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Best Management Practices Guide for Restoration of Native Grasslands and Sensitive Sites Resulting from Energy or Industrial Development

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The intent of this publication is to serve as a general guide to South Dakota landowners who are considering or who have allowed energy or other industrial development on their property and includes guidance on avoidance, pre-contract negotiations, and post-disturbance restoration or reclamation. Guidance includes common native species suggestions that are generally suitable for most areas of South Dakota. Local adjustments to common native species may be necessary. Landowners should seek additional guidance on specific varieties of plants from local rangeland, habitat, or restoration professionals.

Recent energy development projects have impacted several regions of South Dakota with disturbance to native soils (primarily native grasslands) in the form of individual sites (such as wind turbines or staging areas) and in long linear 'temporary' corridors including roads, access trails, or trenches to accommodate pipelines, power lines, or other construction-phase needs (Figures 2 and 3).

Several resources provide excellent overviews of the pros and cons of renewable energy development (Spellman [2014], Dhar et. al [2019a, b, and 2020], Dai et. al. [2015] and Obermeyer et. al [2011]). One of the key knowledge gaps is the lack of information for best reclamation options and how those options influence overall recovery to a resilient native ecosystem. In particular, the scientific literature often identifies avoidance and/or restoration of native soils and vegetation as a key concern in energy development projects, and individual energy company information (via multiple company websites) clearly indicate an industry norm directed at restoring land and resources

Figure 1: Livestock graze on a native pasture riparian area in the shadow of a newly erected wind turbine in Codington County, SD.

Figure 2: Extensive wide flat corridors are constructed to accommodate crane travel, buried lines, and vehicle traffic across miles of terrain as wind development proceeds. Shown here is a corridor constructed across an existing tame grass hayfield in Grant County, SD.

to *'as closely as possible to the original condition'*. Therefore, three primary considerations for South Dakota landowners to consider are:

1. understanding the 'big picture' of overall wind impacts and siting issues
2. avoidance of the disturbance of native ecosystems and
3. contract negotiation, mitigation and restoration in areas where avoidance is not practiced.

Landowners considering energy development access to their properties or those who have allowed development are encouraged to consider the pros and cons of development activities and openly discuss their options with land managers, ecologists, legal representative or attorney, and industry representatives before entering into binding contracts with energy companies.

Understanding the Big Picture of Energy Development:

It is beyond the scope or intent of this publication to review the complex suite of ecological and human impact concerns associated with energy development. However, it is critically important that landowners self-educate on these topics to gain a balanced understanding of potential impacts to their land, water, and wildlife resources and impacts to their farm or ranch operations. The Nature Conservancy provides a good initial source of understanding wind siting issues at their Site Wind Right Map tool, but landowners are encouraged to visit active energy construction sites and contact local ecological, habitat, or grassland professionals for guidance on key ecological issues related to energy development. See section on professional guidance at the end of this publication or visit Site Wind Right at (https://www.arcgis.com/apps/webappviewer/index.html?id=41b78046860641 5e8dcee36b39045d79)

Avoidance – Native Grasslands and Sensitive Sites ***Cannot*** be Fully Restored to Pre-Disturbance Conditions:

The simplest and most cost effective way to ensure long-term resilience of grasslands or other sensitive ecosystems is to avoid surface disturbance altogether. The South Dakota Department of Game, Fish, and Parks' (SD GFP) Siting Guidelines for Wind Power Projects in South Dakota suggest a common sense approach to development of wind power in native

Figure 3: Large heavy equipment is used in the construction of various energy corridors, including wide-tracked cranes often driven from site to site, requiring wide, flat corridors be built on native land where topography requires leveling and filling.

Figure 4: It is advisable to steer development of corridors toward use of previously disturbed (non-native) land, such as this temporary corridor through a crop field in Deuel County, SD.

