be taken to prevent mold buildup. Do not allow stock to dry out for even short periods of time, as survival will be greatly reduced.

Container-grown Stock shall have a root mass of at least 7 cubic inches. Seedling height should be at least 6 inches. Container grown stock must be produced in containers that minimize girdling roots or J-roots.

Bare root seedlings, transplants, or container grown stock shall be dormant when planted. Avoid planting stock after bud break, except for bur oak and hackberry that have been sweated, or golden currant, common lilac, late lilac, Peking cotoneaster, and Tatarian honeysuckle. Container grown stock in gallon pots or larger may be planted after bud break, based on specific situations and individual requests of a variance.

Seeds shall be viable within the limits of the species. There is a large variation in seed quality between species. Some species of trees and shrubs have a high percentage of viable seeds that will easily germinate the first season



Shoot-to-Root Ratio is 12” to 6” or 2:1

Figure 1: Shoot/Root Ratio

after planting. Other species have seed that is very difficult to germinate. Even with proper scarification and/or stratification, some species exhibit only 2-3 percent germination 2 years after planting.

STORAGE OF STOCK

Rooted planting stock and cuttings will be stored in a cool, moist environment (34-38°F) or heeled into the soil. During all stages of handling and storage, keep stock free of mold, and roots moist and cool. Keep roots covered at all times. Evaluate stock that has been allowed to dry, heat up (e.g., within a bale, delivery carton or container), or that has developed mold or other problems. Destroy stock if there is any doubt as to the viability. Live cuttings that are not immediately planted after harvest shall be promptly placed in controlled storage conditions (34-38°F) and protected until planting time.

Seeds shall be stored in a cool (35-40°F), dark area. Depending upon the species, seed storage may require moist or dry conditions. Become knowledgeable of the duration of seed viability. Some species of seeds lose viability within months after maturity. Others, with proper storage, remain viable for years. To learn seed characteristics of a particular species, go to the Woody Plant Seed Manual. http://www.nsl.fs.fed.us/wpsm/ .

Landowners may keep stock for up to one week before planting by storing it in a shaded, cool, moist place. A basement or fruit cellar works very well. Plant bundles should be turned every day when temporarily stored to avoid mold and/ or drying problems within the bundle. Ensure roots are moist and not exposed to the air. Do not store in a bucket of water. Trees will commonly break dormancy (begin to leaf out) with this type of storage, resulting in poorer survival.

For longer storage periods, stock may be heeled in. This can be described as high-density planting in a furrow. Locate the heel-in bed in good soil in a protected location. See Figure 2 for details.

Cover roots quickly to minimize exposure to sun and air. Short periods of exposure can greatly reduce survival and establishment. Leaving plants in a heel-in bed for longer than one season increases the difficulty of transplanting and decreases survivability.

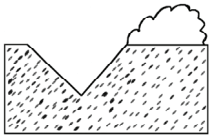


Figure 2A: Dig a trench deep enough for proper root placement.

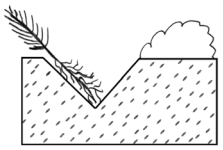


Figure 2B: Break bundles and spread along the trench wall with 2-3 inches between each plant.

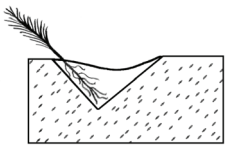


Figure 2C: Immediately cover roots with soil and lightly pack. Thoroughly soak the trench with water after planting to remove air spaces and improve root soil contact.

CARE AND HANDLING REQUIREMENTS

Roots of bare root stock shall be kept moist at all times during planting operations by placing in a water-soil (mud) slurry, super-absorbent (e.g., polyacrylamide) slurry, or covering with wet peat moss, wet shingle tow, or other equivalent material. Do not cover with dry shingle tow, peat moss, etc. and expect to thoroughly wet it afterwards. No matter the amount of water applied, some roots will remain dry.

The rooting medium of container or potted stock shall be kept moist at all times by periodic watering.

Pre-treat stored unrooted cuttings prior to planting by soaking in water for 24-48 hours. Note: There is some debate as to the effectiveness of soaking stored, unrooted cuttings prior to planting. However, soaking will not harm cuttings and may increase survivability.

Pre-treat bare root stock by soaking roots in water or polyacrylamide for several minutes before placing on the tree-planting machine. Keep roots moist and covered throughout the entire planting operation. To further reduce planting shock, stock could be carried during the planting process in buckets of water or slurry. Do not allow rooted conifer stock to be immersed for longer than one hour.

Stock shall not be planted when soil is frozen or dry. Do not handle trees or shrubs when temperatures are freezing or below.

Reduce exposure of bare root seedlings to air and sunshine while loading the planter and during the planting operation. Studies from South Dakota have shown that exposure of Scotch pine roots to air and sun on a 73-degree day for only 2 minutes resulted in 80 percent mortality.

Do not plant on hot, dry, windy days. Refer to Figure 3, Climatic Stress Chart, to identify suitable conditions for planting.

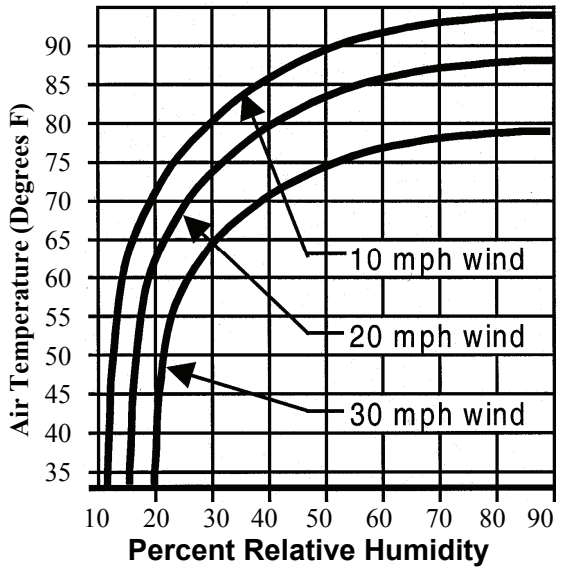


Figure 3: Climate Stress Chart

Cease planting when field temperature and humidity conditions fall above the curved line appropriate for sustained wind speeds at the site. As conditions approach those indicated by the appropriate wind speed line, use extra care to prevent desiccation of roots and tops. Site conditions falling below the appropriate wind speed line are generally considered good for tree and shrub planting. Cease planting when sustained wind speeds exceed 30 mph (miles per hour). To get a feel for changing climatic conditions throughout the previous day, go to the NDSU weather site at http://ndawn.ndsu.nodak.edu/.

Remove any wire or plastic ties that encircle the trunk or limbs of planted stock. If left on, they can girdle and kill the stem above that point as the stem increases in diameter.

Sweating Seedlings
Certain species such as bur oak and hackberry may require special preparation before planting, especially in cold, wet soils. These species have a tendency to not break dormancy without a "sweating" treatment. Trees that do not break dormancy during the first growing season will likely die.

Sweating trees is a simple process that usually requires nothing more than large sheets of plastic, large cardboard boxes and tape. One to two weeks before the trees are to be planted, remove them from the cooler. Line the cardboard boxes with a large piece of plastic. Place broken bundles of trees loosely in the plastic-lined box. Wet them thoroughly. Fold and tape the plastic together to make an air tight seal. Store the wrapped trees at room temperature, away from direct sunlight, for one to two weeks, checking to ensure they do not dry out.

Condensation should form on the inside of the plastic within hours, indicating a tight seal and that the process is working.

When properly sweated, the buds of these species will have swollen and in some cases broken open. Use extra precautions when planting sweated stock, especially if leaves are starting to emerge, because they are very sensitive to drying out during handling and the effects of hot dry winds immediately after planting.

PLANTING SITE PREPARATION

Planting sites shall be properly prepared based on soil and vegetative conditions listed below. Avoid sites that have had recent application of pesticides that may be harmful to woody species.

Check waiting period restrictions and carryover characteristics of pesticides applied to the planting site in the previous one to two years prior to initiating tree planting. If pesticides are used, apply only as needed within Federal, State, and local regulations. Follow label directions and heed all precautions listed on the container.

On sites treated with pesticides, especially tilled sites, be alert to health risks that may result from handling the chemically treated soil or breathing the chemically impregnated dust.

Do not plant trees where previously have been feedlots, manure piles, hay piles, or manure runoff without extensive soil testing to determine

salt and nutrient levels and chemical properties in the proposed planting area.

Site preparation may include the whole field, strips, or patches. Individual site preparation for each tree/shrub should provide a minimum 6-foot diameter circle, or a minimum 6-foot x 6-foot square, or a 6-foot wide strip at each planting spot (3 feet on each side of the planted stock).