Figure 5: It is advisable to steer construction away from sensitive areas, such as native (unbroken) pasture/grassland when possible.

grasslands and other sensitive areas, with avoidance of such habitats as the primary approach, favoring allowing development in previously disturbed landscapes (such as cropland, Figures 2 and 4). A *temporary* road or corridor that manipulates the soil results in a permanent ecological impact. It is impossible to completely restore surface and sub-surface native systems to pre-disturbance condition. Landowners are therefore encouraged to consider avoidance as an option. SDSU Extension provides a statewide public access resource for assisting landowners in various regions of South Dakota in determining if their land is native (previously unbroken or untilled) at its Open Prairie website (Bauman et al. 2015-2020 https://openprairie.sdstate.edu/nrm_data/). Resources provided on this site include detail reports, maps, and data files that can be used at the farm or ranch level to determine native land status (Contact SDSU Extension for more information on access to and use of this resource, Figures 4 and 5).

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Native Grassland Mitigation and Restoration:

If not avoided, the SD GFP and other guidelines suggest that projects in sensitive landscapes consider the collateral impact of roads, transmission lines, substations, etc. While written for wind energy development, these guidelines are generally applicable to all types of industrial or energy disturbance on native grasslands, wetlands, or other sensitive areas in South Dakota (Figure 6).

If considering allowing energy development or other similar access and impacts, landowners should be aware of options and strategies for minimizing damage and ensuring restoration success over time.

Step 1: Partner interests review. A full review of existing easements, contracts, deed restrictions, or other shared interests on the property is necessary. Examples might include various utility easements or term contractual or easement agreements with state, federal, or private organizations. Landowners should ensure all vested parties are aware of any pending development or access decisions. For grasslands and wetlands in South Dakota, examples might include grassland or wetland conservation easements held by the US Fish and Wildlife Service, habitat agreements with SD GFP, or easements and agreements with private conservation groups. Farm Service Agency (FSA) contracts such as Conservation Reserve Program (CRP) acres or Natural Resources Conservation Service (NRCS) contracts like Wetland Reserve Program (WRP), Grassland Reserve Program (GRP), Environment Quality Incentive Program (EQIP), or other Agricultural Land Easement (ALE) program acres may be impacted by such decisions and should be discussed with the partner entity.

Landowners considering energy development or similar access to their land should note that beyond specific regulations that may be in place for surface disturbance on individual tracts of land due to existing easements, contracts, or other agreements, there is

Figure 6: In some cases native hills are leveled (left) and earth used to fill in drainages (right) to create temporary level roads for construction equipment. These temporary corridors result in permanent disturbance areas not easily returned to pre-construction condition.

little regulatory oversight related to the disturbance of native grasslands. So while lack of regulation allows for landowners to allow development, landowners also should be aware that there are no standard regulations to prevent additional or excessive disturbance unless clearly defined in the individual contract. Avoiding unnecessary disturbance and understanding and directing ecologically 'accurate' restoration or reclamation must largely be guided by the individual landowner/operator. It should not be assumed that any individual energy company's standard procedures will necessarily mitigate all factors specific to each site, and customized language for disturbance and restoration specific to the site may be necessary to achieve the stated goal of returning the land to original condition. Finally, landowners should inquire from energy developers if any necessary permits have been or will be acquired related to disturbance of sensitive ecological, historic, or cultural sites and may want to include specific language related to those concerns in access agreements or contracts.

Step 2: Understand the language. A general review of energy company websites and stated guiding principles related to restoration conveys a general intent to minimize short and long term damage to land and resources. Common posted language includes statements similar to the land 'will be returned as closely as possible to the original condition'. While reflecting good intentions, the interpretation of the language and what 'original' implies can be vague and should be discussed thoroughly prior to contract finalization. Landowners should assume that energy companies likely will not have a good understanding of the ecological integrity of their site. Landowners should consider their essential role in directing restoration priorities and consider that a return to 'original' should address, at a minimum, the following: preservation and sorting of soils, return of soils to appropriate horizons, documentation of contours and slopes to be re-established, erosion control, riparian area protection, and a return to a full suite of existing native vegetation (Figure 7). How specific each project is in any given category is largely up to the landowner, but adequate consideration to all is important.