The planting area must be free of living sod and perennial weeds before planting.

Tillage Site Preparation

Site Preparation by Tillage on Sod-covered Sites (or Sites With Perennial Herbaceous Cover)

Perform sufficient tillage to kill the sod and maintain the entire site in a reasonably weed free condition for one growing season prior to tree and shrub planting.

Nonselective herbicides may be used to kill sod grasses and other herbaceous species prior to tillage. Follow guidelines under "Chemical Site Preparation" and instructions found on the herbicide label.

Avoid tilling soils that are wet, to minimize compaction. Compacted soils can reduce rooting success and plant vigor.

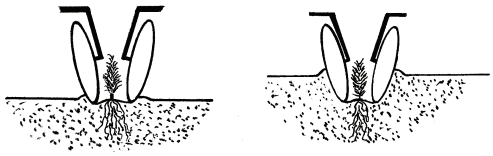
Be alert to potential wind and water erosion risks during the fallow period. Seed an annual cover crop of oats or spring grains to control erosion while minimizing water usage. Oats and spring grains will die over winter, but must be seeded early enough to attain 4-6 inch height prior to freeze up to provide soil protection.

For very erosive sites without rhizomatous grasses, (smooth bromegrass, canarygrass, Kentucky bluegrass, or quackgrass) and no plans for cover crops, till only 6-10 foot wide strips where the trees/shrubs will be planted while leaving and maintaining the existing vegetation between the rows. This will reduce wind and water erosion, sandblasting, provide easier site access, and provide wildlife benefits. The wider tilled area is appropriate for locations where weed control fabric is to be installed after the tree or shrub planting.

Orient tree and shrub plantings on the contour, when possible, to minimize water erosion risks during the fallow period and subsequent planting and maintenance operations.

Avoid deep tillage (greater than 2 inches deep) immediately prior to planting to prevent drying the seedbed.

Firm the seedbed prior to planting, if needed, to reduce soil moisture loss and aid in proper plant placement. A firm seedbed for tree planting should be similar to a firm seedbed for grass seeding where adult human footprints are barely visible and planting equipment leaves a minimal trench (see Figure 4).



This
Firm soil, plants at proper depth.

Not This
Soil too loose, plants pressed too deep.

Figure 4: Effects of Seedbed Firmness

Tillage Site Preparation on Cropland Sites

Shallow tillage immediately prior to planting to remove sprouted annual weeds and grasses is appropriate. Shallow tillage between harvest and freeze up the year before planting is permitted, if needed. Be alert to potential wind and water erosion risks during the fallow period. If needed, seed an annual cover crop of oats or small grains to control erosion while minimizing water usage. Oats or small grains will die over winter but must be seeded early enough to attain a 4-6 inch height prior to freeze up to provide soil protection.

Avoid excessive tillage prior to planting. Tillage is not needed or effective if there are no weeds present. Avoid drying the site with deep tillage.

Prior to planting, firm the seedbed, if needed, to reduce drying and to aid in proper depth placement of the plant and natural moisture movement within the soil. A firm seedbed for tree planting should be similar to a firm seedbed for grass seeding where adult human footprints are barely visible and planting equipment leaves a minimal trench (see Figure 4).

All precautions concerning erosion and sand blasting on sod-covered sites apply on cropland sites.

Consider tilling only 5-6 foot strips where the trees/shrubs will be planted (8-10 foot strips, if weed control fabric is to be installed after planting), thereby, allowing the standing stubble between the rows to act as temporary wind protection for new seedlings.

Scalp Planting Site Preparation

Scalp planting is a method that places plant material in an area cleared of competing vegetation. The area cleared is usually a foot or more wide on each side of the planted row. This operation is usually performed by attachments to the planting machine. It can also be done by other machines in a separate operation, or by hand immediately prior to planting.

Do not scalp plant into aggressive sods such as smooth brome, reed canarygrass, Kentucky bluegrass or quackgrass without additional weed control and site preparation treatments. Follow guidelines under "Chemical Site Preparation" and instructions found on the herbicide label before planting into sites with existing aggressive sods.

Scalping tends to encourage a rapid flush of annual weeds on the freshly exposed soil that will require a post-plant weed control effort.

When scalping on native range sites, orient plantings in locations that are most conducive to tree/shrub growth. Best tree growing sites are often found in toeslope positions, north facing slopes, or in swales and draws. Evaluate alternative locations to avoid establishing trees and shrubs on native range.

When possible, orient rows on a true contour to harvest runoff moisture and reduce erosion. Do not scalp into tilled sites.

Chemical Site Preparation

Chemical Site Preparation on Soddy Sites (or Sites With Perennial Herbaceous Cover)

Site preparation by herbicides on soddy sites should be initiated the growing season before planting. Troublesome species such as smooth bromegrass, Kentucky bluegrass, reed canarygrass or quackgrass, thistle, spurge, etc. may require multiple years of site prep before planting.

Follow label instructions so that application technique and timing of herbicide application will lead to a complete control of the vegetation. Repeated applications throughout the fallow year(s) are usually necessary. To improve herbicide coverage and effectiveness, bale or burn the area and allow fresh succulent regrowth. Apply herbicides at the proper time and rate to this regrowth.

For sites with rhizomatous grasses, (bromegrass, bluegrass, canarygrass, or quackgrass) completely spray the entire area where the trees/shrubs will be planted, including a 10-foot wide band around the outside of the planting.

On very erosive sites without rhizomatous grasses, (bromegrass, bluegrass, canarygrass, or quackgrass) and no plans for cover crops, completely spray out 5-6 foot wide strips where the trees/shrubs will be planted (8-10 feet where fabric will be applied) while leaving existing vegetation between rows. This will reduce potential erosion, sandblasting, provide easier access, and provide wildlife benefits.

Undisturbed dead sod often provides a season's weed control or suppression after the trees or shrubs have been planted.

Herbicides vary as to their risk of leaching or runoff. Avoid using herbicides with high runoff or leaching potential on sites where there is increased risk of polluting surface or ground water sources.

Chemical Site Preparation on Crop Fields

Apply appropriate burndown chemicals according to label directions prior to planting trees and shrubs, if needed.

Natural Regeneration Site Preparation

This procedure should only be attempted on sites within the 10-50 year floodplain of stream systems where adequate native seed trees or shrubs are within 200 yards of every part of the planting site and soils are suitable for tree planting. A healthy stand of cottonwoods or willows may be as far away as 1/4 mile from the seeding area. Stream systems where this could be attempted with a reasonable chance of success include:

- All perennial streams in counties bordering the Red River.
- Scattered segments of the Souris, James, and Sheyenne Rivers that meet flooding, soil, and seed tree requirements.

Perennial grasses should be controlled with herbicides and/or tillage prior to attempting this method of tree and shrub establishment. Riparian forest natural regeneration sites will tend to be very weedy due to large weed seed banks and high nutrient levels until tree canopies become thick enough to shade out the herbaceous vegetation.

Once herbaceous vegetation has been controlled, the site should be tilled to expose bare mineral soil just prior to seed dispersal from the tree species desired. Seed dispersal may occur from mid spring to late fall depending upon the species. During planning phases, determine dispersal times of the desired species to ensure timely site preparation. Besides direct on-site observation, the following source, "Woody Plant Seed Manual", can be used to determine likely seed dispersal times.

Consider leaving strips of vegetation perpendicular to flood flows to reduce scour erosion.

Installed Fabric Site Preparation

Fabric Site Preparation, All Sites

All instructions concerning fabric installation for weed control after planting apply when fabric is used for site preparation. Refer to “Synthetic Mulch (Fabric) Weed Control” under the maintenance section of this reference.

Installation of weed control fabrics as a form of site preparation can be very effective. When properly applied, it can effectively kill vegetation and store seasonal moisture ahead of planting.

Currently, planting trees/shrubs through the fabric must be done by hand; therefore, planting stock with compact root systems is most appropriate. Installing fabric the summer before planting, as a site preparation method, and using container-grown stock, can extend the planting season by 2-4 weeks.

Minimum fabric widths should be 6 feet (about 4 feet of weed control following installation by machine).

Rocks, staples, and/or soil must hold down fabric edges. It is essential that wind not be allowed under the fabric or it will be torn out of the ground. Staples or rocks should be spaced in the center of the fabric close to where the trees/shrubs will be planted the following spring.

When not using soil to anchor the fabric edges, staples, pins, or rocks must be placed every 3-5 feet along the edge. Do not use soil to hold down the fabric centers, as weeds will quickly become established on the soil spots, reducing or ruining the effectiveness of the fabric.

Fabric may be hand placed by anchoring the edges every 3-5 feet with staples, pins, or rocks. Every 10-15 feet a staple, pin, or rock should be placed in the middle of the fabric to prevent "billowing" by the wind.

After installation, fabric should be taut against the soil surface, reasonably level, and well anchored.

Fabric Site Preparation, Tilled Sites

The area to be tilled should be 2-4 feet wider than the width of the fabric, for those sites where fabric will be installed by machine. If the fabric will be hand placed, tillage need only be as wide as the fabric.

To facilitate hand planting, tillage should be deep enough to accommodate roots of the species to be planted the following spring.

Fabric Site Preparation, No Till Sites

Large amounts of grass and other herbaceous cover should be mowed and removed from the site before fabric installation to reduce the risks of rodent damage to the newly planted trees and shrubs.

Equipment modifications may be necessary if installing fabric by machine. Fabric laying machines may need to be “beefed up” in order to get good fabric placement and soil coverage on the fabric edges.

Tools used for planting must be able to easily penetrate untilled soils to the proper depth under the fabric. If easy penetration is not likely, use the “Fabric Site Preparation, Tilled Sites” method.

Native Grass Cover

Warm-season native grass species of blue grama, and/or sideoats grama may be seeded between tree/shrub rows to reduce erosion and runoff, prevent sandblasting, and improve wildlife cover.

When using native grasses between rows, it is essential a weed-free zone of at least 6 feet be maintained around each tree or shrub (3-foot radius around the trunk) for the first 3 years after planting. In areas with annual precipitation less than 16 inches, it is best to maintain the weed free zone for the entire life of the planting.

Warm-season native grass species sideoats grama and blue grama initiate growth after trees and shrubs have leafed out, reducing early season competition for water. These warm-season grass species are shade intolerant and will be suppressed as growing tree and shrub canopies shade the ground. In no case should a sod-forming cool-season grass such as smooth brome, canarygrass, bluegrass, or quackgrass be substituted for these species.

Warm-season grasses seeded between rows to control erosion and provide habitat. Note the chemical weed control within the rows.

Refer to Warm-Season Grass Cover Between Tree Rows fact sheet for detailed instruction on establishing the grass cover. Seeding grass during the prior year fallow period or seeding between rows after tree and shrub planting or fabric installation can minimize the potential conflict between grass seeding and tree planting dates.

Short warm season grasses are particularly effective between fabric strips. Without tillage between fabric strips, there is no risk of the fabric being hooked by a tillage implement and torn out. The following pure stand, drilled, seeding rates are to be used for designing the between row grass seeding

Blue grama 2.5# PLS (Pure Live Seed) per acre

Sideoats grama 7.5# PLS per acre

Broadcast rates must be 1.5 times drilled seeding rates.

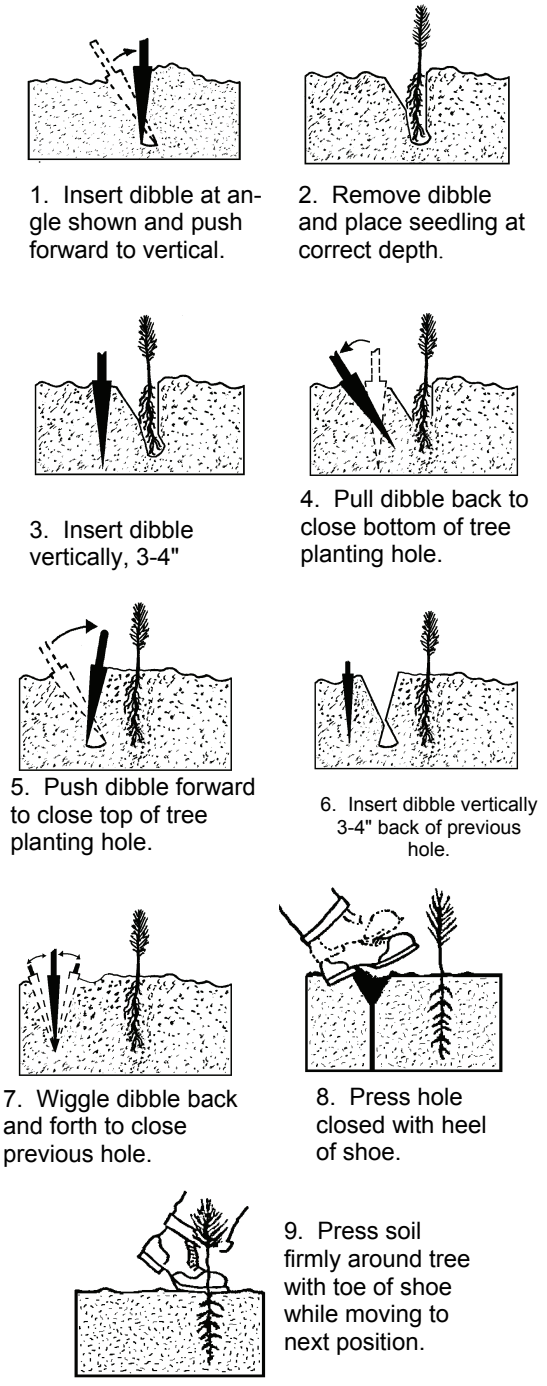


Figure 5: Hand Planting

PLANTING

Planting - All Sites Except Natural Regeneration and Direct Seeding

Plant only in the spring of the year after frost is out of the ground. All stock, except as noted, will be planted by May 31.

Extensions of these planting dates by 10 days may be made by the district conservationist, if local soil moisture and temperature conditions justify it and are documented. Before granting an extension, consider the cooperator's ability and willingness to address the greater need for supplemental watering, wind protection, and/or shade that may be necessary in the weeks immediately following a later planting.

Container-grown stock planted through fabric that has been properly placed a year in advance may be planted up to June 30. Refer to "Installed Fabric Site Preparation" for details. Before initiating a late June planting through fabric (past the cutoff date for all other plantings), ensure a minimum 2-foot depth field capacity soil moisture is present beneath the installed fabric and herbaceous wind barriers are at an effective height to protect the new planting.

Fall planting of trees and shrubs, excluding direct seeding, should not be attempted since consistent survival across the State has never been demonstrated.

Immediately after, or during planting of all stock, whether by hand or machine, pack soil firmly around each plant to eliminate air pockets. Proper adjustment and operation of the tree-planting machine will eliminate the need to pack the edges of tree rows with tractor tires or feet.

Planting - Bare Root Stock (Seedlings, Transplants, Rooted Cuttings)

Rooted stock will be planted in a vertical position with the root collars approximately ½-inch below the soil surface (see Figures 1, 4, 5, and 6).