Step 3: Consider and negotiate long-term restoration management expenses. A review of several energy company websites shows that generally reclamation and restoration priorities include replacement of soil, establishment of vegetation cover, and replacement of infrastructure removed during the construction phase, such as fences. What is not adequately addressed is the longer-term needs to ensure success of the restoration investments. Shorter-term vegetation management including specific and well-timed tools and techniques is often necessary to achieve long-term success, and these needs should be addressed in the contract as they often require additional investments of labor, equipment and supplies for actions such as planting, weed control, and management (see guidelines below).

It may be suggested that the restoration process can be hurried along through use of non-native invasive species, which is not advisable. Native grassland restoration can often take two to five, and even up to ten years to achieve 'success', which can be generally defined by healthy and stable native plant communities, no erosion, adequate ground cover, no noxious weeds, limited invasive species, and a return to previous functionality or income potential (grazing, haying, habitat, or other). Landowners should ensure contract language adequately addresses these goals through inclusion of responsibility for labor, material, time, or expenses relative to post-restoration management over time. This language should consider potential future actions such as fencing livestock out of restoration zones, livestock water, lack of economic return on haying or grazing income lost on the affected land, and annual weed control such as mowing, spraying, grazing, or fire as necessary.

General Guidelines for Landowners to Consider:

Dhar et. al (2019) provide points of concern when considering restoration or reclamation of land impacted by renewable energy development including salvaging and re-using topsoil in a timely manner to avoid loss of native soil seed bank health, revegetation of sites with appropriate species, controlling erosion, avoiding invasion of undesirable plants (non-natives, invasive, and noxious), and monitoring results over time. Further, they also provide a list of avoidable concerns to be mitigated during the restoration process including, but not limited to: heavy grazing during the recovery period, insufficiently salvaged top soils, erosion, and soil compaction. These factors can lead to overall reduction of desirable species

establishment and an increase in undesirable species invasion. All considerations should be adequately addressed in any land access or use contract. Contracts are legally binding, and landowners should not assume any support or investment by energy developers beyond what is defined in the contract. Therefore, contract language must be comprehensive and clearly reflect long-term goals and expectations.

a. **Soil removal and replacement.** Scientific literature suggests that soil removal and storage methods may be important to ensuring that the vegetation community has an opportunity to re-establish from the replaced topsoil (i.e. seedbank). While likely not an adequate sole-source of future vegetation, stockpiled topsoil should be separated from lower soil horizons (layers) and returned to its original position in the soil profile (Figure 7).

Figure 7: Extensive manipulation of native grassland soils can occur with energy contracts. Example of topsoil intentionally stockpiled (top) for future restoration while sub-surface soils are used to level other areas (bottom). Erosion of temporarily stored soils can be a concern if not adequately managed.

Landowners should consider monitoring the construction process through sensitive areas and work with the developer to ensure soils are seperated and a clear plan for returning soils in the appropriate order is adhered to, lest soils become mixed, and compromises the ability to support appropriate native species (Figure 8). In addition, management of rock piles and other artifacts of construction should be agreed upon (Figure 9).

Figure 8: Mixing of soils horizons should be avoided during construction across native sites to ensure topsoil is replaced appropriately, allowing for the best possible opportunity for native seed in the seed bank to germinate and re-establish on disturbed corridors, such as this trench used to bury wind tower cables in Deuel County, SD.

Figure 9: Management of rock piles and other debris should be discussed during contract negotiations.

b. **Erosion control.** Extensive surface disturbance in areas with varying topography can lead to erosion issues during construction and after restoration if soils are not adequately protected. Erosion control may be necessary (Figure 7). Landowners may consider contract language that includes the use of seed-free vegetative erosion blankets that allow

plant growth, similar to those used in highway construction projects.

c. **Seedbed preparation.** Once soil is replaced, seedbed preparation is important. A smooth, well-packed upper soil layer is often most conducive to establishing native grasses and broadleaf plants. Well contoured edges ensure that future management (mowing, spraying, or other) can be achieved without undue equipment damage.

d. **Seeding methods.** There are several sources of seeding information. South Dakota NRCS provides general guidance on seed rates, seed mixes, etc. that can be of value to landowners faced with reclaiming disturbed areas in the Perennial Vegetation Establishment Guide (Range Technical Note No. 4). Landowners should be aware that the NRCS technical guidance only 'officially' applies to those projects where NRCS is involved. Landowners considering rangeland restoration, but with no ties to USDA programs should become familiar with the NRCS technical guide as a valuable reference resource but are not bound to the rules therein unless receiving direct financial or other support through USDA programs (SD NRCS 2020). Because it is a general guidance, the NRCS tech guide includes options for non-native species in certain portions of the document. We recommend only use of native species when restoring or reclaiming disturbance corridors on native pasture, grasslands, rangelands, riparian zones, or sensitive sites (See List 1).

   i. **Drilling seed.** Drilling is a common method of seeding, and works well with processed purchased seed, especially if there are specific planting population or pure live seed (PLS) per acre objectives. Benefits to drilling generally include ensuring good to excellent seed to soil contact and the ability to monitor seed rates. Appropriate planting depth is a critical step in planting native species with a seed drill, and an experience drill operator is an important factor in successful native restoration.

   ii. **Broadcasting seed**. Broadcasting seed over well-prepared soils is another proven method of seeding and works well for both purchased seed and is particularly useful for fluffy or bulk-harvested native seed. Benefits to broadcasting include generally easier or faster seeding in rough or inaccessible areas and can provide for a more complete seeding coverage in certain conditions. Broadcast seeded sites can often be lightly harrowed to gently mix seed with topsoil. Broadcast seeding can be performed in a greater variety of soil or surface conditions, including snow cover. Broadcasted seed is also more susceptible to movement from wind and water. Landowners should work with experienced restoration professionals and energy companies directly to discuss preferred seeding methods for conditions on their property (see Professional Guidance section of this fact sheet).

   iii. **Spiking.** Spiking is an emerging method of adding a few native broadleaf species to a typical seed mix at a very high rate, typically 3 to 10 times the normal recommended seed rate (Comeau et. al 2020). The concept behind spiking is that these species fill in gaps and compete against undesirable invasive species. In trials researchers added higher rates of 3-5 selected native broadleaf plants (forbs) into the seed mix to provide intense competition for Canada thistle. The native broadleaf plants (forbs) were selected on practical measures of:
      1. Availability
      2. Affordability
      3. Seeds per pound
      4. Quick establishment characteristics
      5. Ability to be competitive.

      While it is somewhat premature to suggest this method of spiking competitive forbs into diverse seed mixes to control Canada thistle or other invaders will work in all cases, the initial results are encouraging and may point to an approach that allows natural competition to relatively expensive native plantings.

e. **Seed sourcing.** Landowners involved in restoration of native land should only consider use of native species with strong preference toward sourcing the most local seed practically available. When considering seed sources, landowners should ask the

seed supplier directly about the source of the species in the mix, as multiple sources may be used for a single species as well as across multiple species. Seed should be weed free and of adequate germ quality. South Dakota Game, Fish, and Parks guidelines suggest use of certified weed-free native seed of local variety or ecotype and non-native (exotic) species should be avoided when restoring disturbance corridors through native sites (Article 12:36 of South Dakota codified law addresses commercial seed inspection criteria).

f. **Seeding timing.** South Dakota NRCS provides some general guidelines for planting cool and warm season species in its Perennial Vegetation Establishment Guide (Range Technical Note No. 4). Generally speaking, a mix of native cool and warm season grasses and forbs should be drilled as soil conditions allow after November 1 in the fall or prior to May 15 in the spring or broadcast anytime between Nov 1 and May 15 (SD NRCS 2020). Again these dates serve as a general guideline and, more or less, reflect average dates to hedge against the seed germinating in the fall or soils becoming too hot and dry in the spring. Early arrival of cold fall weather or cool and wet spring weather can shift these recommended dates up to 2 weeks either way in most years. Landowners should monitor weather conditions in their area accordingly and seek the advice of trained restoration professionals.