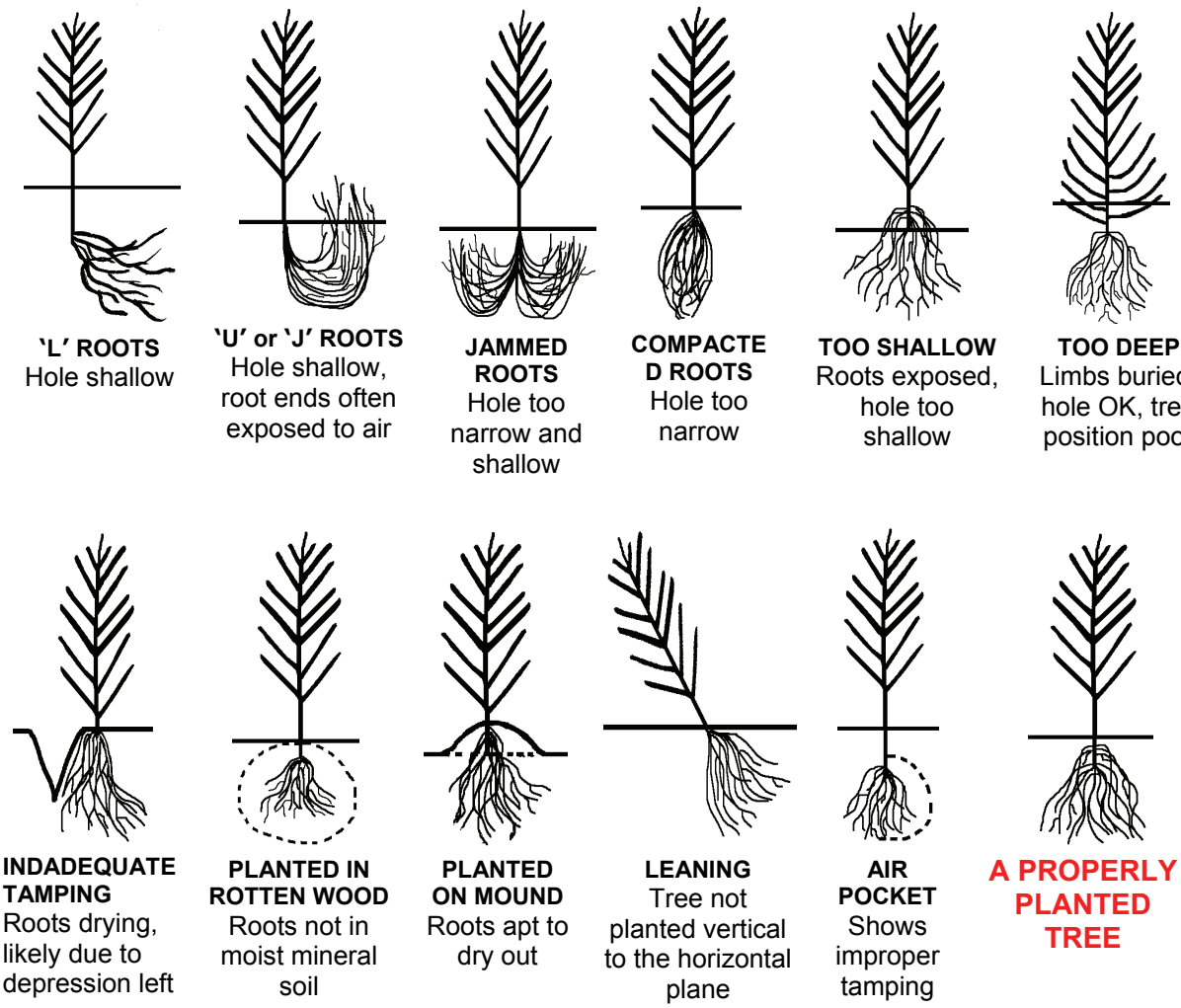


Figure 6: Examples of improperly planted trees.

The planting trench or hole must be deep and wide enough to permit roots to spread out and down without J-rooting or L-rooting. Trim straggly roots of bare-root stock as needed to prevent J-roots, L-roots, broken roots, or wadded roots that may result from "stuffing" too many roots into the planting shoe. Do not over trim roots (see Figure 6).

Planting - Unrooted Cuttings (Willow, Poplar and Dogwood Species)

Base ends of longer cuttings, or the entire cutting if smaller, should be soaked for 10-24 hours before planting. If cuttings have been stored for more than one week, recut the base end at a 45 degree angle to maximize water uptake. Cut back until the cut is in green tissue.

Planting may be by hydraulic jetting, hand dibbles, shovels, tree planters, or probes.

Insert cuttings to the depth required to reach adequate soil moisture with one to two buds sticking above the soil surface. (Note: Depth to growing season water table must be determined before obtaining cuttings to ensure cuttings are

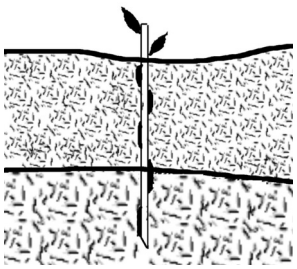


Figure 7: Unrooted Cutting

sufficiently long enough to reach the water table.) Make sure that the base end is planted down (see Figure 7).

When using shorter cuttings through a traditional tree-planting machine, ensure the soil is firmly packed against the cutting. Shorter cuttings may require supplemental watering to ensure survival and establishment during the first year.

When planting by hand, ensure the planting hole is large enough to prevent stripping or damaging the bark and buds.

Once the cutting is in the hole, ensure that voids are eliminated either by packing around the cutting or by using hydraulic jetting to prepare the planting hole.

When planting by hand, avoid excessive force that may kink or break the cutting.

Planting - Container-grown Stock

Remove container stock from the pots, blocks, wire baskets, etc. in which they were grown, if not already done by the nursery. Balled and burlap (B&B) stock can remain in the burlap ball but all ties must be removed from around the trunk and the burlap rolled back off the top of the ball, once placed at the proper depth in the planting hole.

Some potted or B&B stock may have developed girdling roots. If so, the root ball should be gently manipulated and the roots spread radially from the trunk of the tree. In essence, this becomes a bare root planting.

Container-grown stock should be planted so the

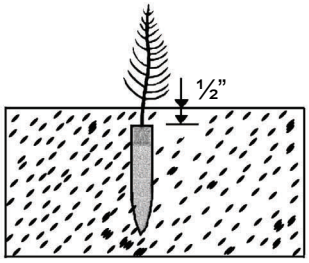


Figure 8: Container-grown planting depth

top of the root ball or plug is covered with just ½ inch of soil (see Figure 8). Some nursery practices result in several inches of soil covering the top roots in the pot. This excess soil should be removed so that proper root planting depths can be achieved. Planting too deep is detrimental to tree health for most species.

During planting, ensure the root ball stays moist. Do not soak in water.

Planting - Natural Regeneration

This method should only be attempted within the 10-50 year floodplain of the following stream systems.

- All perennial streams and tributaries of the Red River in the counties bordering the Red River.
- Scattered segments of the Souris, James, and Sheyenne Rivers.

At least 2 seed producing (nearly mature or mature) trees within 200 yards of the planting site are needed for species producing seeds with samara (wings). Healthy seed producing cottonwoods or willows may be as far as ¼ mile from the planting site. Species that have seeds with no samara (wings) or fluff, shall be within 50 yards of the planting site. Wildlife or floodwaters may bring in other species of trees and shrubs.

Natural regeneration sites, especially riparian sites, will be quite weedy for several years after seeding. High stem counts per acre (in excess of 10,000 trees per acre on some sites) will eventually shade out the weeds. Stem counts of 500-700 stems per acre will satisfactorily capture the site, if not browsed by wildlife, but weed pressures will last longer. High stem counts compensate for heavy deer browse.

Success of this method is dependent upon a good seedbed and seed crop at the appropriate time.

Refer to Natural Regeneration - Site Preparation for guidance in preparing the planting site prior to seed dispersal.

Planting - Direct Seeding

Until more data on the viability of this planting method in North Dakota becomes available, review and approval of each site, planting plan and maintenance schedule shall be obtained from the NRCS State forester.

This method should only be attempted:

- On high water table, run-on, or floodplain sites in the counties bordering the Red River.
- Between the 10 and 50-year flood elevations on scattered segments of the Souris, James, and Sheyenne Rivers. Each site's eligibility will have to be determined individually.

When using this method, it is best to utilize as many species as are available and suited to the site. Mortality and predation of seed will be extremely high with this method, so the amount of seed needs to be increased accordingly.

To determine the amount of seed needed, strive for 15,000 emerging seedlings per acre by the end of the first growing season.

Determine the percentage of each species to be in the mix.

Using purity of seed, amount of hard seed, and percent germination (usually available in seed production manuals), determine how much seed is needed. Example: For basswood to be 20 percent of a mix: 15,000 emerging plants x 20 percent of the stand / 80 percent purity / 2 percent germination / 3,000 seeds per pound = 62.5 pounds bulk seed per acre.

Tree seeds are very particular with respect to depth of planting. Tree seeds generally respond best when seeded to a depth of 1-3 times the diameter of the seed. For species such as quaking aspen or birch, this means they should be placed on the soil surface. For hackberry, basswood, ironwood, etc. plant 1/4 to 3/8 inch deep. Oak, walnut, and similar-sized seed should be planted 1-2 inches deep.

Understand the requirements of each species to know the best time to seed. Some species need a warm-cold-warm stratification period while others need a cold-warm stratification period. Some species such as white oak begin sprouting within days after falling from the tree in natural conditions. In other words, some species are planted in the summer, some in the fall, and some in the spring. For specific information about each species, look in the "Woody Plant Seed Manual".

MAINTENANCE AFTER PLANTING
Weed Control, All Methods

Competitive vegetation will be controlled for a 3-foot minimum radius around each plant for at least 3 years after planting.

To minimize erosion risks and to improve conservation and wildlife benefits, consider leaving, or planting non-sod-forming grasses such as blue grama or sideoats grama, outside the 3-foot minimum weed-free area. Utilize “patch” weed control methods to maintain a 6-foot diameter weed free zone around each plant or a 3-foot wide weed-free band along each side of each row. As the planting matures, the herbaceous vegetation strips will get narrower as the tree and shrub rows get wider, shading out the warm-season grass.