Avoidance of disturbance is the only assurance to keep native ecosystems intact. Landowners wishing to return their property and vegetation community to 'original' condition after energy development must first understand that once heavily disturbed, return to 100 percent original is not realistic and cannot be achieved.

g. **Seed mixes.** For the purposes of this general guidance, SDSU Extension worked with experienced staff from a variety of state, federal, and private organizations with extensive experience in grassland restoration in this region. Landowners wishing to return their property and vegetation community to 'original' condition must first understand that once heavily disturbed, return to 100 percent original is not realistic and cannot be achieved, and thus landowners should set practical goals for a reasonable and functional system. Depending on location, condition, and management history, native grasslands may harbor anywhere from 50 to over 200 species of plants, many of which are difficult to harvest or propagate or are not easily purchased due to price or lack of availability. Therefore, we have developed a general list of reasonably attainable native plants that are common to most native grasslands in the region with the intent of providing landowners an attainable, practical, and defensible species mix when negotiating restoration with energy companies (List 1). In no way are landowners bound to use this suggested mix, and individual landowners may choose to request any variation of native plants for their own site. List 1 provides a list of recommended native species that can be used as a single mix for most locations and soil conditions. Not all species are specifically suited to all soils or hydrology, but this general mix contains species in all categories and thus should

Figure 10: Natural species composition of native sod can vary greatly based on soils and hydrology. Landowners may need to consider additional appropriate species for saturated riparian areas (top) and dry upland prairie areas (bottom).

establish a majority of species under various soils and planting conditions (Figure 10). Landowners are encouraged to explore additional species for specific applications if necessary.

h. **Do not fertilize.** Do not fertilize native plantings. Generally, native plants do not benefit from artificial fertilization. Fertilizer tends to promote establishment of invasive exotic or noxious species, increasing the need for costly future management.

i. **Avoid non-native species.** Do not include exotic (non-native) or invasive species into native grassland or wetland systems seed mixes. Contractors, seed suppliers, and landowners often gravitate toward non-native species for quick establishment of soil cover, as many of these species have characteristics that favor fast establishment in many soil and weather conditions. However, these characteristics also make these species aggressive invaders, and they can often easily move throughout a landscape by wind, water, or animals and can invade and compromise the integrity or quality of a native pasture or grassland system. List 2 provides a list of common non-native species that should be avoided in any native rangeland restoration project.

j. **Plan for future management.** Native grassland species restoration management is a process of utilizing tools and techniques that either stimulate and improve the health of the native plants or harm and otherwise decrease the health of the undesirable or invasive plants, or both. Understanding growth characteristics of both the desired native plant community and the invasive plants will lead to the correct future management action in relation to timing, intensity, duration, and which tool(s) to use or avoid during the establishment or maintenance phases. Future management of disturbed sites should be carefully considered when negotiating energy development access contracts and agreements should reflect the true cost of labor and materials over a mutually agreed upon period of time.

    a. **Establishment phase (typically years 1 to 5)**
        i. Generally, this is the phase that includes planting and planned actions for stimulation of native species and control of invasive species. This is a critical period where management actions can greatly influence long-term success or failure of the planting.
            1. **Assessment.** It is critical to continually evaluate the growth of the planting throughout the first growing season to determine if native species are establishing. Usually, native and non-native early invaders will germinate first and often include exotic species such as smooth brome, green fox, lambsquarters, sweet clover, Canada thistle, etc. Expect some of these species to occur ahead of the native plant community emerging. Identifying invaders in a timely manner will help determine appropriate additional actions.
            2. **Chemical treatment.** In some instances, early invasion of exotic or undesirable species may call for a chemical application. Specific chemistries and rates will be situational and should be discussed with a trained grassland or habitat professional. Chemical coaching from those unfamiliar with the biology of the planted native species should be avoided, such as cropland agronomists or spraying service providers (although these entities may ultimately provide the chemical application service to the landowner). Chemical treatments on well-established native plantings should be carefully considered as chemicals are often non-selective and may harm or kill desired species.