Only a few herbicides are available for controlling weeds on natural regeneration and direct seeding sites. Effective weed control on

these sites usually does not begin until the large number of tree seedlings form a canopy that will suppress the herbaceous weeds. Landowners should be made aware that these two planting methods will look weedy for five years or more.

Aggressive sod-forming grasses such as smooth bromegrass, Kentucky bluegrass, canarygrass, quackgrass, or deep rooted legumes such as alfalfa or sweet clover should be kept from the tree or shrub area for the life of the planting.

Provide a 10-foot wide weed-free zone around the entire planting to serve as a fire break, aid in weed control, and reduce perennial sod encroachment. In areas prone to erosion or to meet owner's wishes, this area could be planted to a fuel break of non-competitive grass and kept short with regular mowing. Fuel breaks provide excellent access for fire fighting personnel and equipment; however, by themselves, they usually don't stop wildfires during extremely dry and windy conditions.

For firebreak and fuel break design, refer to the Firebreak Design and Installation Guide in the North Dakota Field Office Technical Guide.

Where overland water flow may create a scour erosion hazard, orient the weed-free zones as nearly perpendicular as possible to the water flow.

Utilize mowing, herbicides, or tillage to prevent invasion of aggressive sod-forming grasses and weeds, throughout the planting, and until tree canopies begin to close. A sparse cover of annual weeds or grasses, outside the 3-foot wide weed-free zone, may actually benefit the windbreak by trapping snow, cooling the soil surface, and controlling erosion.

Weed control may be by tillage, herbicides, or fabric. When using herbicides, follow label instructions. Control of unwanted vegetation should continue until weeds do not threaten the growth and function of the trees and shrubs.

Damage to roots, trunks, and branches from herbicides, tillage, or animals can significantly reduce the vigor of the planting and make it more susceptible to disease and insect damage thereby shortening the life of the planting.

Mechanical Weed Control

Use caution when tilling around trees and shrubs. Poor tillage techniques (too deep, too close to the trunk) can damage trunks, limbs, and roots. Erosion that may result from indiscriminate tillage may remove several inches of soil exposing roots to severe damage by future tillage operations.

Use tillage only when needed to maintain or improve the health and vigor of the windbreak. Tillage, when weeds are not growing, wastes moisture and fuel and increases the risk of mechanical injury to trees.

Chemical Weed Control

Follow label directions when applying the appropriate herbicide to control weeds. Adhere to State or local rules that apply to herbicide applications on tree and shrub plantings.

Some approved herbicides are nonselective and will kill most weeds but must not come in contact with any part of the tree or shrub. Other approved herbicides prevent weeds from germinating or kill newly germinated weed sprouts but will not harm specific trees or shrubs.

Effectiveness of most herbicides used to control weeds in tree and shrub plantings is very sensitive to different application rates, considerably more so than the common herbicides used to kill weeds in lawns. Too little herbicide applied will not provide adequate weed control. Applying too much of some herbicides, or on the wrong soils, may damage or kill trees and shrubs.

Use herbicides only when needed to maintain or improve the health and vigor of the windbreak.

Organic Mulches

Organic mulches may include straw, wood chips, sawdust, chopped corncobs, grass clippings, or other organic byproducts. Mulches are most effective when maintained to the dripline of the tree or beyond. For newly planted stock, they should be placed in a 6-foot diameter circle around each plant to a depth of 2-4 inches. (Finer mulches should be placed to a settled depth of about 2 inches. Coarser mulches require a 3-4 inch depth.) When mulching shrub rows, mulch can be applied in a contiguous 6-foot wide band (3 feet each side of the plants).

Established perennial weeds and sods, must be killed through tillage or chemical prior to mulching. These weeds will grow through most mulches. Small annual weeds can be killed by

applying mulch. Rhizomatous grasses adjacent to the mulch will require regular maintenance as they will usually root into the mulch from the edges.

In situations of higher precipitation, frequent irrigation, or on tighter wetter soils, it may be appropriate to maintain a 4-6 inch mulch-free circle around each trunk to minimize potential trunk problems. In high moisture situations, mulch against the trunk may hold moisture and encourage bacterial growth resulting in bark injury, which could shorten the life of the tree.

Avoid mulches that may contain weed seeds and/ or grain as they may attract rodents. In some situations, seeds and grain in mulch will germinate and become a thick mat of competing weeds.

Lighter and finer mulches are prone to blowing away. Packing firmly with feet or water will increase resistance to blowing. On exposed sites with strong winds, this will still not be adequate. For extremely windy sites, use mulches with large-sized chips or a high proportion of long (10-16") twigs to “tie” mulch together and resist blowing.

Coarse shredded wood mulches such as those produced in tub grinders have ragged ends and tend to interlock. Though not as decorative, as wood chips or the fine shredded mulches, they tend to stay in place. On extremely windy sites mulch may have to be anchored with netting, or select an alternative form of weed control.

Maintaining standing small grain stubble, herbaceous wind barriers, or a growing crop immediately adjacent to the weed free zone prevents mulch blowout, transpiration losses, and harvests snow moisture.

Organic mulches should be reapplied as necessary to maintain weed control. As trees and shrubs mature, organic mulches should be expanded to the drip line. The larger area of weed control benefits the tree and mulch to the drip line reduces tree injuries from maintenance activities.

Synthetic Mulch (Fabric) Weed Control

Synthetic Mulch (Fabric) Quality - All Methods

Fabric shall be of such quality that the manufacturer warrants complete weed control for at least five years.

Fabric must be black or capable of preventing underlying plant growth. Ideally, it should be resistant to penetration by animal hooves. Fabric may be pin-punched plastic, solid polyethylene, woven polypropylene, or some other rot-resistant material. It must prevent plant shoots from pushing through from below.

Fabrics prone to puncture from hooves (pin-punched plastic, solid polyethylene, etc.) can be used only if approved through the ND-NRCS variance process. This is to evaluate effectiveness of this material over time.

The minimum width for continuous rolls of fabric applied by machine will be 6 feet, nominal 4-5 feet weed control width after installation. Individual fabric pieces shall be 6 foot square or 6 feet in diameter. (Research studies have shown that fabric squares less than 4 feet x 4 feet improve growth and survival of trees no more than if no fabric was applied.)

Consider not using fabric on suckering shrubs where a dense thicket is desired or enlarge fabric openings, as illustrated in Figure 12, once plants are established (in or about the third year after planting).

Consider searing or sizing fabric edges on home-cut individual squares of woven fabric to prevent fabric edges from running or being hooked by maintenance equipment.

Fabric Installation - All Methods

Tilled sites should be firmed and leveled in such a way that the fabric will lie flat against the ground across the entire area covered by fabric. Sites should be firmed to barely show an adult foot print, prior to planting.

Improper Weed Control Fabric Installation	Proper Weed Control Fabric Installation
Tree planted in a furrow. Fabric bridged over limbs. Creates an “oven”. Plants killed by heat.	Fabric flush to ground. All limbs above fabric. Trunk kept cool. No rodent runs.

Figure 9: Improper and Proper Fabric Installation

Fabric should not be bridged over ridges or valleys left by planting operations. Fabric not

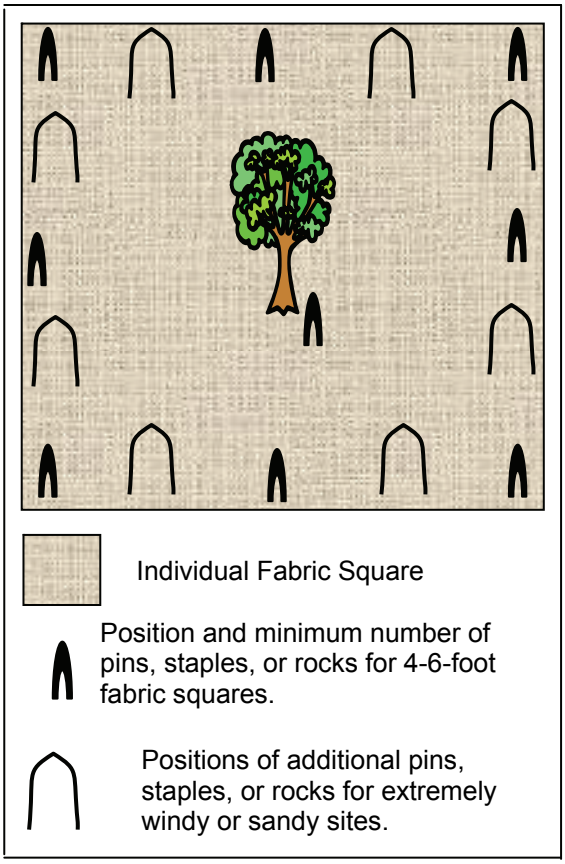


Figure 10: Positions of Pins, Staples, or Rocks for Individual Fabric Squares

flush to the ground around the tree can provide a runway for rodents and trap summer heat sufficient to damage or kill the young plant (see Figure 9).

If a planting trench exists at fabric installation, ensure that the fabric is weighted, pinned or stapled to the bottom of the trench at each tree. The fabric lined trench will funnel runoff to the individual trees in some situations.

If fabric is installed under a no-till situation, excessive vegetation should be removed from the area where fabric will be placed, to reduce rodent habitat and to allow fabric to lie flat against the soil surface.

Openings for trees or shrubs shall be cut with a sharp instrument to avoid tearing of fabric or "running" of individual fabric fibers.

Openings shall be X, C, L or J-shaped. Length of slit should not exceed 12 inches. Do not use I-shaped (straight) slits as abrasion of tree bark can occur.

When fabric is placed over plants before openings are made, use care to avoid cutting the plant when making the opening. Trees and shrubs must be pulled through the fabric within minutes after installation to avoid damaging temperatures created by the fabric "oven."

Ensure fabric edges are firmly anchored.

Fabric is not recommended within floodplains. One flood event could cover the fabric with silt, eliminating its effectiveness, or flood flows could tear out the fabric and trees caught in the fabric.

Do not cover weed control fabrics or plastics with organic mulches. These materials will delay the breakdown of the fabric or plastic, possibly causing damage to the plant, and provide a medium in which weeds can flourish.

Installation of Individual Fabric Pieces

Individual fabric pieces shall be at least 6-foot square or 6-foot in diameter.

Use landscape fabric staples, pins, or rocks to anchor fabric. Do not use soil to anchor individual fabric pieces. Individual rocks should weigh at least 5 pounds to resist being moved by wind or water.

Six-foot squares shall have each corner and the midpoint of each side anchored, as well as a point near the tree or shrub (see Figure 10).

Pins or staples shall be of sufficient length to resist movement, based on soil textures. Follow manufacturer recommendations for staple length.

Installation of Continuous Fabric Strips.

Site preparation, if tilled, shall be at least 10 feet wide to allow enough loose soil to properly anchor fabric.

Fabric strip splices shall be anchored with staples, pins, or rocks. Staples and pins shall be of a length recommended by the manufacturer for the particular soil texture. Rocks must weigh at least 5 pounds. Do not anchor splices with soil. When splices are made with field-cut fabric ends, consider tucking a few inches of the cut end under itself to reduce the risk of snagging the fabric with maintenance equipment.

In lighter soils, or in high wind areas, pins, staples, or rocks may be needed to anchor the fabric at each opening. On extremely vulnerable

sites, an additional pin, staple or rock may be needed every 10 feet or between each tree, whichever is greater (see Figure 11).

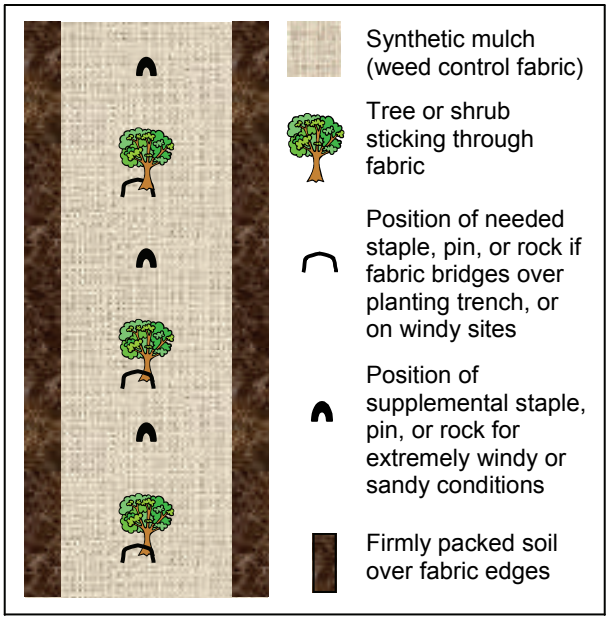


Figure 11: Positions of staples, pins, or rocks for continuous fabric strips.

Machines must be adjusted to ensure 10-12 inches of fabric edge is firmly anchored in the soil (see Figure 9). After installation, it is often necessary to run a tractor or truck wheel over the edge of the fabric to get a firm seal.

Check-dams across the furrow or slight grading of the site may be necessary on sloping land to prevent water from running along the edge of, and uncovering the fabric.

Where fabric crosses larger waterways or areas of concentrated flows, the fabric shall be spliced on either side of the waterway. This is to prevent heavy runoff events from washing out an entire strip of fabric and potentially damaging 300-500 feet of tree row. The smaller spliced section may still wash out, but only a small amount will have to be repaired or replaced.

Pins or staples, instead of soil, may be used to anchor fabric edges. The fabric must lay flat against the soil and the pins or staples must be placed every 3 feet, along the fabric edge. On sites exposed to extremely high winds or on loose soil, pins or staples may need to be closer than 3 feet.

When installing fabric on curves, use extra care to ensure that 10-12 inches along each edge gets covered and packed with soil. Ensure the fabric is not so tight that temperature changes pull the fabric loose. Use pins, staples, or rocks to tack excessively large "puckers" to prevent wind damage. Even when covered with soil, outside edges of curves may need to be pinned or stapled.

Where fabric is desired on a curved planting with a short radius, it may be better to break the curve into short, straighter segments to ensure better quality and easier fabric installation.

Management of Fabric Following Installation

While annually checking the survival, vigor, and form of trees and shrubs, inspect the fabric to:

- Ensure all fabric edges are firmly anchored.
- Ensure openings in fabric are not damaging trunks. Enlarge as needed (see Figure 12).

Remove weeds, soil, or clippings that may have accumulated on the fabric before they become a rooting medium for weeds.

If tilling between fabric pieces, use extreme caution to avoid hooking fabric with tillage tools. Damage to trees and/or fabric may result. Control erosion in tilled areas to prevent silt from accumulating on fabric.

If mowing between fabric pieces, do not allow herbaceous matter (grass clippings) to accumulate on the fabric. Such accumulations will initiate germination of weeds and grasses, reducing the usefulness of the woven types of fabric.

Strongly rhizomatous grasses, such as bromegrass, quackgrass, or canarygrass along the perimeter of the fabric piece should be suppressed or controlled with mowing or herbicides. If not controlled, their extensive root systems will suppress tree growth, even with fabric. They will also crowd over the fabric edge, eventually covering most or all of the fabric.

Edges of fabric could be seeded to nonaggressive warm-season grasses such as blue grama, or side oats grama to help anchor the edge of the fabric and to control annual weeds immediately adjacent to the fabric. Refer to “Native Grass Cover,” pages 7 and 8 of this reference, for warm-season grass establishment details.

Every few years, closely examine the areas where plants grow through the openings to ensure the fabric is not girdling the plant. Fabric in the shade of the plants will last much longer than the manufacturer's minimum life span. Fabric openings may have to be enlarged as tree stem diameters increase to prevent girdling and death of the tree. A sharp knife on a long handle, or a similar tool, will work well to enlarge openings. Four slits regularly spaced and radiating from the existing opening will expose additional growing space (see figure 12). This method is also effective in encouraging profuse suckering from suckering shrubs.

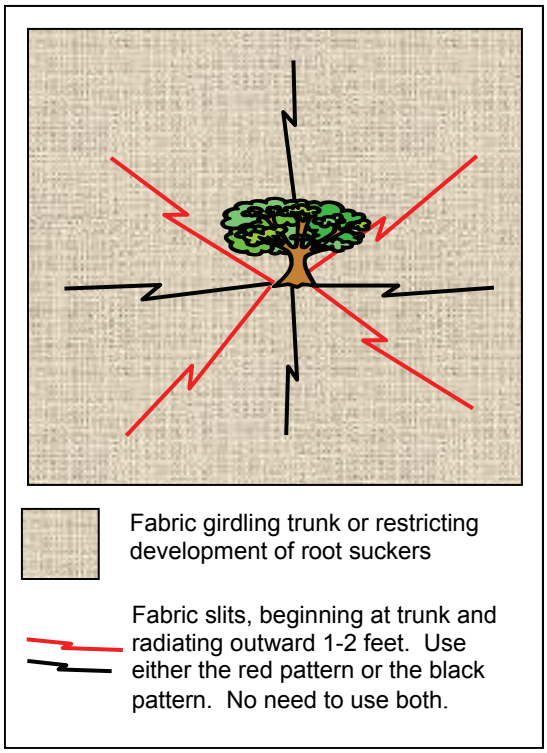


Figure 12: Enlarging fabric openings to prevent girdling or encourage root sprouts

Partial or complete removal of fabric after 5-7 years may be appropriate, subject to rules of financial assistance programs. If removed, regular mowing or chemical weed control should be applied to the area of the removed fabric. Do not use tillage weed control methods after fabric removal as severe root damage is likely.