3. **Mowing.** For the most part, mowing both invasive weeds and native plants several times during the first two growing seasons generally helps the health and vigor of the slower growing native plants while generally hindering the establishment of quick-growing invasive weeds. Again, professional coaching is encouraged, but landowners can do little harm by mowing restoration plantings.
4. **Grazing.** Managing grazing on disturbed energy corridors, such as roads or trenched areas, can be difficult. Generally, grazing should be avoided on native restoration plantings in these corridors during the first two growing seasons, allowing the native plants time to firmly establish root mass which allows the plants to be more resilient to the impacts of grazing, avoids uprooting by livestock, and results in faster recovery times. Grazing avoidance may require significant investment in labor and materials such as temporary or semi-permanent fence and possibly livestock water access materials.
5. **Fire.** Generally, prescribed fire has proven an excellent tool for establishment of management of new native plantings. Well-timed fire stimulates native plant growth while hindering exotic invaders. Burning energy corridors through larger grasslands may pose certain challenges but can be very manageable if the corridors are fenced off and the adjacent pasture is grazed to the point that fuel loads are limited. Typically, landowners should consider late May as a targeted timeframe for fire management on energy corridors, as exotic species are most susceptible to control and surrounding grazed grasslands are often green and less likely to burn at this time.

b. **Maintenance phase (typically years 5 to 10)**
    i. Generally, this phase requires monitoring and maintenance and may require occasional specific action to manage the plant community, but is generally not as intensive as the establishment phase. It is important to continue to evaluate the plant community throughout the growing seasons. Typically landowners will gain a good understanding of the success or failure of the planting during this period. Healthy native plant community establishment will generally continue to persist, but may require occasional targeted management actions to ensure community health. Persistent invasion by exotic species or noxious weeds may require adjustments to timing and intensity of management actions, including a return to grazing or chemical applications in some cases. If unsure, landowners should discuss options during this period with a trained grassland or habitat professional (see Professional Guidance section of this publication).

c. **Recovered phase (10 years and beyond)**
    i. Generally, by this time the plant community is mature and is likely what it will be under the management regime and change (positive or negative) is not as immediately responsive to management actions. Continued control of persistent invasive species issues may be necessary, but landowners should consider integrating management of the corridor into the management of the whole area by this time.

List 1. Common native grassland species to be used in a general seed mix for restoration or reclamation of native grassland, riparian, or wetland corridors across various soil types in eastern South Dakota. Note that not all species will germinate in all conditions, but this mix contatain adequate variety to allow a practical one-pass planting option on linear reclamation corridors.

Common Native Warm Season Grasses

- big bluestem
- indiangrass
- little bluestem
- prairie cordgrass
- prairie dropseed
- prairie sandreed
- sideoats grama
- switchgrass

Common Native Cool Season Grasses

- Canada wildrye
- green needlegrass
- slender wheatgrass
- western wheatgrass

Common Native Forbs/Shrubs

- black-eyed susan
- blanketflower
- anemone
- common milkweed
- cudweed sagewort
- dotted gayfeather
- daisy fleabane
- purple coneflower
- golden alexander
- prairie coneflower
- hoary vervain
- maximillian sunflower
- blazing star
- annual sunflowers
- western yarrow
- wild bergamot
- American vetch
- Canada milkvetch
- purple prairie clover
- white prairie clover
- wild rose/prairie rose
- leadplant
- western snowberry

List 2. Common invasive exotic species to be avoided in restoration or reclamation of native grassland projects in eastern South Dakota

Common Exotic Grasses to avoid

- creeping foxtail (Garrison or other)
- crested wheatgrass
- fescue (tall or hard)
- intermediate wheatgrass
- smooth brome
- meadow brome
- Kentucky bluegrass
- pubescent wheatgrass
- tall wheatgrass
- orchardgrass
- timothy
- reed canarygrass

Common Exotic Forbs to avoid

- alfalfa
- bird's foot trefoil
- cicer milkvetch
- hairy vetch
- red clover
- sainfoin
- sweetclover (white and yellow)
- white clover

Note: Tables 3-7 of NRCS' Perennial Vegetation Establishment Guide provide a comprehensive list of individual species characteristics including such considerations as bloom period, nitrogen fixation, toxicity to livestock, seedling vigor, drought tolerance, suitable soil types, etc. (SD NRCS 2020).

Professional Guidance: on Resource Reclamation or Restoration Contact Rangeland, Grassland, Habitat, or Restoration Staff at:

- SDSU Extension
- SD Department of Game, Fish, and Parks
- Natural Resources Conservation Service
- US Fish and Wildlife Service
- Pheasants Forever
- The Nature Conservancy
- Ducks Unlimited

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