REPLANTING

Any tree or shrub that fails within the first 3 years should be replaced with a similar plant.

Replanting is essential to maintain the intended function of the planting and should be compatible with soils and climate. Growth rates of most replants (when replanted within 3 years of the original planting date) are usually such that little if any size difference is noted, across the planting, after 10 years. Delays in replanting of longer than 3 years will allow adjacent established tree roots to create greater competition to the replants, resulting in slower growth. On some sites with older established plantings (over 15 years old), replants rarely put on substantive growth nor function as desired.

PREVENTING AND REPAIRING DAMAGE

For All Plantings

Inspect planting annually to spot weather and animal damage needing repair, plants needing replacement, fabric or mulches needing repair, weeds needing treatment, or insect and disease threats that may be developing. Time of the inspection will depend upon the potential for a particular threat, but early spring is a good time to spot most problems.

Supplemental Watering

Tree and shrub plantings should be planned for specific site and soil conditions. During the first three years after planting, supplemental water may be beneficial. In the absence of timely rains add 5 gallons per week to each plant. For year 2 and 3 after planting, apply 10 gallons to each plant every other week. For extreme drought conditions after year 3, add 10 gallons per stem diameter inch, measured 1 foot above the ground, once to twice per month. For more details, refer to the Tree Water Management Fact Sheet.

Weeds

Controlling weeds reduces plant stress and makes the plant less susceptible to certain types of insect and disease damage and better able to withstand weather extremes. Pay particular attention to aggressive sod-forming grasses and State listed noxious weeds. For more detailed information, see:

Weed Control in Tree Plantings

Herbicide Weed Control in Windbreaks and Shelterbelts

Synthetic Mulch (Fabric) Management

Tillage for Weed Control in Windbreaks and Shelterbelts

Warm-Season Grass Cover Between Tree Rows

Insects and Diseases

Inspect plantings at least annually to determine if insects or diseases are threatening the planting. The following texts (links) provide diagnostic and treatment options for many of the disease and insect pests found in North Dakota. Further assistance is available from county extension directors or urban foresters.

Insect and Disease Management Guide for Woody Plants in North Dakota

Deciduous Tree Diseases

Common Insect Pests of Trees and Shrubs in North Dakota

Common Insect Pests of Trees in the Great Plains

Diseases and Related Problems of Evergreens

Animal Damage

In parts of North Dakota, deer, beaver, moose, and porcupines have devastated tree and shrub plantings. Hunting, dogs, fences, repellents, and protective shelters have all been used with varying amounts of success. Methods of control vary considerably depending upon the plant species being damaged, the pest causing the damage, and the value of the woody plants. Contact your county extension agent or your local soil conservation district office for specific control measures that may have worked locally.

The following document summarizes the control methods for deer in North Dakota:
Protecting Trees and Shrubs From Deer

For the most complete reference on wildlife damage and control in North America, refer to Prevention and Control of Wildlife Damage by Hygnstrom, Timm, and Larson, and published by the University of Nebraska Cooperative Extension Service.

Yard and Agricultural Pesticides

Many yard and agricultural pesticides are damaging to trees and shrubs. Misapplication of pesticides may not initially kill trees or shrubs. Depending upon the concentration, the product may kill the plant a few months later, or stress the plant so that it is not able to withstand stresses such as drought or frost several years after the misapplication. Regular sub-lethal doses of pesticides to trees and shrubs, as often happens to field windbreaks, make trees and shrubs even less able to withstand stresses of frost, drought, or weeds. When applying these products adjacent to woody plantings, be alert to wind and temperature conditions and be fully knowledgeable of the label restrictions and precautions for each product applied. Second only to weeds, misapplied pesticides damage more trees than any other cause.

Weather

Other than keeping the plant healthy, there is not much one can do to prevent weather problems, however, when weather damage is swiftly corrected, subsequent storms are less likely to cause further damage. Proper selection of species for the site and individual plant placement within a planting may reduce weather-related problems such as snow and ice breakage, wind throw, or drought. See details on pruning below for correction of weather damage.

Protective Tree Shelters

A wide assortment of tree shelters exists in the market place. They range from 1 foot tall to 6 feet tall, from solid tubes, to flat sheets that fold into tubes, to plastic meshes. All are effective in preventing certain kinds of damage.

One of the more common tree shelters in North Dakota consist of tubes, or flat sheets that fold into tubes, that range from 2-6 feet in height and form a 3-5 inch cylinder around the tree. These shelters protect the tree from wind, sun, small mammals, rodents, and deer, encourage faster initial growth, and provide an opportunity for much easier herbicide applications. Five-foot or taller shelters are most effective at preventing deer browse. Deer may still browse plants at the top of the 5-foot tubes, but trees can usually grow past the browse risk.

Tubes are usually tied to wood stakes with plastic ties. Tubes should not be removed for several years after the tree has emerged from the top of the tube. This period of time is needed for the tree to develop adequate stem diameter to withstand wind. Removal of the tree shelter just as the tree reaches the top of the tube will often result in a tree that "lays on the ground" or is broken off at the first strong wind.

There may or may not be merit in raising the tubes a few inches off the ground in the fall to help the tree "harden off." There is no conclusive evidence to indicate one way or the other. If there were value to raising tubes in the fall, it would probably be most beneficial on tree species planted outside their native range of occurrence. If there is a desire to assist tubed trees in hardening off for the winter, lift the tubes about 6" at the first of October, and return them to the soil surface at the end of October. Some manufacturers offer vented tubes that eliminate the need to raise and lower tubes.

Manufacturers should warrant the tubes for at least 3 years before they start breaking down from ultraviolet light. Follow the manufacturer's instructions for installing specific brands of tubes.

After tubes have served their purpose, the tubes, ties, and stakes must be removed to prevent mechanical injury to the growing tree trunk.

Pruning

When applied in a timely manner and properly completed, pruning can greatly improve the life and function of trees and tree plantings. As explained in the references below, there are certain times of the season that are more beneficial for pruning certain species. Generally, pruning is best for the tree when conducted during the dormant season (after leaves fall.)

For most homeowners, however, if the desire to conduct a quality-pruning job has struck, it is best to prune at that moment rather than wait for the "best" time to prune. Quite often, the desire to prune may not strike for another decade and the size of the pruning job and the stress to the tree will have grown exponentially.

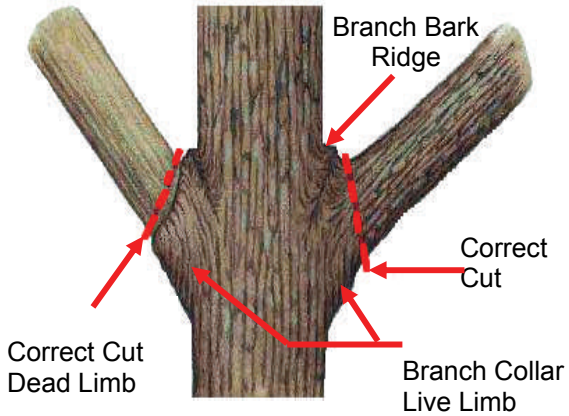


Figure 13

For pruning storm damage, it is best to prune soon after the storm to reduce the area of jagged open scars and potential for disease or insect attack. Another reason to prune storm damage immediately is to reduce hazards to life and property from weakened and damaged trees. Attempt only those pruning jobs commensurate with skills, experience, and equipment of the person doing the pruning. Pruning can be hazardous to those not properly prepared.

The branch bark ridge (see Figure 13) is a raised ridge on top of the limb between the main trunk and the limb. It is a good indicator of the proper pruning position. The branch collar is a slightly swollen area around the base of the limb where it attaches to the trunk. The branch collar contains specialized cells that help the wound to close after a pruning cut. The branch-bark ridge and the branch collar are excellent guides for properly locating pruning cuts. Avoid damaging the branch collar or branch-bark ridge, as the wound will take much longer to callus over.

In most cases, weather and animal damage resulting in broken, scarred or twisted limbs, along with double leaders can be easily corrected with a hand pruner (see Figure 13). Generally, trees should be trained to have a single main stem without v-shaped branch angles on the main trunk. Double leaders and weak branch angles leave a tree susceptible to subsequent breakage, loss of function, and decreased life.

More detailed instructions can be found in: "Pruning Trees and Shrubs"

"Tree Shrub Pruning," conservation practice in Section IV, North Dakota Field Office Technical Guide

Staking

Most newly planted trees shorter than 5 feet in height do not need staking. For those with smaller root balls or those greater than 5 feet in height, the following diagrams illustrate 2 staking methods. Trees should not be staked for more than 2 years, in most situations. Tree trunks need to develop wind hardiness, which is not possible when tightly staked for longer periods of time.

Figures 14a and 14b illustrate two different ways of staking trees. Wires and ties used in staking should not be so tight that the tree can not move

at all. Some movement is desirable. Stakes are to restrict movement during high winds that could uproot the tree.

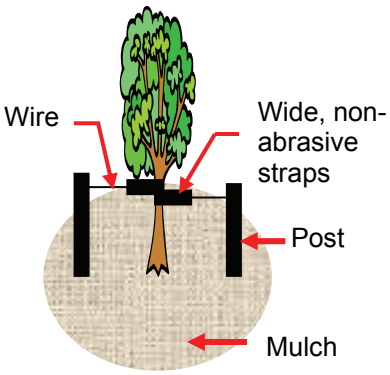


Figure 14a: Staking With Two Posts

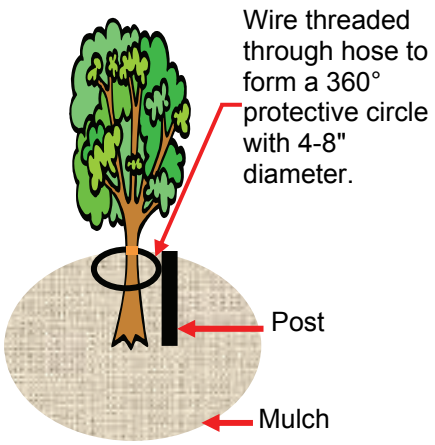


Figure 14b: Staking With One Post

Tipped Trees

Trees older than 5-10 years that have been tipped due to high winds and saturated soils can rarely be pulled back straight. If most of the main roots have not been broken or torn, the trees may stabilize at their new "angle" and continue to grow well. Many will appear straighter with time, but part of the trunk will likely still have a crook.

If roots have been broken and torn, or root balls have been tipped from the soil, establish a new windbreak or tree planting and remove the damaged trees when the new planting becomes effective. If the damaged trees are a hazard, or mostly dead, then immediate removal is appropriate.

Younger trees that have been tipped in saturated soils can be guyed immediately after the storm while the soil is still saturated. Use wide, nonabrasive straps around the trunk and do not pull so much that trunk damage occurs. It may be necessary to complete the straightening over several months.

In short, if the tree is healthy on the right site, they rarely tip. If the tree is unhealthy on a poor site, tipping and other storm damage is more likely and the ability to repair storm damage is greatly diminished.

REQUIRED SURVIVAL PERCENTAGE

To determine when a planting can be labeled a success, refer to **Table 1**. Required survivability of individual plants will vary as the purpose of the planting varies. Wildlife plantings can function perfectly well with considerably more missing trees and shrubs than can a windbreak.

Table 1 - Required Survival Percentages For a Successful Tree Planting
Inventoried after "leaf out" during spring or summer of the second year (% of number planted)

Practice	Percent Survival
380 - Windbreaks / Shelterbelt Establishment	85% of all trees or shrubs planted with no two adjacent plants missing
Sound Barrier	
Visual Screen	
Airborne chemical drift	
Wind borne dust barrier	
Living snow fence	
311 Alley Cropping	
391 Riparian Forest Buffer	75% of all trees or shrubs planted
612 Tree / Shrub Establishment	
580 Streambank/Shoreline Protection	50% of all trees or shrubs planted, unless specific sites require a higher survival percentage
644 Wetland Wildlife Habitat Management	
645 Upland Wildlife Habitat Management	

Additional Information:

Please note that all links in this document were current at publication. If you find a broken link contact North Dakota NRCS at 701-530-2082.

Most tree care and management is the same as it was decades ago. However, the science is constantly changing. Newer styles of weed control fabric are being researched and tried. Herbicides are constantly changing. New species are being released on a fairly regular basis.

For now we face the continuing battle with Dutch Elm Disease. Gypsy moth is a constant threat to our hardwoods, if it ever becomes established in the state. Emerald ash borer looms big on the immediate horizon and is likely to have a serious detrimental effect on urban and rural forests. Other insects and diseases exist and can have devastating effects on individual forest resources.

Keep abreast of changing conditions by attending workshops given by agencies, universities, and nurseries. Direct forestry concerns and questions to foresters with the State Forestry Agencies, State Universities, US Forest Service, Urban and Community Forestry Departments or the Natural Resources Conservation Service.

Acknowledgements:

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Other Resources

Riparian/Wetland Project Information Series No. 17, "Waterjet Stinger: A tool to plant dormant unrooted cuttings of cottonwoods, dogwoods and other species."

Weed Control in Tree Plantings

Windbreak Establishment, University of Nebraska Extension EC 91-1764-B

Windbreak Management, University of Nebraska Cooperative Extension EC 96-1768-X

Windbreak Renovation, University of Nebraska Cooperative Extension EC.98-1777-X

North Dakota Tree Handbook

Synthetic Weed Control Fabric Advantages and Disadvantages

Emerald Ash Borer

Tree and Shrub Characteristics

Expected 20-Year Tree Heights and Windbreak Suitability Group Descriptions

Appendix F Landowner Waivers for Tree and Shrub Replacement at the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Waivers are still in the process of being obtained from two landowners (Green Acres LLLP, Lyle and Karen Bettenhausen). These will be provided as a supplemental filing once obtained.

Appendix G. Tree and Shrub Replacement Quantity and Species by Landowner at the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix G. Tree and shrub replacement quantity and species by landowner or alternate recipient for the Badger Wind Project in Logan and McIntosh counties, North Dakota.

Landowner	Alternate Recipient*	Number of Removed Trees	Number of Removed Shrubs	Number of Replacement Trees	Number of Replacement Shrubs	Tree and Shrub Species Requested	Total of Each Species
Albert and Patricia Brendel	N/A	1	0	3	0	Ponderosa pine and Rocky Mountain juniper	2, 1
Clyde and Anna Meidinger	N/A	35	1	90	0	Ponderosa pine and Rocky Mountain juniper	60, 30
Green Acres LLLP	Phillip Wanner	0	3	8	0	Rocky Mountain juniper	8
Burgad Family LLLP	N/A	3	16	43	5	Green ash, common lilac, and Ponderosa pine	5, 5, 38
Lyle and Karen Bettenhausen	Jeremy Herr	16	0	40	0	Green ash and Rocky Mountain juniper	20, 20
Sheryl Rohweder	N/A	92	6	245	0	Ponderosa pine and Rocky Mountain juniper	123, 122
Shirley Branning	N/A	21	3	30	30	Common lilac, Rocky Mountain juniper	30, 30
Total		**168**	**29**	**459**	**35**		**494**

*Alternate Recipient is the individual delegated by the Landowner to receive all or some replacement trees if the landowner opted not to have all or some trees replanted on their property.

N/A – not applicable

Appendix H. Tree and Shrub Planting Parcel Locations for the Badger Wind Project in Logan and McIntosh Counties, North Dakota

Appendix H1. Trees will be replanted on the parcel shown above to mitigate for trees removed from land owned by Albert and Patricia Brendel.

Appendix H2. Trees will be replanted on the parcel shown above to mitigate for trees removed from land owned by Clyde and Anna Meidinger.

Appendix H3. Trees will be replanted on the parcel shown above to mitigate for trees removed from land owned by Green Acres LLLP. Green Acres LLLP (Troy Lippert) waived the right for tree replacement on their property and requested that trees be replanted on the property of Phillip Wanner (their tenant farmer).

Appendix H4. Trees will be replanted on the parcels shown above to mitigate for trees removed from land owned by Burgad Family LLLP.

Appendix H5. Trees will be replanted on the parcels shown above to mitigate for trees removed from land owned by Lyle and Karen Bettenhausen. It is anticipated that some trees will be replaced on the property of adjacent landowner (Jeremy Herr).

Appendix H6. Trees will be replanted on the parcels shown above to mitigate for trees removed from land owned by Sheryl Rohweder.

Appendix H7. Trees will be replanted on the parcel shown above to mitigate for trees removed from land owned by Shirley Branning.